

Combined Congress

Bloemfontein

21 – 25 January 2019



UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



UFS·UV
NATURAL AND
AGRICULTURAL SCIENCES
NATUUR- EN
LANDBOUWETENSAPPE

Combined Congress 2019 – Participating Societies

Gesamentlike Kongres 2019 – Deelnemende Verenigings



Southern African Society for Horticultural Sciences

**Suider-Afrikaanse Vereniging vir
Tuinbouwetenskappe**

E-mail: karin@arc.agric.za

Website: www.sashs.co.za



South African Society of Crop Production

Suid-Afrikaanse Vereniging vir Gewasproduksie

E-mail: admin@sascp.org.za

Website: www.sascp.org.za



Southern African Weed Science Society

Suider-Afrikaanse Vereniging vir Onkruidwetenskap

E-mail: dewth@arc.agric.za

Website: www.weeds.org.za



Soil Science Society of South Africa

Grondkunde Vereniging van Suid-Afrika

E-mail: admin@soils.co.za

Website: www.soils.org.za

CONTENTS

Organising Committee & Acknowledgements	3
Message from Chairman of the Local Organising Committee	4
Programme	5
Abstracts: Keynote Presentations	11
Abstracts: Oral Presentations	14
Abstracts: Poster Presentations Horticultural Science	145
Abstracts: Poster Presentations Crop Science	170
Abstracts: Poster Presentations Weeds Science	214
Abstracts: Poster Presentations Soil Science	223
Notes	247

Local Organising Committee

Dr James Allemann
Dr Cobus Botha
Dr Gert Ceronio
Dr Gesine Coetzer
Dr Elmarie van der Watt
Mrs Lize Henning
Mrs Nancy Nortjé

Acknowledgements

Workshop: ***Conservation Agriculture***

Prof J Annandale, Prof M Laker, Prof R van Antwerpen, Prof E Verster,
Dr C Botha, Dr W de Clerq, Dr N Cook, Dr E Hugo, Dr G Nortjé, Dr P Raath, Dr H Smit,
Dr J Strauss, Dr P Swanepoel, Dr N Taylor, Dr J van Biljon, Dr M van der Laan,
Mr Lindeque, Mr A Mostert

Reviewers: Our sincerest gratitude to all the editors and reviewers

General Support: Staff and students of the Department of Soil, Crop and Climate Sciences,
University of the Free State, Bloemfontein

Photo: Dijon Pienaar (Front page)

Venue: University of the Free State

Message from the Local Organizing Committee (LOC)

Dear Delegate, it is the privilege of the LOC to present to you the Combined Congress 2019 in the heart of the Free State, Bloemfontein. We are indebted to the Bloemfontein Main Campus of the University of the Free State for their open-hearted gesture of providing their facilities and support in hosting this congress on their premises. The Combined Congress 2019 is co-presented by the Southern African Society for Horticultural Sciences (SASHS), the South African Society for Crop Production (SASCP) the Southern African Weed Science Society (SAWSS) and the Soil Science Society of South Africa (SSSSA). The theme **“A dynamic environment moulds the future”** could not be more appropriate for a season and year such as the one we are currently experiencing.

All that remains is but autumn in spring and winter in summer. Until now clouds of hope were rolling by in great parts of the country, simultaneously taking along the hope, leaving clear skies and a blazing sun. Patches of green turn to gold and in many instances into dust clouds. Hope, hope for desperately needed rain keeps hope alive. When we gather for the opening of this congress, we believe that this source of life has arrived to drench soil, and the green has sprouted from the soil. Research and the better understanding of science is but one factor that provides hope, and is the reason for gatherings such as this. The mere existence of Congresses is ensured by presentations of delegates and especially the support of sponsors. We would therefore like to voice our appreciation to the thoughtful contribution of sponsors during challenging times. Some are regular supporters and we are privileged to welcome new supporters to our family. We are indebted to all who deem the above mentioned subject areas important enough to invest in showcasing progress in these scientific areas. The names and logos of all are published and displayed in numerous ways during the congress. Some of the sponsors have representatives present and you are invited to acquaint yourself better with these, and explore possibilities for cooperation.

Prof. Danie Vermeulen, Dean of the Faculty of Natural and Agricultural Sciences will present the opening address. Participating societies have selected distinguished keynote speakers, who are listed in the programme, to address delegates during the plenary session. We are confident that their valued contributions will be inspirational and stimulate scientific rational. The LOC is also confident that the participating societies have gone to much trouble to ensure the quality of presentations and express their gratitude to the reviewers. More than 300 delegates from both public institutions and private sectors are expected to attend this congress. One hundred and thirty (130) oral and ninety eight (98) poster presentations will be made in four concurrent sessions in the comfort of a single building. A Workshop on “Conservation Agriculture” will replace excursions this year. We are confident that this will be of great value to the private sector but also will include farmers.

We, the LOC of the Combined Congress 2019, thank you for having decided to attend this congress and wish every delegate a safe and comfortable stay in Bloemfontein.

Gert Ceronio
for LOC Bloemfontein 2019

Monday 21 January 2019		
Time	Event	Venue
15:00 – 18:30	Registration	Centenary Complex – 29° 6'44.45"S 26° 11'13.39"E
15:00 – 18:30	Mount Posters	Economic and Management Sciences Building Foyer – 29° 6'31.97"S 26° 11'8.24"S
19:00 – 20:30	Cocktail	Centenary Complex

Tuesday 22 January 2019			
Time	Event	Venue	
07:00 – 08:30	Registration	Economic and Management Sciences Building Foyer	
PLENARY SESSION – Room ALG2			
08:30 – 08:45	Welcome	Dr Gert Ceronio	
Keynote addresses			
08:45 – 09:15	Opening address	Prof. Danie Vermeulen	If you can't measure it you can't manage it
09:15 – 09:45	SASHS	Prof. Umezuruike Linus Opara	Africa's food challenge and the role of horticultural research
09:45 – 10:15	SASCP	Mrs. Desiree van Heerden	The Fall Armyworm, one more devastating new pest to combat in a sustainable agricultural environment
10:15 – 10:40	MORNING TEA – Economic and Management Sciences Building Foyer		
10:45 – 11:15	SAWSS	Mr. Leonard Oberholzer	Future of weed management
11:15 – 11:45	SSSSA	Prof. Rattan Lal	Soil surface management for carbon sequestration
11:45 – 12:50	LUNCH – CENTENARY COMPLEX		

FIRST CONCURRENT SESSION - Tuesday 22 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Modelling	Hort Physiology	Soil Fertility	Weeds
	Prof John Annandale	Dr Karin Hannweg	Prof. Jude Odhiambo	Dr James Allemann
13:00 – 13:20	Improving the performance of crop models by using remote sensing data – Dlamini L	Sugar and calcium concentration of 'Gem' and 'Ryan' avocado fruit during fruit development – Bertling I	Growth and yield responses of maize to sole and combined winery solid waste compost and inorganic fertilizer application rates – Masowa MM	Floristic composition of weed species in rooibos fields – Ferreira MI
13:20 – 13:40	Heat stress in potato: how hot is too hot? – Franké AC	Effect of glucose pulsing on early season 'Hass' skin colour development during ripening – Mathaba N	Assessing soil C sequestration potential and decomposition rates of different wheat residues – Mbava NO	Hierarchical ranking of <i>Urochloa mosambicensis</i> (Bushveld Herringbone grass) and <i>Urochloa panicoides</i> (Herringbone grass) competitiveness in four soil environments – Craven M
13:40 – 14:00	Long-term effects of inorganic fertilizer application on maize yield (<i>Zea mays</i> L.) and soil quality – Maseko SK	Effect of methyl jasmonate on skin colour change of 'Hass' avocado fruit during ripening – Setagane L	Biochar derived from poultry litter as an alternative soil amendment to improve nutrient availability of three different soil types – Lusiba SG	Striga resistance and compatibility of maize genotypes with <i>Fusarium oxysporum</i> f.sp strigea – Shayanowoka AIT
14:00 – 14:20	Integrating a crop model with a farm focused greenhouse gas calculator to identify low carbon agricultural intensification options for smallholder farmers in rural South Africa – Rusere F	Stimulatory effects of plant growth regulators on kiwifruit (<i>Actinidia</i> spp.) stem cuttings at low, medium and high concentration levels – Sekhukhune MK	Poultry litter application increases N and P availability and CO ₂ emission from humic soils – Mkhonza NP	War of the weeds: Allelopathic effects of <i>Amaranthus</i> on Ryegrass – Allemann I
14:20 – 14:40	Development of knowledge engines for use as advisories – Walker S	Manipulating flowering time to produce lemon fruit out of season – Krogscheepers C	Effects of land use on stocks and vertical distribution of pools of soil carbon in selected humic soils - Malepfane NM	Does target-site resistance occur in South African wild oats (<i>Avena fatua</i>) biotypes? - Nienaber H
14:40 – 15:00	Crop response to sulfate salinity – Ronquest ZD	Stomatal regulation of transpiration and photosynthesis in macadamias – Taylor NJ		
15:00 – 15:25	AFTERNOON TEA – Economic and Management Sciences Building Foyer			
SECOND CONCURRENT SESSION - Tuesday 22 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Agrometeorology	Hort Production & Cultivation Practices	Soil Physics	Hort Indigenous & Medical plants; Crop protection and Rural development
	Prof Sue Walker	Dr N Mathabata	Dr Rianto van Antwerpen	Dr Zelda Bijzet
15:30 – 15:50	Integrating seasonal forecast information with crop models for improved climate variability management in farming - Mkuhlani S	Variance components of fruit quality – a 'Golden Delicious' case study - Van Lingen A	Effectiveness of conservation tillage to minimise greenhouse gas emissions and its impact on microbial activity, C & P sequestration in comparison with conventional tillage - Vilakazi BS	Value-adding potential of pomegranate fruit to reduce post-harvest losses: a cosmeceutical perspective – Fawole OA
15:50 – 16:10	Selection of wheat for biomass allocation to improve drought tolerance and carbon sequestration into soils – Mathew I	Evaluation of apple rootstocks planted in different locations in South Africa – Sibozza XI	Long-term impact of no-till conservation agriculture on soil aggregate stability, infiltration and distribution of C in different size fractions – Sithole NJ	Using a computer-based model to establish the fit-for-purpose criteria for botanicals in health systems – Mashela PW
16:10 – 16:30	Effect of cover crop utilisation on wheat production – Smit EH	Impact of drape nets on avocado (<i>Persea americana</i> mill.) cultivars yield - Rathumbu O	The role of conservation agriculture on soil hydraulic properties and carbon sequestration is soil and climate dependent - Tesfamariam EH	Concentration and application interval of Nemarioc-AL phytonematicide for managing root-knot nematode population densities in potato production – Pofu KM
16:30 – 16:50	Evaluation of terminal drought tolerance in selected cimmyt bread wheat (<i>Triticum aestivum</i> L.) genotypes – Thungo ZG	The effect of Cloprop on pineapple yield and fruit quality – Rabie EC	The role of water conservation strategies and benchmark ecotopes for increasing yields in South Africa's semi-arid croplands – Botha JJ	Improving smallholder vegetable marketing in Gauteng province: results from a value chain analysis – Ndou PN
16:50 – 17:10	Early generation selection of wheat genotypes for drought tolerance and agronomic traits – Shamuyarira KW	Effects of growth media on the growth of mmupudu (<i>Mimusops zeyheri</i>) seedlings in the nursery – Tautsagae AC	Leachate migration potential of a duplex soil type at the Bloemfontein southern solid-waste landfill - Mavimbela SSW	Group cohesion and member retention for enhanced production in agricultural community-based projects in Gauteng – Taruvinga B
17:10 – 17:30	Assessing the vulnerability and adaptive capacity of water, energy and agriculture sectors in Southern Africa –Mpandeli S	Seed germination and emergence of two <i>Cyrtanthus</i> species - Sibande NN		
19:00 – Late	BRAAI – FREE STATE BOTANICAL GARDEN – GPS Co-ordinates – 26°12'42.2"E 29°03'10.7"S / End of Rayton Rd continue on Bloemdal Rd off Dan Pienaar Drive			

CONSERVATION AGRICULTURE WORKSHOP - Wednesday 23 January 2019					
Time	ALG2				
	CONSERVATION AGRICULTURE				
07:00 – 07:30	Registration of participants not attending Combined Congress				
07:30 – 07:35	Opening and welcome	Prof M Laker			
07:35 – 07:45	Aims and procedure of workshop	Dr C Botha			
07:45 – 08:05	Introduction to conservation agriculture	Dr J Strauss			
08:05 – 08:25	No-till conservation agriculture in rainfed annual crop production	Dr H Smith			
08:25 – 08:45	Conservation agriculture systems other than no-till in rainfed annual crop production	Prof R v Antwerpen			
08:45 – 09:05	Conservation agriculture in orchards and vineyards	Dr P Raath			
09:05 – 09:25	Conservation agriculture in irrigated agriculture	Dr W de Clerq			
09:25 – 11:45	Soil fertility management in conservation agriculture	Dr G Nortjé			
09:45 – 10:00	Importance of detailed soil surveys in conservation agriculture	Prof E Verster			
10:00 – 10:15	Responsible weed control in conservation agriculture	Dr E Hugo			
10:15 – 10:40	MORNING TEA – Economic and Management Sciences Building Foyer				
10:40 – 11:50	BREAK AWAY GROUPS				
	ALG2	ALG8	AG2	AG3	AG4
	Group 1 - Dr P Swanepoel	Group 2 - Mr L Lindeque	Group 3 - Dr N Cook	Group 4 - Prof J Annandale	Group 5 - Mr A Mostert
	No-till conservation agriculture in rainfed annual crop production	Conservation agriculture systems other than no-till in rainfed annual crop production	Conservation agriculture in orchards and vineyards	Conservation agriculture under irrigation	Soil fertility management in conservation agriculture
11:50 – 12:40	REPORT BACK FROM BREAK AWAY GROUPS ON CONCLUSIONS AND RECOMMENDATIONS				
11:50 – 12:00	Group 1	Dr J Strauss			
12:00 – 12:10	Group 2	Dr C Botha			
12:10 – 12:20	Group 3	Dr N Taylor			
12:20 – 12:30	Group 4	Dr M van der Laan			
12:30 – 12:40	Group 5	Dr Johan van Biljon			
12:40 – 13:20	DELIBERATIONS ON FEEDBACK FROM BREAK AWAY GROUPS AND FORMULATION OF DECISIONS AND RECOMMENDATIONS FROM WORKSHOP				
13:20 – 13:30	CLOSURE				
13:30 – 14:30	LUNCH – CENTENARY COMPLEX				

THIRD CONCURRENT SESSION - Wednesday 23 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Production	Hort Physiology	Soil Biology	Hort Nutrition & Water manage. & Production Practices
	Dr Elbé Hugo	Dr Xolanie Soboza	Prof Jude Odhiambo	Dr Niolette Taylor
14:40 – 15:00	Impact of long-term production management practices on wheat grain yield under a semi-arid climate - Seepamore KM	Fruit for thought: the Kei apple as an indigenous fruit with agro-processing potential – Hajari E	Characterization of the relationship between soil physicochemical properties and macrofauna in organic and conventional wheat - Mamabolo E	The dual-purpose of orange-fleshed sweet potato (<i>Ipomoea batatas</i> var. Bophelo) for improved nutritional food security – Nyathi MK
15:00 – 15:20	Evaluation of row width and plant population for conservation agriculture maize and soybean in the eastern Free State - Visser MH	Apple rootstocks influence leaf gas exchange responses to water stress – Muchena L	Quantifying the soil alteration response following irrigation with diluted winery wastewater in soils of dissimilar textures - Meyer AH	Effect of time-based hot air drying method on mineral elements of <i>Jatropha zeyheri</i> tea - Mutshekwa N
15:20 – 15:40	Evaluation of tine and disc openers for wheat production in soils of different qualities and through various levels of stubble – Magenuka L	Evaluating dormancy management practises and different planting methods for containerised apple (<i>Malus domestica</i> Borkh.) nursery trees - Truter W v H	Identifying indigenous non-agricultural uses of soil by selected communities in Kwazulu-Natal, their safety for use and understanding the soil properties governing these uses - Hlatshwayo NI	Adoption of technology and remote sensing for irrigation scheduling by farmers in the Breede River Catchment – De Witt M
15:40 – 16:00	Diverse management in conservation agriculture cropping systems improve weed management and sustain wheat yields whilst reducing inputs – Strauss JA	Profiling sugar metabolism and accumulation in plums grown in South Africa as related to cultivar difference, postharvest storage regimes and maturity – Majoni T	Short-term change in soil organic carbon and labile carbon pools as attributed by tillage, crop residue and crop rotation management in a sweet sorghum-based cropping system - Malobane ME	Seed potato sprouting pattern in response to foliar applied paclobutrazol and storage conditions – Jokazi KB
16:00 – 16:20	Water use efficiency of potato production systems in the Sandveld region of the Western Cape – Kayes MJ	Effects of edible coatings on storage life and quality attributes of plums – Riva SC	Negative or positive: Impact of genetic modification of Bt maize on ecosystem functioning? - Adeleke RA	Growth, yield and yield components of two amaranth species in response to poultry manure application – Matshona LE
16:20 – 16:45	AFTERNOON TEA – Economic and Management Sciences Building Foyer			
FOURTH CONCURRENT SESSION – Wednesday 23 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Nutrition & Water management	Hort Post-harvest biology	Soil Physics, Genesis, Classification, Mapping	Crop Agrometeorology
	Dr Annelie Barnard	Mr Mark Penter	Dr Kobus Anderson	Dr Michael van der Laan
16:50 – 16:10	Effect of granular and liquid applied nitrogen fertiliser topdressings on yields and yield parameters of spring wheat (<i>Triticum aestivum</i> L.) under controlled glasshouse conditions - Mbangcolo MM	Effect of pre-treatment on quality attributes of dried pomegranate arils during long shelf life - Mokapane FM	Soil ecotope benchmarking in two bioresource units in Kwazulu-Natal: implications for farm planning and management - Barichievy KR	Enhanced learning of undergraduate Agronomy students through creation of social media items aimed at technology transfer to small-scale farmers – Oberholster M
16:10 – 16:30	Ecological sustainability of potato production systems in the North West Province – Steyn MJ	The detection of unripe banana flour adulteration with wheat flour using near infrared spectroscopy and chemometrics – Ndlovu PF	No soil, no vegetation, no wildlife, and no eco-tourism - a case study of Kleins' Camp Concession (KCC) in the Serengeti National Park, Tanzania - Nortjé GP	Effect of rainfall variability on maize varieties: A case of smallholder farming in Hwedza, Zimbabwe – Mugiyi H
16:30 – 16:50	Variability of nitrogen fixation by legumes in response to nitrogen and phosphorous – Chibarabada TP	Determination of pre-symptomatic biochemical markers related to peteca spot in 'Eureka' lemon – Rikhotso MM	Soil erosion prevention is better than cure, in South Africa's only large river network without a dam - Le Roux J	Assessing variability in resource use efficiencies of smallholder potato farms: A case of Gert Sibande in Mpumalanga Highveld and Etshewini in KwaZulu Natal – Sekoboane EI
16:50 – 17:10	Irrigation with mine affected waters - Annandale JG	Quality loss assessment and changes in vitamin C content of sweet peppers in the Tshwane market supply chain – Monama RG	Simulated rainfall-induced soil surface crusting and its effects on infiltration, runoff and soil loss - Mrubata K	Smallholder Irrigation scheme Farmers' Performance in Tshiombo Irrigation Scheme Limpopo Province, South Africa – Mwadingeni L
17:10 – 17:30				How will the projected new climate affect crop growth suitability over West Africa? – Egbebiyi TS

FIFTH CONCURRENT SESSION - Thursday 23 January 2019				
	ALG2	ALG8	AG2	AG3
	Crop Physiology & Production	Hort Indigenous & Medical Plants	Soil Technology	
	Prof Martin Steyn	Dr Riana Kleyhans	Dr Cobus Botha	
08:30 – 08:50	The efficacy of priming with <i>Moringa oleifera</i> leaf extract for Bambara groundnut (<i>Vigna subterranea</i> L.) seed invigoration of a landrace with different seed coat colours – Miya SP	Effect of harvesting methods, plant density and nitrogen application rate on nitrogen use efficiency and yield of <i>Amaranthus tricolor</i> L. – Seetseng KA	The medium-term effects of tillage reduction on the functions describing the vertical distribution of soil organic carbon in maize production systems on Oxisols – Wiese LD	
08:50 – 09:10	Determining the ecosystem service provided by wild bee species on open field grown tomatoes – Kgaphola RN	Seasonal variations of yield and essential oil constituents of <i>Artemisia afra</i> growing wild along the selected in-land regions of the Eastern Cape Province – Mpambani B	Soil salinity management; Questionnaire results on farmer perceptions, knowledge levels and practices - Jumman A	
09:10 – 09:30	Root phenotyping wheat for an ever changing world – Barnard A	Response of <i>Moringa oleifera</i> trees to different soil types under microplot conditions – Maake LP	Site-specific determined fitness-for-use of irrigation water using electronic decision support - Du Plessis HM	
09:30 – 09:50	Evaluation of bio-slurry application rates and soil management options on dryland maize production under in-field rainwater harvesting – Khamkham TI	Overall distribution of essential and non-essential mineral elements on different plant parts of indigenous tea (<i>Jatropha zeyheri</i>) – Mamabolo LK	The effects of rehabilitation methods as a function of topsoil thickness on soil chemical properties under a grass mixture – Wiese LD	
09:50 – 10:10	The effects of cultivar, nitrogen fertilizer rates and plant density on yield and yield components of sorghum – Ajidahun AJ	Seasonal variation of essential and non-essential mineral elements of indigenous tea (<i>Jatropha zeyheri</i>) – Sehlapelo AM	The effects of rehabilitation methods as a function of topsoil thickness on compaction, yield and water use of a grass mixture - Beukes DJ	
10:10 – 10:30	Critical factors influencing the effectiveness of Fetsa Tlala farmer support programme on subsistence maize producers in Limpopo Province of South Africa – Makgato MM	Response in growth and total aboveground biomass of selected <i>Amaranthus</i> species to commercial compost application as a source of nitrogen - Seetseng KA		
10:30 – 10:55	MORNING TEA – Economic and Management Sciences Building Foyer			
SIXTH CONCURRENT SESSION – Thursday 23 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Protection & Modelling	Hort Physiology	Soil Chemistry	
	Dr Scott Sydenham	Dr Isa Bertling	Prof Pardon Muchaonyerwa	
11:00 – 11:20	Insects in Agriculture-competitors or allies - Jankielsohn A	The effect of Moringa leaf extract on growth and development of radish (<i>Raphanus sativus</i>) and green beans (<i>Phaseolus vulgaris</i>) – Mabaso MC	Quantitative and qualitative changes in soil carbon following 20 years of wheat production management in the semi-arid eastern Free State – Loke PF	
11:20 – 11:40	Arthropod diversity in Bt and non-Bt soybean trial plots in South Africa – Schutte N	Pre-harvest illumination of cherry tomato reduces the ripening period, enhances fruit carotenoid content and overall fruit quality – Ngcobo BL	High density sludge from acid mine drainage treatment as a soil amendment: soil and crop response – Sukati BH	
11:40 – 12:00	Screening of <i>Spodoptera frugiperda</i> (Lepidoptera: Noctuidae) for susceptibility to cry1ab and cry1a.105+cry2ab2 Bt maize in South Africa – Botha AS	Organic manure application on crude oil impacted soil: effect on growth and macro-nutrients accumulation in roots and leaves of cassava (<i>Manihot esculenta</i> Crantz) in Nigeria - Harrison UE	Measuring and modelling triazine leaching in contrasting South African soils – Dlamini SD	
12:00 – 12:20	Diversity assessment of ground beetles (Coleoptera: Carabidae) in wheat agroecosystems – Makwela MM	<i>Plectranthus esculentus</i> response to environment is affected by ploidy level – Pentter M	Composted municipal solid waste soil treatment effects on availability and crop uptake of lead and cadmium - Dube PH	
12:20 – 12:40	Interactive effects of Nemafric-AL, Nemafric-BL and Mosamina phytoneimaticides on nematode suppression and plant growth in sweet stem sorghum – Maleka KG	Growth and yield response of sweet potato to nitrogen fertilizer in soils of Ladysmith, Kwazulu-Natal, South Africa – Mvula NG	Amount of monoammonium phosphate needed to increase extractable soil P in alkaline and calcareous sandy soils – Venter AE	
12:40 – 13:00	Non-phytotoxic concentration of Nemafric-Ag and Nemafric-Bg phytoneimaticides on carrot cultivar 'Cape Market' - Tshehla TM	Effect of organic fertilizer application on the growth of Kale plants – Laurie R		
13:00 – 14:00	LUNCH – CENTENARY COMPLEX			

SEVENTH CONCURRENT SESSION - Thursday 24 January 2019				
Time	ALG2	ALG8	AG2	AG3
	Crop Breeding, Adaptation & Quality	Hort Biotechnology, Breeding & Propagation	Soil Genesis, Classification & Mapping	
	Dr Maryke Craven	Dr E Hajari	Mr Martiens du Plessis	
14:00 – 14:20	Determining breeding values of parental genotypes for sugarcane biomass yield – Mbuma NW	Progress towards the micropropagation of Macadamia – Hannweg K	Spatial variability of cations in cultivated and fallowed soils following irrigation with treated wastewater - Phadu ML	
14:20 – 14:40	Chasing wheat yields in challenging environments – Sydenham SL	Size, weight and flower count of litchi panicles as influenced by the cultivar, flower stage and season – Mabirimisa A	Disaggregation of the land type survey to estimate erosion risk - Flynn TCF	
14:40 – 15:00	Efficacy of <i>Einesia fetida</i> secretion against Fusarium root rot during wheat seedling growth and establishment - Akinnuoye-Adelabu DB	New rootstock selections contributing to a stable, high yielding environment for citrus scions – Bijzet Z	Mapping the changes in water soil erosion potential risks over South Africa for the period of 2000 and 2017 - Chauke MP	
15:00 – 15:20	Effect of seeding rates and threshing regime on the yield and quality of sesame (<i>Sesamum indicum</i> L.) seeds in the Southern Guinea Savannah region of Nigeria – Orbunde AK	Use of an accelerated breeding scheme for selection of sweet potato lines - Laurie SM	Hydropedology, what makes it different? - Le Roux PAL	
15:20 – 15:40	Genotype by region interactions of released sugarcane varieties in the South African sugar industry – Duma S	Evaluation of cowpea genotypes using nutritional values in the grain – Gerrano AS	Application of hydropedological information to conceptualize pollution migration from dry sanitation systems in the Ntabelanga catchment area, South Africa - Mamera MM	
15:40 – 16:00	AFTERNOON TEA – Economic and Management Sciences Building Foyer			
	ANNUAL GENERAL MEETINGS			
16:00 – 17:30	SASCP – ALG2	SASHS – ALG8	SSSA AG2	SASWS – AG3
19:00 – Late	AWARD WINNING DINNER – CENTENARY COMPLEX			

ABSTRACTS
KEYNOTE PRESENTATIONS

Africa's food challenge and the role of horticultural research

Professor Umezuruike Linus Opara
SARChI Postharvest Technology
Stellenbosch University, South Africa

The African continent is very diverse in many ways and home to nearly 20 percent of current global population of just over 7 billion. With its youth population, it is projected that Africa will contribute the majority of the increase in global population that is expected to exceed 9 billion by 2050. The ability of Africa to feed itself now and into the future, and contribute to global food and nutrition security, depends on the status of agriculture and food systems on the continent, including the prospects for intra-African trade and with the rest of the world. The prevailing narrow and limited understanding of the role agriculture in the food system among policy makers and development practitioners focuses almost exclusively on food calorie production and consumption. This trend ignores or at best underplays the critical role of horticulture as an important part of the food system as well as a sector that creates wealth and quality jobs.

It is projected global food production will have to increase by about 70 percent to meet demand by 2050; however, we argue that this projection does not take into account the need to save current harvests. Despite its abundant natural resources, Africa remains a hot-spot on the world food insecurity map, and this situation will remain in the short to medium term. Africa has a huge and growing food challenge due to a myriad of internal and external factors, which, acting in synergy, manifest in (i) the lowest crop yields compared to the rest of the world, (ii) high incidence of postharvest food losses, especially horticultural produce, and (iii) widespread poverty. Consequently, the vast majority of African farmers and other agribusiness operators remain globally uncompetitive. Meanwhile, cheap food exports and foreign aid to Africa have become mainstreamed into the development agenda of 'donor' countries to meet both the food deficit and changing food habits of Africans. Under this scenario, horticultural foods are conveniently branded as luxury items rather than the necessity they are for a balanced diet and healthy population. This raises an important question: what is the role of horticulture in assuring food and nutrition security at all levels – community, national, continental and global?

In this paper, we highlight the status of agriculture and food systems in Africa, and discuss various continental Agenda and Declarations enunciated to transform African agriculture for food security and prosperity. The low productivity of African agriculture, high magnitude of postharvest losses and rising food imports are reviewed to demonstrate the need for an integrated approach to agricultural transformation beyond the current and almost exclusive focus on production (farming) and cereal crops. Literature evidence is presented (a) to highlight the rising global appetite for horticultural foods and (b) demonstrate, at the farmer level, the competitiveness of investment in horticultural crops compared with agronomic ('calorie') crops. It is concluded that a new broad-based vision and action for African agriculture is urgently needed to mainstream horticulture and horticultural research in the agriculture transformation agenda for food security and prosperity. A case study of SARChI Postharvest Technology at Stellenbosch University is presented to demonstrate the importance of a multi-disciplinary approach and building human capacity to drive the change.

The Fall Armyworm, one more devastating new pest to combat in a sustainable agricultural environment

Mrs Desiree van Heerden

Food security is often threatened by environmental factors outside of our control such as adverse weather conditions such as drought, high temperatures, unexpected cold spells, or too much rain. Within our control lies agricultural practices, when should what be planted, inputs such as fertilizer, and control measures for diseases and insects. New pests such as the Fall Armyworm, *Spodoptera frugiperda*, pose a serious threat to the estimated 37 million hectares of maize fields in Africa of which 3 million hectares are large-scale producers and more than 98% smallholder family farmers. Control options in Africa are at more than one cross road as not many registered products are available or affordability. The availability of various chemical products are real issues and logistics are a challenge in most African countries. First world solutions such as biological control, drone applications, and too many choices are often offered to third world conditions to assist in managing a devastating pest like FAW. Government interventions are based on “free” or donor contributions. In most cases responsible application, well maintained equipment and safety to applicators and the environment lack far behind European standards.

The novelty of investigating the pest and compile information on the FAW’s biology, damage and possible control options are now behind us. There are now an overload of available publications, new technologies, various expert opinions, and mobile device apps in the agricultural world. Farmers are therefore faced with real challenges and hurdles in combating the FAW most effectively with practices that will be economical viable. An up to date overview on the biology, host plants, damage, origin, invasion into Africa, current distribution, new unconquered potential areas, role players, projects and technology available will be covered. Emphasis will be on the South African situation and what is happening locally, highlighting a few examples of control options and trial results from Syngenta and touching on Integrated Pest Management and the way forward.

ABSTRACTS

ORAL PRESENTATIONS

LISTED ALPHABETICALLY

Negative or positive: Impact of genetic modification of Bt maize on ecosystem functioning?

Presenter: RA Adeleke (Adeleker@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
RA	Adeleke	Agricultural Research Council- Soil, Climate and Water
DAV	Van Wyk	Agricultural Research Council/North-West University, Potchefstroom
OHJ	Rhode	Agricultural Research Council-GCI
CC	Bezuidenhout	North-West University, Potchefstroom

Introduction

Risks associated with the potential threats of genetic modification (GM) of plants could affect ecosystem functionalities of microbes associated with biological fertilizers such as Arbuscular Mycorrhizal (AM) inoculum and vermicompost (VC). In the present study, we investigated potential impact of GM of Bt maize on the ecosystem functionalities of two biological fertilizers, namely, AM inoculum and Vermicompost VC.

Materials and Methods

A maize pot trial experiment was conducted with treatment combinations that consisted of Bt maize seeds in 10 kg soil, Bt maize seeds in 10 kg soil incorporated with 30 g of AMF, Bt maize seeds in 5 kg soil incorporated with 5 kg of vermicompost and 30 g of AMF, three replicates each at three sampling times. These treatment combinations were also conducted for non-Bt maize seeds. A randomised complete block design was used in the experimental layout. Rhizospheric soil and fine root samples were collected at 60, 90 and 120 days after planting (DAP). Ecosystem functionalities were studied by means of AM colonization of root samples, DNA metabarcoding of the rhizobacteria, soil chemical properties and enzyme activities (acid phosphatase, β -glucosidase and urease). In addition, total dry matter of the whole plant at 120 DAP was determined. Data were statistically analysed using SAS and Statgraphics software.

Results and Discussion

Maize dry matter results indicated that Bt maize plants performed better compared to non-Bt maize plants. Differences in chemical characteristics were noted between Bt and non-Bt maize soil treatments, with pH and potassium showing significant differences at 120 DAP. Enzymatic activity results showed no differences between Bt and non-Bt maize soil treatments. However, differences were observed for urease and acid phosphatase activities in soils amended with AMF and VC. Evidently, the addition of AMF and VC into the soil had a stimulating effect on all enzyme activities. Over the sampling period, there were varying degrees of mycorrhizal colonization expressed as percentages between Bt and non-Bt maize. These effects were more pronounced in treatment combinations containing vermicompost. The detection of bacteria such as *Acidovorax*, *Bacillus*, *Flavobacterium*, *Paenibacillus* and *Pseudomonas* in both Bt and non-Bt maize treatments are of great importance for plant health, productivity and soil fertility.

Conclusions

The rhizosphere soil bacterial community of Bt maize differed from those of non-Bt maize across plant growth stage and between bio-inoculants as well as bio-fertilisers. These differences were more pronounced between the diversity and abundance of particular species, rather than in the species richness of the maize bacterial community.

The effects of cultivar, nitrogen fertilizer rates and plant density on yield and yield components of sorghum

Presenter: JA Ajidahun (mayowaajidahun@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
JA	Ajidahun	Food Security and Safety Niche Area, Faculty of Natural and Agricultural Sciences, North West University, Mafikeng Campus, Private Bag X 2046, Mmabatho, 2735
ET	Sebetha	Food Security and Safety Niche Area, Faculty of Natural and Agricultural Sciences, North West University, Mafikeng Campus, Private Bag X 2046, Mmabatho, 2735

Introduction

Sorghum is an important cereal crop in the semi-arid regions sub-Saharan Africa due to its good production yield (Dicko *et al.*, 2006). Sorghum yield varies significantly under different nitrogen fertilizer rates while the selected cultivars and plant density employed during planting have variable effects on the yield and yield components. The aim of the study was to determine the effect of nitrogen fertilizer rates, cultivar and plant density on the yield and yield components of sorghum.

Materials and Methods

The study was conducted during 2016/17 and 2017/18 planting seasons at Mafikeng and Taung, North West Province of South Africa. The experimental design was a split-split plot arrangement fitted into a randomized complete block design with four replicates. The main plot factors were high and low plant densities. The nitrogen fertilizer rates were 0, 100 and 150 kg N ha⁻¹ as the sub plot factor. The sub-sub plot factors were two sorghum cultivars, PAN 8625 is a late maturity class and PAN 8816 is a medium-late maturity. The measured yield parameters were panicle length, panicle mass per plant, panicle mass ha⁻¹, 1000 grain mass, biomass yield and grain yield, harvested from an area of 9.6 m² per plot.

Results and Discussion

Cultivar, plant density, and location had significant effect ($P < 0.05$) on panicle mass/ha, grain yield and biomass yield of sorghum. During 2016/17 planting season, sorghum cultivar PAN 8625 had significantly higher grain yield of 1820 kg ha⁻¹ than PAN 8816. Sorghum planted under high plant density had significantly higher biomass yield of 5589 and 10896 kg/ha in 2016/17 and 2017/18 planting seasons respectively. Sorghum cultivar PAN 8625 had significantly higher panicle mass of 3034 and 6489 kg ha⁻¹ than PAN 8816 in 2016/17 and 2017/18 planting seasons respectively. PAN 8816 had significantly higher 1000 seed mass of 25.70 and 33.68 g in 2016/17 and 2017/18 planting seasons respectively than PAN 8625. The panicle length at Mafikeng was 35.50 cm and 29.78 cm at Taung during 2016/17 planting season, while during 2017/18 planting season Taung had 37.86 cm and Mafikeng had 37.80 cm. The higher panicle mass/ha, grain and biomass yield observed may have been attributed to late maturity status of the cultivar and better adaptability to environmental conditions.

Conclusions

The study shows that PAN 8625 is superior to PAN 8816 with regards to yield and yield production. Mafikeng is a good production location for sorghum. Increasing nitrogen fertilizer rates has no effect on yield components of sorghum cultivars used.

Efficacy of *Einesia fetida* secretion against *Fusarium* root rot during wheat seedling growth and establishment

Presenter: DB Akinnuoye-Adelabu (solakinns@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
DB	Akinnuoye-Adelabu	Department of Zoology and Entomology, Afromontane Research Unit, Faculty of Natural and Agricultural Sciences, University of the Free- State, Private Bag 13, Phuthadijhaba 9866, South Africa
C	Villier	Department of Plant Pathology, Agricultural Research Council small grains institute Private Bag 13, Bethlehem, South Africa
T	Terefe	Department of Plant Pathology, Agricultural Research Council small grains institute Private Bag 13, Bethlehem, South Africa
E	Bredenhand	Department of Zoology and Entomology, Afromontane Research Unit, Faculty of Natural and Agricultural Sciences, University of the Free- State, Private Bag 13, Phuthadijhaba 9866, South Africa
J	Hatting	Department of Plant Department of Pathology, Agricultural Research Council small grains institute Private Bag 13, Bethlehem, South Africa

Introduction

Fusarium root rot causes up to 20% reduction in wheat production and quality. Colonization of wheat root by *Fusarium graminearum* has been recognized, but controlling the root infection through biological substance such as earthworm (*Eisenia fetida*) secretion has received little attention. Earthworms secretion (mucus and vermiwash) have antifungal ability against pathogenic diseases in plants. This study evaluated the antagonistic property of earthworm extracts against *Fusarium graminearum* and the effect of the extracts on seedlings above and below ground growth under laboratory conditions.

Materials and Methods

The growth inhibition test against *Fusarium graminearum* using earthworm extracts and sterile water (control) was conducted in quintuplicate at *Fusarium* laboratory of Department of Plant Pathology in Agricultural research Council small grains in Bethlehem) The seedlings growth experiment was done using (Labcon laboratory Equipment Germany L.T.I.E) at 16/24°C for 12 dark/12 light hours' night cycles). The 7 day old wheat seedlings were inoculated with *Fusarium conidia* suspension accordance to methods described by Wang *et al.*, (2015). Then, watered with respective earthworm extracts (vermiwash, augmented vermicompost tea) and distilled water (control). Root biomass, shoot and root length and disease index across 2, 4, 7, 14 and 21 days after inoculation were measured. The percentage of fungal growth was analyzed statistically with One-Way Analysis of Variance (ANOVA), while Two-way ANOVA was used for root biomass, root and shoot length, and disease severity across days after inoculation.

Results and Discussion

The earthworm extracts significantly inhibited ($P < 0.001$) the mycelial growth of *F. graminearum*. Significant variation of Infections \times Earthworm extracts occurred on the root and shoot lengths, root biomass and disease index. Infected seedlings treated with vermiwash and augmented vermicompost tea had lesser root biomass, root and shoot length loss. Vermiwash was able to supplement the plant nutrient status and inhibit the effect of the pathogen. This study was in agreement with Piening *et al.* 1976 who reported that a well-nourished plant are less affected by *Fusarium* root rot.

Conclusions

Mucus of *E. fetida* and vermiwash obtained at 14 days moderately antagonised (27%) *Fusarium graminearum* in wheat seedling roots due to moderate bioactive compounds present in extracts. Likewise, vermiwash obtained at 14 days and augmented vermicompost tea were able to inhibit the *Fusarium* root rot in the infected seedlings while untreated but infected seedlings were severely damaged. Earthworm extracts moderately antagonized and suppressed *F. graminearum* and can evolve as potential bio-fungicide supplemented with the use of high vigour seed and agro-management practice.

WAR OF THE WEEDS: Allelopathic effects of *Amaranthus* on Ryegrass

Presenter: I Allemann (ingridallemann@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
I	Allemann	University of the Free State, PO Box 339, Bloemfontein, 9300
M	Cawood	University of the Free State, PO Box 339, Bloemfontein, 9300
E	Van Der Watt	University of the Free State, PO Box 339, Bloemfontein, 9300

Introduction

There are more and more drought periods occurring in certain places, which is also a major limiting factor in crop production. Weeds also cause major financial losses in our agricultural systems. It has been proven that *Amaranthus* has allelopathic properties thus the aim of this study was to determine the effect of drought stress on these properties and its influence on germination and seedling growth of the weed ryegrass.

Materials and Methods

Amaranthus cruentus plants were drought stressed for 0, 24, 48, 72 and 96 hours, while incubated under a 12 hours light photoperiod at 28/21°C day/night temperatures. The allelopathic potential of plant residues from these stressed plants were evaluated using the agar sandwich method. This method was done when a total of 10 of 50 mg of dried, powdered leaves were placed into three wells of a six-well (10 cm³ area per well) multi-dish plastic plate. Agar powder was used as the growth medium (0.5% w/v). Each well contained, 5 ml of agar solution added on top of another 5 ml agar to make two layers of gelatinised agar (containing either 1 or 5 mg ml⁻¹ litter per well). The *A. cruentus* leaf litter was placed between the two gelatinised agar layers. Radicle and hypocotyl lengths as well as germination percentage were measured after three days of incubation in the dark at 25°C. All data were analysed using SAS and Turkey's least significant difference (LSD) test at 5% level of significance to determine statistically significant differences between treatment means.

Results and Discussion

Seed germination was significantly inhibited by residues from drought stressed plant. Germination was inhibited with the 24 to 96 hours stress at the highest concentration. Results also indicated that there was a clear inhibition of 93% on the germination with non-stressed plant at the highest concentration of plant material. Seedling growth was inhibited by up to 98% for both the radicle and hypocotyl length when exposed to stressed leaf residues.

Conclusions

Residues of all five drought treatments significantly inhibited the radicle and hypocotyl lengths at the highest concentration of 5 mg ml⁻¹. Time of exposure to drought stress was not showing significant differences, however concentration of stressed residues showed allelopathic effects on germination and growth of ryegrass seedlings.

Irrigation with mine affected waters

Presenter: JG Annandale (john.annandale@up.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
J G	Annandale	Dept Plant and Soil Sciences, Univ of Pretoria
P D	Tanner	Dept Plant and Soil Sciences, Univ of Pretoria
H M	Du Plessis	Dept Plant and Soil Sciences, Univ of Pretoria
B H	Sukati	Dept Plant and Soil Sciences, Univ of Pretoria
J M	Steyn	Dept Plant and Soil Sciences, Univ of Pretoria
Z D	Ronquest	Dept Plant and Soil Sciences, Univ of Pretoria

Introduction

There is renewed interest in the use of mine water for irrigation as a means to reduce mine impacted water treatment costs and to create sustainable livelihoods for emerging farmers as mines reach closure and communities need to diversify away from mining. Large volumes of mine waters are impacted, and many mine waters are suitable for irrigation. There is also land available in close proximity to these waters, especially rehabilitated land.

Materials and Methods

A 19 ha demonstration centre pivot has been erected on previously un-mined land in the Middelburg District of Mpumalanga. Maize and stalling rye have been grown successfully on this site with mine impacted water. A pivot on rehabilitated land is also planned, and small plot screening trials irrigated with acid mine drainage (AMD), limestone neutralised AMD (unclarified), and clarified lime treated AMD are also underway. Crop production and water and salt balances are measured to ascertain the impact of mine water irrigation and to gather data for model parameterisation in order to predict the suitability of mine waters for irrigation. In addition, a site specific, risk-based irrigation water quality decision support system (DSS) has been developed to assist in the assessment of the suitability of mine water for irrigation.

Results and Discussion

The DSS has proved very useful in assessing the suitability of mine waters for irrigation. In particular, the tool assists in determining under what conditions marginal irrigation waters can be used. Trace elements abundant in soils are often in high concentrations in mine waters, and this is often flagged by the DSS as being potentially problematic. Research is needed to ascertain if these trace element thresholds can responsibly be reduced. The demonstration pivot has shown that some mine waters can be successfully used for crop production. Crop screening trials are still in an early phase, but valuable results are expected from these trials.

Conclusions

Some mine waters are suitable for irrigation, but not all mine waters are. The irrigation water quality DSS is a useful tool in assessing the suitability of mine waters for irrigation. Future research will focus on improving the DSS for assessment of the suitability of mine impacted waters for irrigation. There is also a focus on ensuring food and fodder produced with mine water is safe to consume.

Soil ecotope benchmarking in two bioresource units in Kwazulu-Natal: implications for farm planning and management

Presenter: KR Barichiev (kurt.barichiev@kzndard.gov.za)

Initials	Surname	Authors Company/Organisation and Postal Address
KR	Barichiev	KZN Department of Agriculture and Rural Development: Private Bag X9059, Pietermaritzburg 3201

Introduction

KwaZulu-Natal is a diverse Province in terms of climate, topography, soils and land use, resulting in a very complex landscape. This diversity, coupled with the need to sustainably utilise natural resources, has seen the development of the Bioresource Unit (BRU) Programme by the Provincial Department of Agriculture (Camp, 1995). The BRU Programme has been in operation for nearly 25 years and incorporates a range of natural resource datasets into a single, user-friendly interface. To work effectively the BRU Programme requires regular updates in terms of in-field verification, commodity prioritisation and suitability parameters. Benchmarking of resources in priority agricultural areas provides this opportunity and ultimately improves BRU accuracy and relevancy for all users.

Materials and Methods

For this study two mutually exclusive farms, both in terms of spatial location and commodity type, were selected for benchmarking. The first farm, Koperbult, is located in BRU Vb13 near Wartburg and produces dryland sugarcane. The second farm, FCL, is located in BRU Wxc5 near Bergville and primarily produces dryland maize. For both enterprises representative soil observations were made and soils were classified into ecotopes based soil functional group, clay content and effective rooting depth. Long term yield data for both farms were extracted, processed and evaluated against the soil ecotope data.

Results and Discussion

Results of the benchmarking exercise for Koperbult reveal that dryland sugarcane, although extensively grown in BRU Vb13, is shown as not viable within the current Programme parameters. Consequently, an entirely new set of ecotope and yield relationships were developed. Yield analysis indicates mottled and poorly drained soils tended to outperform their well-drained counterparts. This is owing to the marginal rainfall conditions experienced in this BRU in terms of sugarcane suitability. Shallow, rocky and sandy ecotopes corresponded to the poorest long-term sugarcane yields. In terms of FCL, the BRU Programme confirms that dryland maize can be successfully grown in the BRU, however the yields presented are far below the actual yields being attained. This discrepancy is due to improved maize varieties and farming methods. On average, modelled yield predictions within the BRU Programme were increased by between 25 and 40%, depending on the soil ecotope.

Conclusions

Farmers and scientists require the most up-to-date and accurate information regarding natural resources to make informed land use management decisions. Constant updating via BRU and soil ecotope benchmarking has been found to be, not only adequate, but essential in this regard and will hopefully increase sustainable production and management where completed.

Root phenotyping wheat for an ever changing world

Presenter: A Barnard (barnarda@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Barnard	ARC-Small Grain, Private Bag X29, Bethlehem, 9700
SL	Sydenham	ARC-Small Grain, Private Bag X29, Bethlehem, 9700
BS	Wentzel	ARC-Small Grain, Private Bag X29, Bethlehem, 9700

Introduction

The most important limiting factor for wheat production is the availability of sufficient water. Better understanding of root architecture could contribute to alleviating challenges facing agriculture, namely better use of fertiliser and water. Significant variation in root angle has been documented in wheat (Manschadi *et al*, 2006). Plants with narrow seminal root angles tend to have deeper roots (Oyangi, 1994), which has been theorised to give access to subsoil moisture. This hypothesis was tested by measuring root angles and examining its relationship with yield and other parameters.

Materials and Methods

A clear-pot-method was initially investigated to determine differences in root architecture between high and low yielding cultivars. However, this method was ineffective and consequently a modified high-throughput hydroponics system was devised for the screening of 108 high yielding entries. After eight days, root and leaf lengths and wet biomass of ten seedlings per entry were determined. For the determination of root angle, seeds were evenly spaced on two layers of germination paper, moistened with 50ml of distilled water. The seeds were covered with a second layer of paper and rolled into a tube. These tubes were sealed in plastic bags and allowed to germinate for 72 h in a germination cabinet with a constant temperature of 20°C. Root angle was determined using the software ImageJ.

Results and Discussion

Significant differences could be observed between low and high yielding cultivars planted in clear pots. Plant height, root length, root and leaf biomass were 23%, 32%, 33% and 28% higher in the high yielding cultivar. Moderate uphill relationships ($R^2 > 0.50$) were found between root length and root biomass, root length and leaf biomass and root and leaf biomass. High levels of genetic variation for seminal root angle were observed. The entries could be assigned to three groups (narrow, moderate and wide) based on their root angles. Yields varied between 6.8 and 8.8 t ha⁻¹ under supplementary irrigation. However, in this study no significant correlation could be found between root angle and yield.

Conclusions

This preliminary data suggest that genetic variation exists for root angle in wheat. However, root angle appears to have no effect on yield in this study. A possible explanation is that the entries used in this study were specifically selected for their high yields. Root length and biomass are fundamental elements in the expression of high yields in wheat. As yield stability is a complex quantitative genetic trait, influenced by root architecture, minor trends may prove significant in future.

Sugar and calcium concentration of 'Gem' and 'Ryan' avocado fruit during fruit development

Presenter: I Bertling (bertlingi@ukzn.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
I	Bertling	Horticultural Science, UKZN P. Bag X01, Scottsville 3209
NP	Mbele	Horticultural Science, UKZN P. Bag X01, Scottsville 3209

Introduction

Fruit quality in general, and avocado (*Persea americana*) in particular, has been aligned to the fruit calcium (Ca) (Bower and Cutting, 1988) and soluble carbon 7 sugar (Bertling and Bower, 2005) concentrations. While Ca holds an important position in fruit quality due to its role in upholding membrane integrity, the carbon 7 sugars have implicated as storage sugars and transport sugars in avocado. In order to investigate a potential alignment of fruit Ca and carbon 7 sugars, the concentration of Ca and sugars was investigated in the black skin 'Hass'-like cultivar 'Gem' and the green skin 'Ryan' cultivar.

Materials and Methods

'Gem' and 'Ryan' avocado fruit, typical for the stage of development, were randomly harvested from a commercial orchard in the KZN Midlands throughout growth and development. Fruit were cut into halves, the seed removed and the exocarp/ mesocarp tissue analysed for Ca concentrations by AAS, while sugars were analysed using HPLC-RID. Results were statistically analysed using Genstat 10.

Results and Discussion

Fruit Ca concentrations were initially (March/April) above 1200 mg Ca, decreasing in both cultivars thereafter; however, Ca in 'Ryan' remained higher than in 'Gem' up to the last sampling. The C7 sugar mannoheptulose was initially the dominant sugar in both cultivars, but decreased more rapidly in 'Ryan' than in 'Gem' fruit'. Perseitol concentrations were also higher in 'Ryan' than in 'Gem' fruit, indicating that these special avocado sugars could be indicators of fruit quality as proposed earlier (Bertling and Bower, 2005). In both cultivars, perseitol was the most abundant sugar in the seed, with even higher sucrose than mannoheptulose concentrations, confirming the proposed perseitol role of a storage carbohydrate in the seed (Tesfay *et al.*, 2005). The harsh drop in mesocarp mannoheptulose at the last sampling, however, places doubt on the possibility to use the mesocarp mannoheptulose concentration as an internal fruit quality indicator.

Conclusions

The pertinent role of C7 sugars in fruit development was confirmed in two previously not well-studied cultivars. As the maintenance of the C7 sugar concentration might play an important role in fruit quality, means to maintain higher C7 sugar levels later in the season should be sought, if it is anticipated to late-hang a particular cultivar.

The effects of rehabilitation methods as a function of topsoil thickness on composition, yield and water use of a grass mixture

Presenter: DJ Beukes (danie.beukes122@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
DJ	Beukes	229 Emmarentia street, Meyerspark, 0184
LD	Wiese	Department of Soil Science, Stellenbosch University, PBag X01, Matieland, 7206
MV	Kidson	ARC-SCW, PBag X79, Pretoria, 0001

Introduction

Although opencast coal mining is a vital component of South Africa's economy, ongoing concerns regarding the resulting environmental degradation has highlighted the need for improved environmental maintenance and rehabilitation (Tanner, 2007). Grazing land capability measured on the reclaimed mine soils in the Mpumalanga Highveld revealed that fertilization of pastures and topsoil thickness affected pasture yields (Rethman, 2006). The ARC–Soil, Climate and Water (ARC-SCW) was contracted by Agron (Pty) Ltd, in collaboration with Fraser Alexander (Pty) Ltd, to evaluate in a 2-year study various rehabilitation methods as a function of topsoil thickness on soil chemical, biological and physical properties, as well as on the composition, growth and yield of a grass mixture.

Materials and Methods

A strip plot design was used to lay out in November 2014 a field trial consisting of four topsoil (TSs) thicknesses (0, 70, 150, 300 mm) and seven rehabilitation methods (RMs), including a control, at the Mimosa Coal mine site outside Carolina. The test crop was a mixture of annual and perennial grass species. Soil water content (SWC) was measured regularly with a neutron water meter. Grass biomass sampling and production was performed annually. Standard analytical and statistical procedures were used for sample analysis and processing of data.

Results and Discussion

Grass element status varied as a function of both RM and TS with values for most macro elements lower than the deficiency norm, thereby reflecting the relatively low soil nutrient status that was measured. There was a tendency of an increase in element status with an increase in TS thickness. Micro nutrients appeared to be well supplied. A good correlation was found for grass N vs. soil inorganic N status. Basal and canopy cover varied significantly as a function of RM and TS. Dry biomass varied significantly in the first season as a function of RM, while an increasing trend was visible with increasing TS thickness. Both RM and TS thickness significantly affected water use efficiency (biomass production $\text{mm}^{-1} \text{ha}^{-1}$). Noteworthy is the marked increase in WUE on a 300 mm topsoil compared to a 0 mm topsoil.

Conclusions

Grass macro element status was lower than the deficiency norms, caused by a low soil nutrient status. Using basal and canopy cover, as well as WUE, as indicators, a RM with the highest application amount on a 300 mm TS and under a mixed grass species stand can be recommended as a sustainable rehabilitation practice.

New rootstock selections contributing to a stable, high yielding environment for citrus scions

Presenter: Zelda Bijzet (zeldab@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
Z	Bijzet	ARC-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, South Africa
M	Booyse	ARC-Biometry Unit, Private Bag X5013, Stellenbosch, 7599, South Africa
NK	Combrink	ARC-Tropical and Subtropical Crops, Addo Research Station, P.O. Box 52, Addo 6105, South Africa
JH	Husselman	ARC-Tropical and Subtropical Crops, Addo Research Station, P.O. Box 52, Addo 6105, South Africa
AD	Sippel	ARC-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, South Africa

Introduction

In Citrus, rootstocks have a pronounced effect on various traits of the scion (Koepke & Amp; Dhingra, 2013). The financial impact of a rootstock is therefore extrapolated from the scion impact. Disease resistant, high yielding rootstocks will have a positive impact on both the profit margin as well as on the environment by reducing the use of harsh chemicals. Rootstocks thus present a non-transgenic approach to rapidly respond to the changing environment and expand agricultural production demands of the future.

Materials and Methods

Hybrid seed is obtained by conventional breeding methods. Pollen parents are normally chosen for their tolerance/resistance to nematodes and root pathogens while seed parents carry the tolerance to calcareous soils. GA treatments have been used to suppress the nucellar embryos (poly-embryonic) and improve the breeding efficiency. The hybrids are all rooted in the mist-bed and only those seedlings with the ability to root easily and generate a good root system are evaluated further. The better performing hybrids are budded to Limoneira 8A lemon for horticultural evaluation.

Results and Discussion

A total of 1707 hybrids based on their ability to root easily and generate a good root system were selected from 126 cross combinations between 36 female parents and 14 male parents. Yield is a polygenic trait and thus very difficult to calculate repeatability or broad sense heritability. However, based on the yield data taken over 10 years, an ANOVA over the males showed significant variations amongst the males used, with regard to conveying the ability for yield and yield stability, with Australian trifoliolate being the best male parent. The best female parent with regard to yield was P23.

Conclusions

The best producing and most stable hybrids as well as the best parent combinations with regard to the ability of the rootstock to affect good yields in the scion. The poly-embryony and disease resistance of the hybrids is unknown. It is incorrect to assume that the inherent amount of roots of a seedling or that the field survival rate of the hybrids, correlates with disease resistance. The trial method implied the yield to be measured on a clonal rootstock while it is unlikely that nurseries will make use of a mono-embryonic citrus rootstock or a rootstock with a low percentage of poly-embryony, as this will inflate the tree price. A further dimension of this project will thus have to include verifying the level of embryony of the best selections as well as screening for disease resistance.

Screening of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) for susceptibility to Cry1Ab and Cry1A.105+Cry2Ab2 Bt maize in South Africa

Presenter: AS Botha (nwuluan@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AS	Botha	North-West University, Potchefstroom 2520, Unit for Environmental Sciences, Integrated Pest Management Program
A	Erasmus	ARC-Grain Crops, Potchefstroom
H	Du Plessis	North-West University, Potchefstroom 2520, Unit for Environmental Sciences, Integrated Pest Management Program
J	Van den Berg	North-West University, Potchefstroom 2520, Unit for Environmental Sciences, Integrated Pest Management Program

Introduction

Spodoptera frugiperda (Fall armyworm - FAW) is a new invasive pest species that attacks maize in Africa (Goergen *et al.*, 2016). Transgenic maize that express Cry proteins, have been used effectively to control this pest in the USA, Canada and several countries in South America. *Spodoptera frugiperda* has evolved resistance to Cry1F Bt maize in Puerto Rico, Brazil and the USA, and Cry1Ab maize in Brazil (Storer *et al.*, 2010; Omoto *et al.*, 2016). This study provides the first data on the response of *S. frugiperda* to Bt maize in Africa and reports on base-line levels of susceptibility of five *S. frugiperda* populations evaluated between January 2018 and May 2018 in South Africa.

Materials and Methods

Larvae of *S. frugiperda* were sampled in non-Bt maize fields from four of South Africa's nine provinces. These localities were in the districts of Dundee (designated DNE18), Koster (KOS18), Stofberg (SFB18), Vaalharts (VAA18) and Nelspruit (NSP18). Bioassays were conducted with each population. Each bioassay consisted of three treatments: treatment one (single-gene event = Cry1Ab), treatment two (pyramid event = Cry1A.105+Cry2Ab2) and treatment three (control) of which each treatment had ten replicates. Each replicate consisted of ten plastic aerated containers (50 ml) with one larva per container. Larval feeding bioassays were conducted in which plant tissue of maize between vegetative stage eight and ten were fed to the larvae. Survival and different life history parameters were recorded.

Results and Discussion

Results indicate moderate susceptibility to single-gene Bt maize and complete susceptibility to pyramid Bt maize. The moderate susceptibility of FAW to Cry1Ab maize can be attributed to factors such as the single-gene event being a low-dose event for *S. frugiperda*, as well as the fact that the population which initially arrived on the continent may have carried resistance alleles to Cry1Ab protein. The different modes of action of Cry1A.105 and Cry2Ab2 proteins in pyramid Bt maize contribute to the complete susceptibility of FAW. This study provides important base-line information for future monitoring of shifts in the susceptibility of FAW populations.

Conclusions

All populations were moderately susceptible to Cry1Ab maize and completely susceptible to Cry1A.105+Cry2Ab2 Bt maize. The levels of susceptibility of FAW to Bt maize should be monitored, especially that of populations collected from ecological regions where this pest may establish permanently in South Africa.

The role of water conservation strategies and benchmark ecotopes for increasing yields in South Africa's semi-arid croplands

Presenter: JJ Botha (BothaC@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
M	Hensley	Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa
PAL	Le Roux	Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa
JJ	Botha	Agricultural Research Council - Soil, Climate and Water, Private Bag X01, Glen, 9360, South Africa
LD	Van Rensburg	Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa
JJ	Anderson	Agricultural Research Council - Soil, Climate and Water, Private Bag X01, Glen, 9360, South Africa

Introduction

Recently published results regarding South Africa's cropping potential show that about one third of the arable land is of low potential, located mainly in semi-arid areas, with the main problem water shortage. This is therefore an appropriate time to review priorities and procedures, for selecting benchmark ecotopes to represent marginal areas, and for research needs with regard to water conservation strategies to mitigate the problems of low yields. Relevant international principles encapsulated in the words agro-ecology, sustainability, socio-economic conditions, are discussed.

Materials and Methods

Relevant new technologies are described, namely: digital soil mapping (DSM) that will facilitate the identification of benchmark ecotopes; a stochastic procedure to predict rainfall intensity data from daily rainfall that will facilitate runoff predictions; a crop yield cumulative probability procedure that enables sustainability to be described quantitatively. As a case study results from a successful field experiment using the infield rainwater harvesting (IRWH) production technique on benchmark ecotopes in a semi-arid area, inhabited by subsistence farmers, is presented.

Results and Discussion

DSM can greatly facilitate and improve the efficiency of identifying important benchmark ecotopes through the disaggregation of land types using terrain analysis, expert knowledge and GIS methodology. Considering the future need to evaluate the productivity of many marginal benchmark ecotopes in semi-arid areas, if the use of the combination of the rainfall intensity, runoff and crop yield prediction models proves to be consistently reliable, this strategy offers a useful means of estimating the yield benefits obtainable with the IRWH technique before conducting expensive field experiments on an unnecessary number of benchmark ecotopes. The most important benchmark crop ecotopes should be identified in order to seek possible remedial actions and food security.

Conclusions

The objectives of the study, procedures used and the method of expressing the results are recommended as guidelines for contributing towards mitigating the problem of low crop productivity on a large arable area in South Africa.

Mapping the changes in water soil erosion potential risks over South Africa for the period of 2000 and 2017

Presenter: MP Chauke (1109434@students.wits.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MP	Chauke	School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg

Introduction

Approximately 85% of South Africa's land is threatened by soil erosion; with three quarters of the country susceptible to erosion by water (Le Roux *et al.*, 2008). Water soil erosion is the most severe and concerning type of erosion in the country. South Africa is considered a developing country which lacks proper methodology for assessing potential erosion risks and knowledge of locating major hotspots of water soil erosion. Evaluation of erosion at a regional scale is a challenge due to spatial variability of the factors (climate, soil properties) driving water soil erosion (Le Roux *et al.*, 2007). Relevant studies indicate that it is impractical to use process based methods, such as small-scale experiments to quantify erosion rates at a regional scale (Lu *et al.*, 2003). The study evaluates erosion risk and spatial distribution of water erosion in South Africa with the use Universal Soil Loss Equation (USLE) model. The choice of using USLE model is because it is most widely used and relatively simple to assess regional scale water erosion.

Materials and Methods

The USLE model (Eq.1) has been applied to determine the annual soil loss in South Africa over the past 18 years. The model parameters were obtained from the Agricultural Research Council-Institute for Soil, Climate and Water (ARC-ISCW) database. $E_a = R \times K \times L \times S \times C$ (1) Where, E_a = Average soil erosion that will be estimated (Classes; $t\ ha^{-1}\ yr^{-1}$) R = Rainfall-runoff erosivity factor- rainfall and runoff events- their intensity and variability ($MJ\ mm\ ha^{-1}\ h^{-1}\ yr^{-1}$) K = Soil erodibility factor- indicating the internal susceptibility of soil to erosion ($t\ ha\ h\ ha^{-1}\ MJ^{-1}\ mm^{-1}$) LS = Slope length and steepness-variability of topography (classes) C = Land cover and management factor (classes)

Results and Discussion

The eastern part of the country experiences moderate to high erosion rates which indicates presence of high climatic variability (heavy rainstorm), extensive farming and mountain ranges. While the western part of the country experiences low erosion rates. There is an increase in distribution of water soil erosion from 2000 to 2017. The average estimated annual soil loss rate for the entire country is $14.6\ t\ ha^{-1}\ yr^{-1}$.

Conclusions

The estimated erosion by water indicates that there was a large transformation over the 18 year period. The erosion risks maps are useful in determining areas highly susceptible to water erosion and where control management practices should be implemented.

Variability of nitrogen fixation by legumes in response to nitrogen and phosphorous

Presenter: TP Chibarabada (ChibarabadaTP@ufs.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
TP	Chibaraba	University of the Free State, PO Box 339, Bloemfontein, 9300
AC	Franke	University of the Free State, PO Box 339, Bloemfontein, 9300

Introduction

Legumes play an integral role in enhancing soil fertility status due to their nitrogen (N₂) fixing ability. Nitrogen fixation by grain legumes greatly varies in response to genotypes, environment and management practices (Giller 2001). Nitrogen (N) and phosphorous (P) are two important macro nutrients influencing N₂ fixation. A systematic review was conducted to explore the variability of biological N₂ fixation and associated traits of legumes in response to applied N and P fertilizer.

Materials and Methods

ScienceDirect®, Scopus® and Web of Science™ were used to search for literature on “nitrogen fixation AND phosphorus” and “nitrogen fixation AND nitrogen” with alternative formats. The search yielded 530 and 270 observations on effect of N and P, respectively. Effect of N observations were categorized into 0 kg N ha⁻¹, 1 – 25 kg N ha⁻¹, 26 – 75 kg N ha⁻¹ and > kg N ha⁻¹ to represent control, low, medium and high applied N. Effect of P observations were categorized as 0 kg P ha⁻¹, 1 – 15 kg P ha⁻¹, 16 – 30 kg P ha⁻¹ and > 30 kg P ha⁻¹ to represent control, low, medium and high applied P. Observations were also categorized into crop species. Analyses focused on the relative and absolute magnitude and variability of nitrogen fixation and associated traits in response to N and P application.

Results and Discussion

The analysis showed that N₂ fixation decreased by up to 100% and 125 kg ha⁻¹ with the high N application. Nitrogenase activity decreased from ≈ 140 μmol ethylene plant⁻¹ hour⁻¹ under the control treatments to ≈ 30 μmol ethylene plant⁻¹ hour⁻¹ under high N. Phosphorous application increased N₂ fixation by up to 200 kg ha⁻¹ under field conditions. Nitrogenase activity increased from ≈ 10 μmole ethylene plant⁻¹ hour⁻¹ under the control treatments to ≈ 50 μmole ethylene plant⁻¹ hour⁻¹ under high P. Common bean was more responsive to high P compared to soybean, cowpeas and chickpea, as N₂ fixation increased by up to 400% while for the other crops N₂ fixation increased by up to 150%.

Conclusions

Nitrogen fixation of legumes in response to N and P varied substantially among crop species, and the amount of fertilizer applied. The higher the N rate, the lower the N₂ fixed. Phosphorous rates above 30 kg ha⁻¹ increased N₂ fixed. Common bean was more responsive to high P rates compared to other legume crops.

Hierarchical ranking of *Urochloa mosambicensis* (Bushveld Herringbone grass) and *Urochloa panicoides* (Herringbone grass) competitiveness in four soil environments

Presenter: M Craven (CravenM@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
M	Craven	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520, South Africa
PT	Mokoena	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520, South Africa
MM	Van der Walt	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520, South Africa
L	Morey	Agricultural Research Council - Biometry, P.O. Box 8783, Pretoria, 0001, South Africa
AEJ	Saayman-du Toit	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520, South Africa

Introduction

The competitive relationship between *Urochloa mosambicensis* (Hack.) Dandy (Bushveld Herringbone grass) and *U. panicoides* P. Beauv. (Herringbone grass), was investigated during 2017/18 as part of a follow-up study conducted by Agricultural Research Council-Grain Crops and the North West University (2016/17).

Materials and Methods

The four environments tested under glasshouse conditions (15/30°C) were 1) 16% clay, dry 2) 16% clay, wet 3) 35% clay dry and 4) 35% clay, wet. Dry and wet treatments received 1 and 2 L water, respectively daily. The two grass species were planted in five treatment combinations at proportions of 4:0, 3:1, 2:2, 1:3 and 0:4 plants per pot. The trial was planted as a split-plot trial with the soil profile (wet vs dry) as main-plot and soil type and mixture ratio combinations as subplots. The trial was maintained until maturity (55 DAP). Root weight and biomass were determined and used to calculate competitive indices Aggressivity (A), Competitive ratio (CR), Relative yield (RY) and Relative yield total (RYT). Root:shoot ratios were determined.

Results and Discussion

Urochloa mosambicensis competed best in 16% clay, wet environments, whilst *U. panicoides* preferred the 35% clay, dry environments. *Urochloa mosambicensis* adjusted its root:shoot ratios in both monoculture and in competition with a companion weed in the 35% clay soils to a greater extent than *U. panicoides*.

Conclusions

Hierarchical ranking of various indices allowed for the creation of levels of preference for each weed over the four different environments tested. *Urochloa mosambicensis* demonstrated greater plasticity in the 35% clay soils, suggesting it to be the more successful of the two species.

Adoption of technology and remote sensing for irrigation scheduling by farmers in the Breede River Catchment

Presenter: M De Witt (marlenedw@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
M	De Witt	Stellenbosch University Water Institute (SUWI), Al Perold Building, Victoria Street, Stellenbosch
W	De Clercq	Stellenbosch University Water Institute (SUWI), Al Perold Building, Victoria Street, Stellenbosch

Introduction

Numerous technologies have been developed to support farmers to schedule their irrigation more effectively. This study set out to determine to what extent, if at all, farmers in the Middle Breede River Catchment use technology to inform their scheduling. Particular attention was paid to the use of an existing, free remotely sensed product in the Western Cape, Fruitlook™. The second aim of the study was to analyse whether remote sensing is useful to farmers as a decision-making tool for scheduling.

Materials and Methods

Farmers' uptake of technology was tested using questionnaires that were completed by the researcher during personal interviews. Thirty-seven farmers were contacted for interviews. Farmers interviewed are located between Robertson, Bonnievale and Ashton, plus one in Worcester. The interviews also tested farmers' opinions on the usefulness of remote sensing. In order to quantify the usefulness of remote sensing, comparisons were drawn between hourly weather and soil moisture data, and Fruitlook data. Soil water data were obtained from six farmers with soil probes and weather data from stations between 500 m and 10 km from these farms.

Results and Discussion

Twenty-nine farmers agreed to be interviewed. Twenty-four farmers (83%) use soil water measurements, or are in the process of installing equipment, to inform their irrigation scheduling. Amongst these farmers, 16 (67%) use Irricon continuous logging probes coupled to a computer dashboard, 4 (14%) use Neutron water meters, one person uses a tensiometer and one a mobi-probe. Only one farmer reported to use a pressure bomb (leaf water potential) and one uses remote sensing through the Fruitlook programme. All farmers deem experience and intuition as important, or more important than the technology they use. No significant relationship exists between age or farm size and the uptake of technology. The analyses of remote sensing data against weather and soil moisture measurements showed that while it can serve as a warning tool for farmers, it is not suited as an everyday decision-making tool for scheduling.

Conclusions

Amongst commercial farmers in the Middle Breede Catchment, soil water probes were found to be the preferred technology for scheduling, but there is still a heavy reliance on experience and intuition. Only one out of 29 farmers use remote sensing to inform their scheduling decision-making, which shows that farmers are not adopting technology, even if it is freely available to them. Further analyses showed that remote sensing is not yet accurate enough for daily irrigation demand decision-making purposes.

Measuring and modelling triazine leaching in contrasting South African soils

Presenter: SD Dlamini (saneleddlamini@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
SD	Dlamini	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
M	Van der Laan	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
PC	De Jager	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
JM	Dabrowski	Confluent Environmental, Private Bag X03, Gezina, 0031, RSA

Introduction

Increased use of pesticides in South Africa raises concerns regarding potential impact on our water resources. Over 400 active ingredients are registered for use locally, with little knowledge on their transport and fate in the environment. Improved modelling capacity can help us reduce these uncertainties. We studied triazine (herbicide) leaching in contrasting South African soils, including a high clay, very sandy, highly structured, and soils subjected to both conventional tillage (CT) and conservation agriculture (CA) management.

Materials and Methods

The laboratory leaching column study set-up was initially assessed using chloride (Cl) as a conservative tracer, for example to screen for unacceptable bypass flow along the column walls. A total of six different soils were considered for the main study, collected around Pretoria as undisturbed soil cores. Soil pH (water) ranged from 5.5-6.5, saturated paste extract salinity from 150-450 mS m⁻¹, and CEC ranged from 4-10 cmolc kg⁻¹. Clay content ranged from 10-60% and the saturated hydraulic conductivity ranged from 0.0864-8600 mm day⁻¹. Atrazine and terbuthylazine were applied at recommended rates and then leached over a period of two months with between 10 and 12 pore volumes for each column. Leachate was analysed using gas chromatography and break-through curves (BTC's) established. Data was compared with PWC (Pesticide in Water Calculator) model outputs to assess predictive capability of pesticide leaching.

Results and Discussion

Chloride leaching BTC's indicated that the leaching column set-up was suitable for studying herbicide leaching. BTC's varied for different soil types and management practices. Herbicide leaching rates were closely related to the adsorption coefficient (K_d) and hydraulic conductivity (K) of the soils. Further work is currently underway to better understand pesticide leaching dynamics under CA versus CT practices, and these findings will be presented.

Conclusions

Improved knowledge on pesticide leaching dynamics in South African soils is essential to minimize the export of these compounds to the environment and make regulatory decisions on what active ingredients can be used and where.

Improving the performance of crop models by using remote sensing data

Presenter: L Dlamini (lulehdlamini@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Dlamini	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, Rondebosch 7701, Cape Town, South Africa
O	Crespo	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, Rondebosch 7701, Cape Town, South Africa

Introduction

Climate change is expected to exacerbate the stress already endured by rural agriculture. One technical edge could lie with numerical tools such as crop models can be used to improve rural agriculture. Those crop models are key tools used to explore sustainable ways to increase production at various locations, under variable conditions. However, the lack of data is a major challenge for the calibration and validation of these models. Combining remote sensing (RS) data with crop models may provide an effective way to improve the performance and use of crop models, especially in data-limited areas (Yaping *et al*, 2008). This has successfully been conducted in Asia, America and Africa (Mishra *et al*, 2013; Leroux *et al.*, 2017). Nonetheless, few studies have integrated RS data with crop models in South Africa. Therefore, the aim of this study is to explore how to best use RS data in combination with crop modelling tools, with the intent to improve the crop yield simulations in field data-limited areas.

Materials and Methods

This study will use global daily soil moisture (SM) data from the European Space Agency with a resolution of 25 km. We propose to use the RS (1) soil moisture (2) data to re-calibrate DSSAT model and achieve a satisfactory calibration of the numerical tools without field data, in Bloemfontein. This will be achieved by modifying the model soil profile, planting rows and crop variety to reduce the SM difference, over the growing and non-growing season and repeated with consideration of inter-annual variability, and long-term trend. Maize yield will also be simulated and compared to the observed records.

Results and Discussion

Without recalibration, the model was able to capture the long-term variability and trend of yields but generally underestimated the yields. The model performed better at simulating SM during the non-growing season and it captured the inter-annual variability of SM. Modifying the soil profile slightly decreased the difference between the RS SM and simulated SM. We believe that altering more variables will produce better results.

Conclusions

Although actual field data cannot be obtained, where this data is unavailable, we expect to demonstrate the added value of using remote sensing and to assess this improvement in the case of Bloemfontein, DSSAT and soil moisture. We expect that this framework can offer rural agricultural advisors decision support that is currently available under high data conditions.

Site-specific determined fitness-for-use of irrigation water using electronic decision support

Presenter: HM Du Plessis (meiringd@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
HM	Du Plessis	Department of Plant and Soil Sciences, University of Pretoria, Pretoria
JG	Annandal	Department of Plant and Soil Sciences, University of Pretoria, Pretoria
N	Benade	Department of Plant and Soil Sciences, University of Pretoria, Pretoria

Introduction

It is prudent to determine the fitness of the water source before embarking on any irrigation development, and at regular intervals afterwards, in order to pro-actively identify and circumvent potential water quality induced problems. Water resource managers are concerned with the flipside. They need to know what the water quality should be so that it will not jeopardise irrigation in a specific area.

Materials and Methods

A Decision Support System (DSS) that introduce site-specificity and consider risk was developed in response to a directed call by the Water Research Commission to revise the 1996 South African Water Quality Guidelines. A team of specialists reviewed the current South African and international irrigation water quality guidelines, to identify the factors that determine general and site-specific risks associated with water quality constituents. This knowledge was incorporated into a user friendly DSS.

Results and Discussion

The DSS considers the effect water quality constituents have on soil quality, crop yield, crop quality and irrigation equipment. Each of these indicators are further subdivided into several sub-indicators, the output of which are colour coded to display the water's fitness-for-use as being 'ideal', 'acceptable', 'tolerable' or 'unacceptable'. The DSS operates at two levels or tiers. Tier 1 provide generic, conservative, guidance regarding the effects of water quality constituents and resembles the 1996 guidelines. Tier 2 assessments are more rigorous and are used to determine whether the fitness-for-use of a water would not be assessed as more favourable when site-specific conditions are considered. A scaled down version of the Soil Water Balance model is used to dynamically simulate the interactions between irrigation water constituents and the soil-crop- atmosphere system over a period of up to 50 years and quantify the probability and severity of a specific effect occurring. Pre-defined databases allow the user to select an appropriate weather station, soil texture, irrigated crop, irrigation management and system. Examples are presented of how the fitness-for-use of an irrigation water changes under different site-specific conditions.

Conclusions

A DSS was developed that estimates the risks associated with using water of a known composition at a specific site. It also provides guidance about the desired water quality to maintain successful irrigation.

Composted municipal solid waste soil treatment effects on availability and crop uptake of lead and cadmium

Presenter: PH Dube (dube2@webmail.co.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PH	Dube	Department of Agriculture, Forestry and Fisheries, Private Bag X 343, Pretoria, 0001

Introduction

Disposal of municipal waste organic output (MWOO) into landfill sites is creating a major dilemma for most developing and developed countries (Epstein *et al.*, 1992). The use of MWOO in agriculture as a soil amendment can reduce organic waste in landfills and benefit farmers simultaneously. Municipal waste organic output is associated with heavy metals which pose a risk to humans through the food chain and the environment (Smith *et al.*, 2009; Hargreaves *et al.*, 2007). Mkhabela and Warman (2005) noted that the use of composted MWOO in agriculture is gaining popularity.

Materials and Methods

The experiment was conducted at the University of New England glasshouse, Armidale, in the region of New England, New South Wales, Australia. Bulk soil samples were collected, classified and prepared. Analysis of soil and MWOO was carried out in triplicate. Analyses measured were pH in 1:5 soil: water ratio (m/m), electrical conductivity (EC) (1:5 soil: water). Exchangeable cations (Ca, K, Mg and Na) were measured in ammonium chloride at pH 7 using ICP-OES and Cowell P method was used for phosphorus determination. Soil organic matter and nitrogen were determined using Truspec-LECO.

Results and Discussion

Treatment biomass in both crops was significantly greater than control biomass. The overall biomass of sorghum was significantly lower than maize. The greatest yield in maize was obtained at a rate of 100t ha⁻¹ of MWOO but it was not significantly different to other biomass at 50 and 140 t ha⁻¹ MWOO application rates except for control. Sorghum shoot biomass was similar between the three treatments except for the control which was significantly less. The highest root biomass yield in maize was obtained at MWOO application rate of 140 t ha⁻¹. Between the two crops maize had higher Cd concentration in roots than sorghum but sorghum had significantly higher shoot Cd concentration than maize. Cd concentration in maize shoot was highest at control and it followed an increasing trend with an increase in application rate.

Conclusions

MWOO application increased Pb and Cd in roots, was different in treatments and tended to increase with an increase in application rates but the translocation to above ground plant parts was the same in plants in all treatments and crops. Despite the similarities in above ground plant Pb and Cd concentration the tended to increase slightly with an increase in MWOO application rate.

Genotype by region interactions of released sugarcane varieties in the South African sugar industry

Presenter: S Duma (Chillexor@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Duma	UKZN, Private Bag X1, Scottville, 3209 (212524170)
H	Hussein	UKZN, Private Bag X1, Scottville, 3209
S	Ramburan	N/A

Introduction

Sugarcane (*Saccharum officinarum*) yields in South Africa are largely affected by genotype by environment interactions (GEI). The objective of this study was to investigate the nature of genotype x region interactions among selected sugarcane genotypes based on regional evaluation trials to inform future testing strategies.

Materials and Methods

Eleven sugarcane hybrids were evaluated across five regions of the industry, including the Midlands (M), Hinterland (H), South Coast (S), North Coast (N), and Irrigated North (I). Sugarcane genotypes were tested using a randomized complete block design with four replications in each trial, and harvested over three to five crops. Data were collected for cane yield (TCANE), estimated recoverable crystal content (ERC), and ERC yield (TERC). Data were analysed using combined analysis of variance, additive main effects and multiplicative interaction (AMMI) and genotype plus genotype by environment (GGE) bi-plot analyses.

Results and Discussion

Significant ($P > 0.001$) effects of genotypes, locations, crop year and their interactions were found for all three traits. Genotype x location contributed more to variation than genotype x crop. The AMMI biplot revealed differential genotype interactions with regions, and showed that the M and H regions discriminated genotypes similarly. Results from AMMI were in agreement with GGE biplot in terms of site discriminating ability, genotype mean performance and stability.

Conclusions

The GGE biplot identified two mega-environments (MGE) for the industry, with MGE1 comprising the M and H regions and MGE2 comprising the S, N, and I regions. This preliminary study is the first to have identified two broad regional groupings in the industry, and this may have implications on breeding strategies.

How will the projected new climate affect crop growth suitability over West Africa?

Presenter: TS Egbebiyi (EGBTEM001@myuct.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
TS	Egbebiyi	Department of Environmental and Geographical Science, University of Cape Town, Private Bag X3, Rondebosch, 7701, Cape Town, South Africa
OB	Crespo	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, Private Bag X3, Rondebosch, 7701, Cape Town, South Africa
C	Lennard	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, Private Bag X3, Rondebosch, 7701, Cape Town, South Africa

Introduction

The West African region is highly dependent on rainfed agriculture as means of livelihoods and mainstay economy. Climate strongly affects rainfed agriculture with direct consequences on food security (Schulesser *et al.*, 2016, Sultan and Gaetani, 2016) Future climate is projected to deviate from present-day by unprecedented measure with direct consequences on agricultural production with increasing global warming (Mora *et al.*, 2013). However, there is need to understand how the projected new climate due to deviation from historical variability will affect crop suitability over the region. Hence, the need for this study which aim is to investigate how the projected emergence of new climate will affect crop growth suitability over West Africa. This is information is very crucial in understanding the influence of the emerging new climate on crop suitability growth over West Africa.

Materials and Methods

10 Global Climate models downscaled by regional climate model, RCA4 was used to generate climate data used as input into crop suitability model, Ecocrop. The crop data are obtained from Ecocrop crop threshold database for computing crop growth suitability for maize, millet, cassava, plantain, pineapple, tomatoes, cowpea and groundnut based on FAO statistics. We computed monthly climatological mean for a 20-years running periods, at every 5 years timesteps for t-min, t-mean and precipitation from 1951-2100. The resulting 12 months values per 20-year window was used as changing climatology inputs in driving, EcoCrop and to compute suitability for each crop. The overlap period (1951-2010) period between the observation and the downscaled GCMs were used as input crop suitability model, EcoCrop to assess crop suitability in the zone over the past climate.

Results and Discussion

Our findings showed that the emergence of new climate will be more severe on root and tuber crops notably cassava as compared to other crops. The legumes crops will perform better with increase suitability as compared to the other crops under a new climate with increasing global warming. The suitability of horticultural crop notably pineapple will also decrease with increased warming over the region. However, maize is projected will increase in suitability and spatially going into the Sahel as compared to the historical climate with increased warming.

Conclusions

This study shows new climate may be more detrimental to the root and tuber crops in comparison to other crops like cereals, legumes and horticulture. It will also improve our understanding on how the emergence of new climate can strongly influence climate-crop suitability thresholds over West Africa in the future.

Value-adding potential of pomegranate fruit to reduce post-harvest losses: a cosmeceutical perspective

Presenter: OA Fawole (olaniyi@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
OA	Fawole	0002 Al Perold Building, Stellenbosch University
UL	Opara	0002 Al Perold Building, Stellenbosch University

Introduction

Pomegranate fruit has become one of the most important specialty crops in South Africa. However, postharvest losses of pomegranate between 20 to 40% limit fruit supply and consumption despite its high demands (POMASA, 2015). Sunburn alone renders 15% of pomegranate fruit unmarketable as fresh fruit in both export and local markets. Sunburn bleaches the characteristic red colour of the pomegranate aril. As a result, such fruit are usually used as cattle or pig feed or disposed of as waste, resulting in an environmental problem. From industrial and health perspectives, the most effective way to add value to sunburned pomegranate is to utilize the seeds for oil which can be used as a functional ingredient in the cosmeceutical industry. This was the focus of this study.

Materials and Methods

Oil samples were extracted with petroleum ether by ultrasonification after drying using different drying techniques (freeze-, sun- and oven-drying). Compositional analysis included p-anisidine value, total phenolic content (TPC) as well as essential oils and sterols while the investigated bioactivities included radical scavenging ability (RSA) using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and tyrosinase enzyme inhibition ability.

Results and Discussion

Results showed that oven-dried seeds, regardless of seed source (Sun-burned fruit, SBF or Healthy fruit, HF), yielded higher oil ranging from 20.20% to 24.35% of dry matter. However, regardless of drying method, oil obtained from SBF contained higher TPC (1.4 – 2.8 mg g⁻¹ of oil gallic acid equivalent, GAE) than those obtained from HF. A total of 17 compounds were identified by GC-MS analysis with the predominant being 9,12,15- Octadecatrienoic acid, a conjugated linolenic acid, constituting 70-72% of total essential oils. Gamma-tocopherol constituted 95% of total tocopherol while β -sitosterol constituted between 85-87% of total sterols. Overall, good RSA was exhibited by all oil samples with IC₅₀ ranging from 34.77 to 59.29 μ g ml⁻¹ AAE. RSA was influenced by seed source ($p = 0.006$) and drying method ($p = 0.025$). All the oil samples showed good ability to inhibit tyrosinase enzyme regardless of seed source and drying method, with monophenolase and diphenolase IC₅₀ ranging between 0.31 and 0.49 mg ml⁻¹ and 0.64 and 2.43 mg ml⁻¹, respectively.

Conclusions

This study indicated that seeds from sunburned pomegranate fruit can be exploited for high quality oil due to similar yield and bioactive composition compared with oil extracted from healthy fruit. In general, regardless of drying method, oils from seeds of SBF and HF both had good antioxidant activity and tyrosinase enzyme inhibition ability, which is applicable in skincare and beauty industries.

Floristic composition of weed species in rooibos fields

Presenter: MI Ferreira (mikefe@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MI	Ferreira	Plant Sciences, Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7607 South Africa

Introduction

Rooibos occurs naturally in the Cape Floristic Region of South Africa where it is an endemic plant of the fynbos biome, and as such presents a unique weed spectrum. Information on native weeds occurring in this area would be beneficial in the selection of necessary control procedures and the development of new production practices. The aims of this survey were to determine the weed species composition and provide baseline information on rooibos fields for future comparison.

Materials and Methods

A weed survey was conducted in ten rooibos fields at two localities in the rooibos production area, namely Clanwilliam and Nieuwoudtville, during March and September. Twenty sampling points along an inverted 'W' pattern were randomly allocated and separated by about 20 m each. At each sampling point, weed species were identified and the number of individuals inside a 0.25 square metre quadrat recorded. Data were used to calculate frequency, uniformity, relative density and abundance for each species.

Results and Discussion

A total of 14 weeds were observed within quadrats in this survey. The weed spectrum in both localities was dominated by broad leaf weeds, but it differed significantly between localities. Across localities, the most common and serious weed was musk heron's bill with a frequency of 14.8%, density of 16.2 plants per square metre and an abundance of 45.1%. Ryegrass had the greatest uniformity at 13.7%. Other weeds that occurred within quadrats in frequencies greater than 10% included Cape marigold and wild radish. Stinking weed, as a native plant, had the second highest density at 15.4%.

Conclusions

Differences in weed management and the particular environmental factors influence the configuration of weed communities. This information is vital to set weed research priorities and direct research toward new control measures.

Disaggregation of the land type survey to estimate erosion risk

Presenter: TCF Flynn (17369916@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
TCF	Flynn	Private Bag X1, Matieland, 7602

Introduction

Soil water erosion effects on field crop yields by removing topsoil material which store and release nutrients. This removal further effects water quality by polluting rivers with sediment and nutrients which decrease photosynthesis from aquatic plants and can cause eutrophication. Traditionally, digital soil mapping uses soil observations to train machine learning algorithms and predict the spatial distribution of soils. However, soil observations are costly to obtain and do not utilise existing resources such as the Land Type Survey. It is hypothesized that the Land Type Survey can be disaggregated into generalised soil erosion indices suitable for environmental models and policy making.

Materials and Methods

The research site is the Mvoti catchment encompassing 317 square kilometers in the Midlands, Kwa-Zulu Natal. The double disaggregation method implemented in this study, follows the structure of the Land Type Survey. First, landform elements were classified through a novel pattern recognition algorithm known as geomorphons. The landform elements were used to stratify land types into terrain units. The terrain units were disaggregated further using a novel machine learning algorithm known as "Disaggregating and harmonising of soil map units through resampled classification trees". Three erosion indices according to the CORINE model were estimated which classify the inherent risk a soil has to erosion, the actual erosion risk taking into account vegetation, and the susceptibility to an increase in erosion risk when changing land use. The disaggregation method was compared to estimating the erosion indices with 900 soil observations using 70:30 train to validate samples.

Results and Discussion

The disaggregation method produced accuracies of 61%, 76%, and 96% for the three indices, respectively. The catchment is characterised by low actual erosion risk, however, forest plantation and natural shrubs are susceptible to land use change. The soils of the site are resistant to erosion due to a high soil organic carbon content in the topsoils and Fe content and deep effective rooting depth of the subsoils. These characteristics can be seen in the humic top soils and deep apedal subsoils, respectively.

Conclusions

The disaggregation of the Land Type Survey produced erosion risk estimates comparable to estimating erosion risk through soil observations. The results obtained were satisfactory and show potential in estimating additional soil attributes specified in the Land Type Survey and attributes that can be calculated from the Land Type Survey.

Heat stress in potato: how hot is too hot?

Presenter: A C Franké (FrankeAC@ufs.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
AC	Franke	University of the Free State, Bloemfontein
ATB	Machakaire	University of the Free State, Bloemfontein / McCain Foods
JM	Steyn	University of Pretoria, Pretoria

Introduction

Recent crop modelling studies indicated that potato yields and water use efficiencies in South Africa will be negatively affected by increased heat stress in future (2050) (Haverkort *et al.*, 2013; Franke *et al.*, 2013). However, positive impacts of elevated ambient CO₂ levels on photosynthesis and transpiration are expected to outweigh negative impacts from increased heat stress in coastal and high altitude regions, but not in warmer interior regions. The outcome of such studies however is highly sensitive to assumptions regarding cardinal temperatures affecting photosynthesis and radiation use efficiency (RUE).

Materials and Methods

The growth of potato (summer crop under irrigation, varieties Mondial and Sifra, sandy to loam soils) was monitored in five farmers' fields over three seasons (2015-2018) in the western Free State (Christiana) and North West province (Louna) of South Africa. Growth parameters (leaf area, radiation interception, biomass of plant parts), crop management information, and weather data from a station adjacent to the field were used to evaluate the cardinal temperatures commonly applied in potato growth models, obtained through a survey of literature.

Results and Discussion

High maximum day temperatures (>38°C) commonly recorded during the growing season did not appear to have any severely negative impact on canopy development and photosynthesis rate. Canopy development was as expected and the crop remained full crop cover for most of the growing period. The large observed yields of 85-100 t fresh tuber ha⁻¹ were presumably close (80-90%) to potential production. Using a RUE of 2.5 g MJ⁻¹ PAR and a forced leaf area development, potential yields estimated by a RUE-based crop model greatly varied depending on the cardinal temperatures chosen, but were in many cases lower than observed yields, suggesting model predictions were wrong.

Conclusions

The ability of potato to photosynthesise well under high temperatures is underestimated with at least some of the commonly used cardinal temperatures in crop growth models, impacting their ability to assess future impacts of climate change. Possibly, current varieties are better adapted to high day temperatures than older varieties from which temperature-photosynthesis relationships have been derived. In addition, crop management techniques, such as evaporative cooling of the crop through overhead irrigation during the hottest time of the day, can reduce heat stress. Observations from weather stations outside the cropped field may thus not be that representative for conditions in the crop canopy.

Evaluation of Cowpea genotypes using nutritional values in the grain

Presenter: AS Gerrano (agerrano@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
AS	Gerrano	Agricultural Research Council, Vegetable and Ornamental Plants, Private Bag X293, Pretoria, South Africa
WS	Jansen van Rensburg	Agricultural Research Council, Vegetable and Ornamental Plants, Private Bag X293, Pretoria, South Africa
M	Bairu	Agricultural Research Council, Vegetable and Ornamental Plants, Private Bag X293, Pretoria, South Africa
S	Venter	Agricultural Research Council, Vegetable and Ornamental Plants, Private Bag X293, Pretoria, South Africa

Introduction

Cowpea is a good source of protein, essential minerals including Ca, Cu, Fe, K, Mg, Mn, Na, P, and Zn vitamins, carbohydrates and antioxidants that are essential for human health, growth, and development (Berdanier *et al.* 2016). Nutritionally enhanced plant varieties provide considerable amounts of bioavailable nutrients useful to alleviate nutrient deficiency among rural and urban populations. The objective of this study was to assess the grain minerals and protein composition of diverse cowpea collections to select promising parents to develop a breeding population.

Materials and Methods

The seeds were collected from the ARC gene bank and planted at two sites for nutritional evaluation. The seeds were manually sorted and cleaned to remove any extraneous materials. The seeds were then oven dried at 80°C for 24 hours to reduce the moisture content. The dried seeds were ground using a laboratory seed grinder and then sieved using a 0.5 mm sieve. From this, 0.5 g of flour was sampled for analysis. Mineral content and protein analysis was conducted at the ARC Soil, Water and Climate analytical laboratory, Pretoria, South Africa. The concentration of nine mineral elements, including Ca, Cu, Fe, K, Mg, Mn, Na, P and Zn were determined using an Atomic Absorption Spectrophotometre (Spectra AA 300). Crude protein content ($N \times 6.25$) was determined by the combustion method (Leco®model, FP-528, St. Joseph, MI). The data set was subjected to analysis of variance (ANOVA) and PCA using GenStat for Windows 17th edition (Payne *et al.* 2016) statistical software.

Results and Discussion

The present study assessed genetic variability of 22 cowpea genotypes for mineral elements and grain crude protein content under two environmental conditions. The cowpea genotypes showed a wide range of genetic variability for the mineral elements and protein content. This genetic variability would contribute to achieving food security and improved nutrition towards sustainable production and conservation of biodiversity of cowpea (Badigannavar *et al.* 2015) and finally to the grain. The diversity present among the genotypes for the mineral elements and protein content suggested their importance in cowpea breeding.

Conclusions

The present study found a wide range of genetic diversity among the 22 cowpea genotypes that were evaluated for concentration of selected mineral elements and crude protein content. The identified cowpea genotypes are useful genetic resources for breeding population development and cultivar release emphasising enhanced grain nutrients composition.

Fruit for thought: The Kei apple as an indigenous fruit with agro- processing potential

Presenter: E Hajari (HajariE@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
E	Hajari	Agricultural Research Council-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, Mpumalanga, South Africa
D	Nonyane	Agricultural Research Council-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, Mpumalanga, South Africa
K	De Jager	Agricultural Research Council-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, Mpumalanga, South Africa
R	Du Preez	Agricultural Research Council-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, Mpumalanga, South Africa
W	Augustyn	Department of Chemistry, Tshwane University of Technology, PO Box 56208, Arcadia, Pretoria, 0007, South Africa
T	Regnier	Department of Chemistry, Tshwane University of Technology, PO Box 56208, Arcadia, Pretoria, 0007, South Africa

Introduction

The Kei apple (*Dovyalis caffra* Warb.) is indigenous to southern Africa and has been identified as having the potential to promote rural development and sustainable land care and as a candidate for new food and beverage products. When ripe, the fruit produced are eaten by rural villagers despite its sour taste. Fruits have also been used to produce jams, jellies, marmalades and as a filling for pies. The pulp can be diluted and sweetened to produce nectars and the fruit can be dried into fruit leather. Kei apples have been identified as an indigenous fruit of interest since they are nutritious with a high vitamin C and polyphenol content. The present study investigated the molecular diversity and chemical composition of Kei apple selections. Since there have been no reports on the genetic characterisation of Kei apple, the Sequence-Related Amplified Polymorphism (SRAP) markers were tested as they are recommended for species with little published genetic information.

Materials and Methods

Genomic DNA was extracted from leaves using a commercially available kit. All SRAP primers were first screened with a select, but phenotypically diverse, sub-sample of cultivars. Primers that gave clear peaks and provided non-ambiguous scoring data were used to further analyse selections. The SRAP markers used were as per Li and Quiros (2001). The PCR products were visualised via capillary electrophoresis. All reactions were repeated to verify data.

Results and Discussion

Forty Kei apple selections and four closely related species within the same family were investigated. The co-phenetic correlation coefficient (CCC) value obtained was 0.986 with the Jaccard method, which indicates a good fit between the data and analysis method. The cluster analysis indicated separation into three main groups. The first comprised the closely related outlier species which were used to root the tree. The Kei apple selections separated into two groups with most of the females occurring in one group and all of the males in the second. Six female trees were found to group with the males. These results were also compared with chemical analysis of Kei apple fruit, viz. protein content, antioxidant activity, total phenolic content and volatile metabolic profiling.

Conclusions

The tested markers were found to be suitable to assess the genetic relatedness amongst Kei apple selections. The markers could separate males from females with some overlap. A good relationship was found between chemical profiling and genetic analyses.

Progress towards the micropropagation of Macadamia

Presenter: K Hannweg (karin@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
K	Hannweg	Private Bag X11208, Nelspruit, 1200
M	Penter	Private Bag X11208, Nelspruit, 1200

Introduction

Micropropagation was initially developed as a useful tool for the rapid propagation of elite genotypes. Subsequent to this breakthrough, the last half century has seen a variety of regeneration systems being developed, with application in plant breeding and improvement programmes for a wide range of plant species. Unfortunately, both clonal multiplication and the use of *in vitro* manipulation as tools in breeding and improvement programmes of tropical and subtropical fruit crops are hampered by a number of challenges. Not only do aspects such as physiological status, genotype and environmental factors play a role in successful initiation and subsequent manipulation, but also, amongst others, high levels of secondary metabolites (e.g. phenolic compounds), exogenous and endogenous pathogens and response to various *in vitro* conditions. Progress towards the successful initiation and manipulation of field-grown clonal material of macadamia HAES 814 will be presented.

Materials and Methods

In vitro methods involve the optimisation of all steps in the procedure, including selection of mother material in the optimum state, sterilisation of field-grown material, optimum explant type selection, the most appropriate method for the eventual outcome required as well as the optimum use of plant growth regulators and gelling agents. Two different direct organogenesis systems were investigated using various explants. The effect of sterilisation methods (CaOCl and H₂O₂), plant growth regulators (BAP, GA₃ and TDZ) as well as the effect of gelling agents (Gelrite® and agar) on tissue manipulation were explored.

Results and Discussion

Since macadamia is difficult to manipulate, both a clonal shoot culture method using nodal explants as well as a thidiazuron (TDZ)-mediated method using kernel, integument and leaf sections were investigated. Young, green, just hardened-off shoots were most successful in terms of contamination risk, oxidation by phenolic compounds and ease of manipulation for shoot cultures. BAP at 1 mg l⁻¹ was optimum for shoot proliferation, however GA₃ when added to the culture medium to stimulate shoot elongation, induced shoot hyperhydricity. This phenomenon was also observed when Gelrite®, rather than agar, was used to solidify the culture medium. For the TDZ-mediated method, embryo-like structures developed on the tissue sections and these eventually formed shoots.

Conclusions

Although significant progress towards the *in vitro* propagation of macadamia was made in this study, rooting of the shoots is currently being investigated since the success of any *in vitro* protocol requires that micropropagated propagules be acclimatised under ambient conditions.

Organic manure application on crude oil impacted soil: Effect on growth and macro-nutrients accumulation in roots and leaves of Cassava (*Manihot esculenta* Crantz) in Nigeria

Presenter: UE Harrison (ubongeharrison@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
UE	Harrison	Department of Biology, College of Education, Afaha Nsit, Akwa Ibom State, Nigeria
SR	Osu	Department of Biology, College of Education, Afaha Nsit, Akwa Ibom State, Nigeria

Introduction

Cassava is one of the most important staple food crops grown in Nigeria (Teye *et al.*, 2011). Cassava cultivars (TMS-30572, NR-8082) and Local Variety (LV) are commonly grown in the Niger Delta area of Nigeria where oil spillage often occurs (Harrison *et al.*, 2018). Soil amendment with organic manure has the potential to improve the fertility of crude oil impacted soils (Ijah *et al.*, 2008). The objective of this study is therefore, to assess the effect of soil amendment with organic manure on growth and accumulation of macro-nutrients in cassava cultivated in soils that have been polluted by crude oil.

Materials and Methods

Field experiment was conducted in 2016/2017 cropping season to assess the effectiveness of oil palm bunch ash (OPBA), dried poultry manure (DPM) and combined application of OPBA and DPM as organic materials for the amendment of crude oil impacted soil at Ikot Ada Udo, a village in the Niger Delta region of Nigeria, using Cassava (Crantz) as test crop. This experiment was a 3 x 4 (three Cassava varieties and four amendments, including control) factorial fitted into a randomized complete block design (RCBD) with three replications. Soil samples were collected prior to the experiments and analyzed for physical and chemical properties. Data were collected on Cassava growth - plant height (cm), number of nodes per plant, stem girth (cm) and leaf area (cm²). At harvest, the roots and leaves of Cassava plants were sampled and analyzed for macronutrients. Data collected were subjected to Analysis of Variance (ANOVA) and Standard Error Means (SEM). Least Significant Difference (LSD) was employed to separate means.

Results and Discussion

Results showed that improved cassava varieties (TMS-30572 and NR-8082) had higher growth rate than local variety (LV). The combination of DPL and OPBA gave higher Cassava growth (plant height of 206.7 cm, number of nodes per plant of 106.94, stem girth of 7.89 cm and leaf area of 463.2 cm²) at 36 WAP than their single applications. However, potassium was the most dominant macronutrient in both cassava roots and leaves with leaf concentration ranging from 3069±185 to 8480±488 mg kg⁻¹, while that of the root ranged from 1989±388 to 3000±487 mg kg⁻¹.

Conclusions

Based on the findings, soils amendment with organic manure improved growth and enhanced the accumulation of macronutrients in both the root and leaf of Cassava.

Identifying indigenous non-agricultural uses of soil by selected communities in Kwazulu-Natal, their safety for use and understanding the soil properties governing these uses

Presenter: NI Hlatshwayo (noxolomhayise@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NI	Hlatshwayo	University of KwaZulu-Natal King Edward Avenue, Scottsville, Pietermaritzburg, 3201

Introduction

Soil is mostly used for agricultural purposes, however the non-agricultural use of soil has not been well explored. In many parts of Africa and South Africa, soil is used as skin cleanser, sunscreen, for body beatification, to treat skin diseases and gastrointestinal tract problems, as well as for geophagy. Geophagia is a practice of consuming soil for cultural purpose, enjoyment or to satisfy a craving. Problems associated with soil use however are that not much information is available on their safety to humans for the various purposes. This study sort to identify the non-agricultural uses of soil by selected communities in Kwazulu-Natal (KZN), and their safety for use through different biological (microbial biomass, microbial counts), and physico-chemical soil analyses. Questionnaires were used to identify these uses in Elandskop and KwaNxamalala in Pietermaritzburg (PMB), while soil properties were determined using standard laboratory techniques.

Materials and Methods

Fifty questionnaires were distributed per area. The soil colour was characterised by Munsell colour chart. The soil particle size was determined by using hydrometer method and bacteria and fungi was determined by colony count.

Results and Discussion

Findings showed that soils were mostly used for cosmetic (sunscreen, skin cleansing) and geophagia purposes, followed by medicinal use (skin problems, heal ingcabo (traditional incision) while use for construction was relatively minor. Cosmetics and traditional uses, they use same soil types. The result for cosmetic soils had pH ranges of 4-6 in water and 4-5 in 1M KCl, which was within the range of normal skin pH. The dominant colours for cosmetic soils were red and light red, which are effective for sun screening abilities. Soil textural classes of cosmetic soils ranged from silty loam, silty clay loam to clay loam. Soils used for geophagia however had colours that varied from reddish yellow, brown to reddish brown, while their pH values ranged between 4-5 in water and 4-4.7 in KCl. Soil textural classes for geophagia were silt loam, sandy loam and sandy clay loam. Bacterial colony counts for cosmetic range from 1×10^5 to 5×10^6 and for fungi and 1×10^5 to 8×10^6 . Geophagic soils colony for bacteria ranged from 1×10^5 to 8×10^6 CFU g^{-1} and for fungi it was between 1×10^6 to 7×10^6 CFU g^{-1} of soil which indicates high contaminating microorganism that are not safe for consumption.

Conclusions

Soil colour is traditionally used to identify the soil uses of testing. The soils are not safe for consumption they indicated high contaminating microorganism

Insects in Agriculture-competitors or allies

Presenter: A Jankielsohn (jankielsohna@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Jankielsohn	ARC-Small Grains, Private Bag X29, Bethlehem, 9700

Introduction

Sufficient food production for a growing human population has become an issue of global concern. The challenges are to secure high and quality yields sustainably. In the race for survival insects have been predominantly perceived as competitors. Insects are however vital within our food supply chains. Soil is the regulating center of nutrient cycling processes, both in natural ecosystems and agroecosystems. Dung beetles contribute to soil health by increasing nitrogen, phosphorous, potassium, calcium and magnesium or total proteins content and actively contribute to the ecological process of nutrient cycling through burial of dung and in constructing nesting galleries in the soil. Dng beetle assemblages can be a useful tool in developing environmentally sustainable agricultural practices. The aim of the study is to describe the structure of dung beetle communities in both crop and grazing ecosystems and correlate their presence and diversity to the physical and chemical properties of soil in these systems.

Materials and Methods

Dung beetles were monitored from September to December in grazing and crop ecosystems. Monitoring was done in two areas in the Eastern Free State at Reitz and Vrede. At Reitz a total of 9 sites were monitored: 4 grazing sites, 4 conservation agriculture crop sites and 1 conventional agriculture crop site. At Vrede a total of 11 sites were monitored: 2 grazing sites, 9 conservation agriculture crop sites and 2 conventional agriculture crop site. Each site was monitored for 24 hours with three dung baited pitfall traps, spaced 50 m apart. Collected samples were sorted, identified, and counted. Data were analysed for significant differences in abundance, diversity and assemblage structure. Functional feeding groups were analyzed.

Results and Discussion

Significant differences in the structure of dung beetle assemblages were found between the different sites and different months indicating that cultivation practices have an influence on the structure of dung beetle assemblages impacting their ecosystem services.

Conclusions

Using dung beetle assemblages can be a useful tool in developing environmentally sustainable agricultural practices. Dung beetles return carbon and nitrogen in cattle and sheep dung to the soil to maintain the nutrient cycles. There is a decreased need for artificial fertilizers and agrochemicals where diverse dung beetle assemblages are present. In order to benefit from the ecosystem services provided by a dung beetle assemblage both temporal and spatial diversity is important in this assemblage. A sustainable dung beetle assemblage can be supported by changing cultivation practices.

Seed potato sprouting pattern in response to foliar applied Paclobutrazol and storage conditions

Presenter: KB Jokazi (kbjokazi@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KB	Jokazi	Döhne Agricultural Development Institute, Private Bag X 15, Stutterheim, 4930

Introduction

Potato (*Solanum tuberosum*) is an important source of nutrition for human consumption. Planting material is a very important component for improving tuber yield and quality of the subsequent crop. The performance of 'seed potatoes' is determined by both external and internal factors in the field (during production), during harvest and at storage (Ezequiel and Singh, 2003). After harvest, potatoes exhibit a state of dormancy, a stage at which it is regarded to be of high quality for consumption. The duration of the dormancy period and sprout growth rate determine the tuber's storage life (Carli *et al.*, 2010). At the end of the dormancy state, tubers start sprouting, signalling their physiological aging.

Materials and Methods

A study was conducted to determine the effects of foliar sprayed paclobutrazol (PBZ) on dormancy and sprouting of seed potatoes in the Research Farm and laboratories of the University of Fort Hare (UFH), Alice Campus. The PBZ rates (0 mg L⁻¹, 100 mg L⁻¹, 200 mg L⁻¹ and 300 mg L⁻¹ of active ingredient) were applied during the 2016/17 growing season. The PBZ was foliar applied 40 days after planting. After harvest, small sized tubers (30 g to 100 g) were stored at ambient temperatures in a darkroom and another batch was subjected to cold storage (2°C to 4°C) for one month before they were moved to the darkroom.

Results and Discussion

Overall sprouting was slower on tubers which were directly stored under ambient temperatures compared to seed potatoes that first received cold treatment. However, regardless of the storage conditions, tubers treated with paclobutrazol had the shortest sprouts, higher branching tendencies and had higher numbers of branched sprouts. PBZ treated tubers also had the thickest sprouts and a higher percentage of mass loss compared to non-treated tubers. Dormancy break was faster on treated tubers which were subject to constant ambient temperatures compared to non-treated tubers. In contrast, tubers which were first subjected to cold room storage had no significant difference in time of the end of dormancy. The early dormancy break and poor sprout elongation could be attributed to the inhibitory effect of PBZ to abscisic acid (ABA) catabolism and gibberellic acid biosynthesis as reported by Rademacher (1997).

Conclusions

Paclobutrazol treatment can help to manipulate seed sprouting patterns, thereby improving seed supply to the market and optimizing availability during the planting season.

Soil salinity management: questionnaire results on farmer perceptions, knowledge levels and practices

Presenter: A Jumman (ashiel.jumman@sugar.org.za)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Jumman	South African Sugarcane Research Institute, P/Bag X02, Mount Edgecombe, 4300, South Africa
PS	Van Heerden	Picwat, PO BOX 11632, Universitas, 9321, South Africa
R	Van Antwerpen	South African Sugarcane Research Institute, P/Bag X02, Mount Edgecombe, 4300, South Africa
LD	Van Rensburg	University of Free State, Department of Soil, Crop and Climate Sciences, Faculty of Natural Sciences, PO BOX 339, Bloemfontein, 9300
M	Adendorff	South African Sugarcane Research Institute, P/Bag X02, Mount Edgecombe, 4300, South Africa

Introduction

In the South African sugarcane industry MacVicar (1971), (as quoted by Johnston, 1978), reported that 20% of irrigated land (21 000 ha) is adversely affected by waterlogging and/or salinity. Hillel and Vlek (2005) reported that, globally, soil salinity was widespread, pervasive and inherent enough to question whether irrigation could be sustained for long periods. There is a need to reduce the occurrence and ill-effects of salinity by improving the adoption of preventative and corrective measures. Within a Water Research Commission (WRC) funded project, the aim of this work was to capture farmers' current perceptions, knowledge levels and salinity management practices in order to inform more effective design and facilitation of a 'technology dissemination and knowledge exchange' initiative.

Materials and Methods

A structured questionnaire survey was conducted with 34 commercial sugarcane growers, farming an area of 18 174 ha (17% of the sugarcane area under irrigation in South Africa). The questionnaire comprised 51 questions, of which 23 were 5-point Likert-scale questions (Likert, 1932 and Uebersax, 2006) used to test five hypotheses (H1-H5). The remaining questions captured baseline data and supplemental information, with the aim of testing knowledge and perceptions relating to soil salinity.

Results and Discussion

The hypotheses test results suggested that participants adequately perceived the threat of salinity (H1) and also have sufficient knowledge about the causes (H2) and the preventative and corrective measures for salinity management (H3). In addition, the sample of farmers appeared to be satisfied that the benefits of salinity management outweigh the costs (H4). The only hypothesis which was accepted was that the benefits of preventative and corrective measures did not outweigh the implementation effort (H5). In stark contrast to H1-H4 test results, data from other questions indicated very little evidence of implemented practices or measures aimed at addressing the problem, that is (a) no consideration of salinity in irrigation scheduling (66% of sample); (b) few examples of controlled leaching being implemented (12% of sample); (c) little differentiation in irrigation strategy for saline and non-saline soils (26%); and (d) very little tracking of water quality and soil salinity status.

Conclusions

In conclusion, farmers were aware of the salinity threat, but were not actively engaged in addressing the problem. Farmers were uncertain about the effort required to implement salinity management. It is recommended that extension activities should extend to beyond just knowledge sharing. Interventions should create the opportunity for exposure to implementation on smaller scales and learning and upskilling through practical experience.

Water use efficiency of potato production systems in the Sandveld region of the Western Cape

Presenter: MJ Kayes (18756654@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MJ	Kayes	Stellenbosch University, Agronomy Department, Welgavallen Experimental Farm
JM	Steyn	University of Pretoria
AC	Franke	University of the Free State
P	Brink	Yara Africa Fertilizer (Pty) Ltd

Introduction

Uncertainty regarding the rate at which water moves and the distribution of water through the soil profile is key in managing water in potato production systems in the Sandveld. The sandy soils with low water holding abilities complicate irrigation water management. Information on efficient water management practices is scarce due to the difficulties of measuring water losses to the environment. Thus, the aims of this study were to quantify the soil water balance components throughout the crop growth and assess yields and water-use efficiencies (WUEs).

Materials and Methods

The study was conducted on three potato fields (processing cultivar FL2108) between March and October 2018 in the Sandveld. Water inputs were monitored using flow meters. Rain gauges placed in the field measured precipitation. Water losses (drainage and leaching) were assessed using drainage lysimeters. Soil movement throughout the profile was monitored with the use of capacitance probes. Tuber yield was determined at crop maturity, and soil-water balance components, as well as water-use efficiencies were calculated.

Results and Discussion

Fresh tuber yields between 34.7 t ha⁻¹ and 51.5 t ha⁻¹ were recorded. Rainfall distribution ranged between 250 and 280 mm. Irrigation amounts varied considerably from 260 to 580 mm. Using the soil-water balance method, a total seasonal evapotranspiration of 623 mm was calculated for the highest yielding field. Deep drainage losses occurred from 214 to 400 mm. WUEs of 60 to 70 kg mm⁻¹ were obtained. A previous study conducted in the Sandveld (Steyn et al. 2016) reported values of 46 to 162 kg mm⁻¹, with an average of 78 kg mm⁻¹. WUEs were, therefore, low and can be accredited to the low yields and high drainage losses. The relatively low yields are attributed to the cool temperatures and less available solar radiation during the winter and autumn. Yields obtained were below 60 t ha⁻¹ compared to summer planted crops, which, on average, reported to yield between 60 to 80 t ha⁻¹. The crop that produced the lowest yield of 34.7 t ha⁻¹ was affected by late blight (*Phytophthora infestans*) towards the end of the season.

Conclusions

Substantial deep drainage was observed, indicating possible over-irrigation of the crop. Low water holding capacity of the sandy soils makes management problematic. The use of soil water monitoring tools that allow better administration of irrigation to ensure water application meets actual crop water use and demand is recommended. More fields are currently being evaluated to better represent the entire Sandveld region.

Determining the ecosystem service provided by wild bee species on open field grown tomatoes

Presenter: RN Kgaphola (retangkgaphola23@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RN	Kgaphola	PO BOX 19 Mooketsi 0825
W	Haddad	PO BOX 19 Mooketsi 0825

Introduction

Pollination is one the most important ecosystem service. The quality of most agricultural crops species are increased by pollination by insects , however it is a seriously endangered ecosystem service. There are variety of bee species these include; domesticated honey bees and wild bees. Wild bee species are a group of bee species that pollinate tomatoes (*Solanum lycopersicum*). However, because of climate change, the use of pesticides, the removal of natural vegetation and mono-culture there has been a decline in the population of wild bee species. In this study there are two objectives, the first objective was to measure the visitation rate by wild bee species on different climatic regions and we further expanded our knowledge by conducting an exclusion trial to research the impact of wild bee species pollinators on the quality of tomatoes.

Materials and Methods

The wild bee species visitation rate was measured by recording the number of opened tomato flowers “kissed” by wild bee species and opened flowers not “kissed” at different climatic regions, and correlate to the yield (t/ha) . The exclusion study was carried out in a commercial tomato field in ZZ2. The trial was laid out in a completely randomized block design. The field observations were made during blooming period (late August until early October). In this experiment two treatments were applied, Enclosed flower clusters and Open flower clusters. The flower clusters were enclosed with small nylon nets in order to exclude all bee species and the opened clusters allowed bee activities. The bags were removed when the flowers senesced to allow fruit development without disturbance. At the moment of ripeness normally considered for commercial purposes, the fruits were harvested in both treatments for fruits analysis.

Results and Discussion

The results obtained showed a difference in wild bee species visitation rate depending on the climate of the area and blocks which are closer to the natural vegetation (potential bee habitat) also have high visitation rate. In addition, areas with high visitation rate has high yield when compared to areas with low wild bee visitation. With the exclusion experiment, bee pollinated fruits showed less malformations, greater fruit weight and longer shelf life due to their firmness than fruits obtained from enclosed flower clusters where pollination by wild bee species was withdrawn.

Conclusions

In conclusion our results showed that wild bee species provide an essential ecosystem service (pollination), it increase the yield (t/ha) and improves quality of the tomato fruits.

Evaluation of bio-slurry application rates and soil management options on dryland maize production under in-field rainwater harvesting

Presenter: TI Khamkham (tkhamkham@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TI	Khamkham	Department of Rural Development and Agrarian Reform, Dohne Agricultural Development Institute, Stutterheim, Eastern Cape, South
JJ	Botha	ARC-ISCW, Glen, Orange Free State, South Africa
ST	Hadebe	Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, Alice, Eastern Cape South Africa
JJ	Anderson	ARC-ISCW, Glen, Orange Free State, South Africa
C	Chiduzo	Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, Alice, Eastern Cape South Africa

Introduction

Water conservation practices, such as in-field rainwater harvesting (IRWH) in combination with management practices (application of mulch and bio-slurry and planting of cover crops) can increase crop yields and improve rural livelihoods. The aim of this study was to evaluate optimum bio-slurry application rate in combination with various soil management options (bare soil, cover crop and mulch) on maize growth and yield.

Materials and Methods

Field experiments were conducted at Fort Cox College over two seasons (2016/2017 and; 2017/2018) as a four by three factorial experiment in a Randomized Complete Block Design replicated four times. The four levels of bio-slurry application rates were: 3, 5 and 7 t ha⁻¹, respectively and a control with no application of bio-slurry. The three soil management levels were: IRWH with mulch in basins (IRWHm), IRWH with cover crop in basins (IRWHcc) and IRWH with bare basins (IRWHBare). Parameters used for evaluation were biomass, grain yield, harvest index and rainwater productivity. Plant height and stem diameter were only collected for 2017/2018 season. Analysis of variance was done on results using statistical software NCSS 6.0.21 (Hintze, 1996).

Results and Discussion

Overall optimum performance was obtained at 3 t ha⁻¹ bio-slurry followed by 5 t ha⁻¹ then 7 t ha⁻¹, and lastly the control treatments. Contradictory to literature review and experience, IRWHBare performed better than IRWHm and IRWHcc. This was attributed to the fact that the bio-slurry formed a loose layer on top of the soil surface in the basins which suppressed evaporation from the soil surface far better than the other two treatments without impeding water infiltration. Cover crop stand in the basins was poor and therefore it was less successful in suppressing evaporation from the soil surface as compared to bare and mulch treatments.

Conclusions

It is therefore recommended that resource poor farmers must make use of the combination of IRWH and bio-slurry at 3 t ha⁻¹. Further experimentation with regards to optimal management options is still required.

Manipulating flowering time to produce lemon fruit out of season

Presenter: C Krogscheepers (18270220@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
C	Krogscheepers	Department of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland, 7602
OPJ	Stander	Citrus Research International, Department of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland, 7602

Introduction

South African lemon production is expected to increase rapidly, with a projected 30 million cartons to be exported by 2021. An ancient Sicilian technique, Forzatura, can delay the lemon harvesting period. Water-deficit (WD) stress is applied by halting irrigation in midsummer to produce a flowering reaction in autumn, and a harvestable crop in the following summer. Sicilian producers have perfected this technique by quantifying the optimum WD stress, and applying nitrogen-based fertiliser upon re-irrigation. Winter GA₃ spray treatments are known to decrease citrus spring flowering.

Materials and Methods

'Lisbon' lemon trees were budded onto 'Carizzo' rootstock and planted in a sandy soil in De Doorns, Western Cape Province. Water-deficit stress was applied in midsummer (December-January), at two different intensities, i.e. moderate stress (0.5x) and extensive stress (0x). The 0.5x trees received half of the commercial irrigation amount, resulting in a minimum stem water potential of -2.84 MPa, maintained for 42 days. The 0x trees received no irrigation, maintained for 21 days. A gibberellin-biosynthesis inhibiting uniconazole soil drench treatment (2 ml Sunny® per 2 L water per tree) and a urea (1% LB) foliar spray treatment, respectively, were also applied to moderately stressed (0.5x) trees in separate treatments, halfway through the WD stress treatments. Inhibition of spring flowering was performed on 'Eureka seedless' lemon trees budded onto 'Rough lemon' rootstock and planted in a clay soil in Stellenbosch, Western Cape Province. The trial was repeated in De Doorns. Two GA₃ (Progibb® 40%) sprays were applied in May at three concentrations; 10, 20 and 40 ppm. For both trials, ten, one-year-old branches per tree were selected at time of treatment. The amount of flowers and new vegetative shoots per selected branch were counted weekly.

Results and Discussion

A large flowering peak was observed in autumn, with moderately stressed trees achieving a significantly larger flowering reaction than the control. Extensively water-stressed trees (0x) were weakened and did not flower more than the control. The GA₃ foliar sprays in winter not only significantly reduced spring flowering, but in some cases also increased the number of potential bearing positions for the forzatura flowering reaction.

Conclusions

Winter GA₃ sprays can be used to reduce spring flowering, and the Forzatura technique can be applied to increase autumn flowering of lemon trees grown in a Mediterranean-type climate in South Africa.

Use of an accelerated breeding scheme for selection of sweet potato lines

Presenter: SM Laurie (slaurie@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
SIM	Naidoo	ARC-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001, South Africa
SM	Laurie	ARC-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001, South Africa
WM	Mphela	ARC-Vegetable and Ornamental Plants

Introduction

Sweetpotato is a major world staple contributing to food security in the developing countries. Interest in growing sweetpotato has increased considerably over the past three decades as the roots and leaves contain several nutrients (carbohydrates, fibre, pro-vitamin A, vitamin C, *riboflavin*, thiamine and niacin). An accelerated breeding scheme (ABS) was proposed by Grüneberg *et al.* (2015) to achieve fast gains in desired traits. Directly after the multiplication step of true-seed derived from crosses, the clones are tested in small plots at 2–3 environments. Selected clones thereafter enters directly into the advanced breeding stages, leading to a much shortened breeding cycle. At ARC-VOP, five male and five female parents were chosen for crosses, based on nutrient content and flowering ability and 367 progenies were generated. The present study aimed to evaluate and select progenies exhibiting desired agronomic traits using ABS.

Materials and Methods

Early phase evaluation trials were conducted at the ARC-VOP, Gauteng (Köppen-Geiger classification: BSk) and on-farm at Jozini, KZN (Köppen-Geiger climate classification: Cfa). The two sites represented selection pressure for high input and *Fusarium* wilt hot spot; and *Alternaria* blight hot spot and drought prone area. The trials included 367 clones and 10 parental lines as controls. Each plot contained two plants. Selection was based on visual appearance (no/few root defects), flesh and skin color and raw taste; supported by data collection on total and marketable root yield and dry mass content. Analysis of variance (SAS version 9.3) was performed over two locations on yield variables.

Results and Discussion

Out of 367 progenies planted, a total of 72 lines were selected at Roodeplaat based on visual assessment. Only lines selected at Roodeplaat were considered for selection at Jozini, consequently 21 lines were selected at Jozini (6% selection ratio). High yielding lines achieved a mean marketable yield of 4.26 kg plant⁻¹ at Roodeplaat, while the trial mean was 1.46 kg plant⁻¹ (4.46 storage roots plant⁻¹).

Conclusions

Future continuation of the work will include estimation of beta-carotene and other important nutrients of the clones; as well as estimation of genetic gain and heterosis. ABS can increase breeding efficiency of sweetpotato with regards to time, human and financial resources.

Effect of organic fertilizer application on the growth of Kale plants

Presenter: R Laurie (rlaurie@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
R	Laurie	ARC-VOP, Private Bag X293 Pretoria 0001
H	Araya	ARC-VOP, Private Bag X293 Pretoria 0001
L	Kafua	ARC-VOP, Private Bag X293 Pretoria 0001

Introduction

Kale (*Brassica oleracea*) is a leafy vegetable planted in the rural communities for personal consumption and selling on the informal market. Kale leaves are nutritious in that they contain various vitamins, minerals and antioxidants. Kale is a hardy crop that can withstand harsh conditions like low water availability and cold winters. The cost of commercial fertilizer is often out of the reach of the general small holder farmer and alternative fertilizers need to be used. In this trial chicken manure is used as an alternative to commercial fertilizer due to its cost and availability.

Materials and Methods

Kale plants were planted in a RCBD design, in a rain out shelter, consisting of 35 plots each containing 35 plants with 5 fertilizer treatments and 7 repeats. The 5 treatments were different levels (control, recommended, 25%, 50% and 100%) of chicken manure in the soil. Plants were monitored (one month after planting) for the amount of leaves, plant height and the effect on chlorophyll fluorescence (KCF) in the leaves. Monitoring of the variables was done monthly over a period of 3 months (T1, T2, T3). Regular watering and weeding were performed during the trial.

Results and Discussion

An increase in plant height was observed, with the biggest increase at the 100% treatment level and the lowest at the control level. Leaf count declined between the first two periods of monitoring with the sharpest decline at the 50% treatment level. The decline in leaf count stabilized at the third period of monitoring. Initial fluorescence yield (F_0) measured decreased over the three monitoring periods although it seems that the fertilizer treatments had no effect on the levels of F_0 at a specific monitoring period. The kale plants' ability to convert sunlight energy to chemical energy and to use it increased as the trial continued. Although no statistical difference was observed F_{abs} continued to increase with the increase in fertilizer application level at T3. The F_{abs} values did not differ statistically from each other at specific fertilizer treatments at both T2 and T3 but clear differences were observed comparing the recommend and control values, indicating a possible effect on the photosynthetically active pigments in the leaves of the plants by the fertilizer treatment.

Conclusions

It is concluded that the different fertilizer treatments on kale plants had an effect on the leaf count, plant height and CF measurements. Further detailed investigations are advised to confirm these results and advise end users (farmers) accordingly.

Soil erosion prevention is better than cure, in South Africa's only large river network without a dam.

Presenter: J Le Roux (Lerouxjj@ufs.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
J	Le Roux	University of the Free State, P.O. Box 339, Bloemfontein 9301

Introduction

The Mzimvubu River Catchment is the only large river network in South Africa without a dam, but proposals for water resource development in the Tsitsa tributary (at Ntabelanga and Laleni) have been put forward. However, the Ntabelanga Dam Catchment consists of highly erodible soils with widespread soil erosion evident (approximately 4 000 gullies, affecting an area of approximately 3 000 ha). Due to limited resources it will not be feasible to rehabilitate these gullies with large and costly structures at the catchment scale. Furthermore, structures in the erodible dispersive soils will enhance subsurface accumulation of water and cause further erosion around structures (worsening the problem). Therefore, in order to implement resources and investments optimally, it is important to prevent further erosion by protecting areas that are not eroded.

Materials and Methods

This was achieved by mapping gully-free areas susceptible to gully development in the catchment, by mapping areas that have the same DEM-derived topographical variables and parent material-soils interactions than gullied areas but which are still gully-free.

Results and Discussion

The main outcome of this study is a map of gully-free areas that are susceptible to gully development in the Ntabelanga Dam Catchment. More than 9 000 ha (5%) of the catchment is highly susceptible to further gully development. These areas consists of gentle slopes in zones of saturation along drainage paths with a large contributing area, erodible duplex soils derived from mudstones.

Conclusions

If not protected, these susceptible areas will contribute additional sediment loads to the river network. Soil erosion prevention will not only reduce the sediment yield and increase dam life expectancy, but will also benefit the local communities by preventing further soil degradation of their land.

Hydropedology, what makes it different?

Presenter: PAL Le Roux (hierdiehuis@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
PAL	Le Roux	University of the Free State
JJ	Van Tol	University of the Free State
GM	Van Zijl	Digital Soils Africa
D	Bouwer	Digital Soils Africa

Introduction

Hydropedology integrates traditional pedogenesis, hydrology, soil physics, soil chemistry, lithology and geomorphology to understand spatial and temporal water flow in the vadose zone of soils and hillslopes, where hillslopes include wetlands.

Materials and Methods

Several

Results and Discussion

The knowledge of traditional pedogenesis is largely controlled by what fits the A/B/C/R model of pedogenesis, a theory that also controls the soil classification system. Soils, as a first order control mechanism of hydrology, at hillslope and catchment scale justifies digital soil mapping as part of the application of hydropedology in the natural ecosystem. By implication, the intensity and scale varies. Hydropedology is a 3D application of pedogenesis, process hydrology, soil physics and chemistry applied to several land units controlling the flow of water in the hillslope at different scales. It includes the analysis of the factors controlling the flow of water in horizons, soil forms, hillslopes and catchments. What makes it different to standard pedogenesis? Quantifiable morphological soil properties, generally applied to classify soils, are integrated with environmental properties to improve the understanding of all processes especially those that leave reliable visible indicators of hydrology for example water/redox and solubility relationships. Recognition of the role of lateral flow in soil horizons, soil forms, underlying rock, hillslopes and catchments compared to a one dimensional downward (rain) and upwards (ET) hydrology. Contrary to only downward saturated flow, the recognising of upward saturated flow in soils in the terrestrial and wetland zones. Improvement of the understanding of the hydrology of soils from saturated, wet, moist and dry to understanding the hydrological temporal response of soil horizons, soil forms, hillslopes and catchments units. Excluding the conceptual hydrological response of hillslopes to a conceptual hydrological response model for hillslopes. With the catena as sole carrier of information, hydropedology is now extrapolated applying Digital Soil Mapping at a high level of accuracy and low input.

Conclusions

Hydropedology can improve a Soil Scientist's skills to better serve the agriculture, environmental and hydrological sciences using additional insights into the interpretation of pedogenesis. More Soil Scientists are invited to improve their skills in hydropedology to serve agriculture better and specifically the environmental and hydrological sciences.

Quantitative and qualitative changes in soil carbon following 20 years of wheat production management practices in the semi-arid Eastern Free State

Presenter: PF Loke (lokepf@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
PF	Loke	Department of Soil, Crop and Climate Sciences, University of the Free State
E	Kotzé	Department of Soil, Crop and Climate Sciences, University of the Free State
CC	Du Preez	Department of Soil, Crop and Climate Sciences, University of the Free State
L	Twigge	Department of Chemistry, P.O. BOX 339, Bloemfontein

Introduction

Soil cultivation and disposal of crop residues by burning are still common practices in South Africa despite their detrimental effects on soil C and environmental quality. This study evaluated effects of wheat production management practices on different C fractions and SOC structural composition of a semi-arid Plinthustalfs in a long-term trial established in the Eastern Free State near Bethlehem.

Materials and Methods

The treatments that were applied for 20 consecutive years, included two straw management (unburned and burned), three tillage (no-tillage, stubble mulch and ploughing) and two weed control (chemical and mechanical weeding) methods. Samples collected from 0-50 mm depth of soils subjected to specific treatment combinations, were analyzed for soil organic C (SOC), soil inorganic C (SIC), permanganate oxidizable C (POXC), cold water extractable C (CWEC), hot water extractable C (HWEC), extractable humic substances (CEX), humic acids (CHA), fulvic acids (CFA) and organic C functional groups. Humification (HI) and polymerization (PI) indices as well as alkyl C/O-alkyl C ratios were also calculated.

Results and Discussion

No-tillage combinations demonstrated potential to reverse losses of soil C fractions in the 0-50 mm soil layer. Increased concentrations of POXC, CWEC, CEX and CFA revealed the lability nature of accumulated SOC in no-tilled treatments, suggesting that SOC therein could be rapidly lost if no-tilled soils are brought under cultivation again. Although the HI and PI values were not always significantly different across the sampled treatment combinations, their decrease in the unburned chemically weeded no-tilled plots also suggest minimal decomposition, which comes as a benefit especially in sandy Plinthustalfs with low soil C storage capacity. Strong positive correlations between SIC and most SOC fractions (POXC, CWEC, CEX and CFA) imply that an increase in these SOC fractions protected SIC, resulting in its accumulation in treatment combinations that included no-tillage. Functional groups of SOC seemed to mimic chemically fractionated SOC fractions as O-alkyl C decreased with concomitant increase in the alkyl, aromatic and to some extent carbonyl C as a result of 20 years of cultivation.

Conclusions

Responses of the measured C fractions basically highlighted that no-tillage combinations could be an ideal management strategy to restore quantity and quality of SOC in the drought-prone agro-ecosystems dominated by sandy soils.

Biochar derived from poultry litter as an alternative soil amendment to improve nutrient availability of three different soil types

Presenter: SG Lusiba (ciphiwe.gloria@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
SG	Lusiba	University of Venda, Private bag, X5050, Thohoyandou, 0950
JJO	Odhiambo	University of Venda, Private bag, X5050, Thohoyandou, 0950
R	Adeleke	Agricultural Research Council- Soil, Climate and Water (ARC-ISCW), Arcadia, Pretoria, 600 Belvedere St, Arcadia, Pretoria, 0083
S	Maseko	Tshwane University of Technology, Private Bag X680, Pretoria, 0001

Introduction

Acid soils coupled with low nutrient availability are major constraints limiting crop production by smallholder farmers in the Vhembe district of Limpopo Province. This study evaluated the impact of biochar derived from poultry litter on selected macro and micro-nutrients of three different soil types in Vhembe district.

Materials and Methods

A pot experiment was conducted in a shade house at the University of Venda, from May to August 2017. Treatments consisted of poultry litter biochar with application rates of 0.5, 1 and 2% (w/w) and a control (0%) as well as three soil types as Fernwood, Pinedene and Griffin. The treatments were laid out in a completely randomized design and replicated four times. Poultry litter biochar was produced by heating poultry litter at 550-600°C in a kiln furnace at the University of Venda. Maize was used as a test crop. Selected macronutrients (P, K Ca, Mg and Na) including CEC and micronutrients (B, Cu, Fe, Mn, Mo and Zn) as well as mineral N (extractable $\text{NH}_4^+\text{-N}$, and $\text{NO}_3^-\text{-N}$) were measured after harvest. Data were subjected to ANOVA using the GLM of GenStat, version 18 and significant means were compared using the LSD test at $P \leq 0.05$.

Results and Discussion

Application of poultry litter biochar from 0.5 to 2% resulted in an increase in pH, available P and exchangeable cations including CEC in all soil types. The Fe and Cu content decreased at 2% poultry litter biochar application in the Fernwood and Pinedene soils, whilst Zn content increased at 0.5 to 2% in the Fernwood soil. Nitrate was similar but higher in the control and at 0.5% and decreased at 1 and 2% poultry biochar application in the Fernwood soil. In contrast, the C/N ratio decreased at 2% but showed a similar trend in the control, 0.5 and 1% poultry biochar application. The Pinedene soil exhibited higher ammonium nitrogen when poultry biochar was applied. The poultry biochar had greater amount of exchangeable cations and ash content which probably resulted in higher pH and availability of essential nutrients in the studied soils.

Conclusions

Nutrient availability and soil pH in this study increased with an increase in poultry litter biochar application from 0.5 to 2%. This suggest that poultry litter biochar could serve as an alternative source of nutrients to improve acid poor nutrient soils in Vhembe district. For optimum nitrogen availability the application of 0.5% poultry biochar is recommended.

Response of *Moringa oleifera* trees to different soil types under microplot conditions

Presenter: L.P Maake (maakepl@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LP	Maake	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0700, South Africa Department of Agriculture and Rural Development P.O Box 1513, Shiluvane, 0873
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0700, South Africa

Introduction

Soil types in Limpopo Province range from high to low potential agricultural soils, with calcareous soils being common in the arid parts of the Province, whereas heavy clay soils and sandy soils are also common. Most of the marginalized communities were historically relocated to areas where soil potential was inherently marginal for agricultural purposes. *Moringa oleifera*, a highly nutritious plant, is being investigated for use as a food security source, with limited information on how it would perform in areas with marginal soils. The objective of the study was to investigate the responses of growth and chemical compounds of *M. oleifera* trees to different soil types.

Materials and Methods

Moringa seedlings were raised in artificial microplots comprising 10 L plastic containers, filled with steam-pasteurised loam, clay, calcareous and sandy soils, were arranged in RCBD, with 10 replications. The study was initiated in the beginning of autumn and terminated at the end of spring at the University of Limpopo. Collected plant variables included chlorophyll content, petiole length, petiole number, plant height, petiole number, stem diameter, roots and tubers. Data were subjected to analysis of variance using Statistix 10.0 software.

Results and Discussion

Soil type had significant effects on plant height, stem diameter, petiole length, petiole number, chlorophyll content, dry root mass, dry tuber mass and dry shoot mass, contributing 72, 76, 73, 62, 74, 86, 90 and 96% in total treatment variation (TTV) of the respective variables. Relative to loam soil, clay and sandy soils increased and reduced plant height of *M. oleifera* by 50 and 37%, respectively. The stem diameter and dry shoot mass on clay soil increased by 101 and 88%, respectively. Relative to loam, calcareous soil reduced chlorophyll content and dry tuber mass by 67 and 67%, respectively, whereas sandy soil reduced plant height, petiole length, petiole number and dry tuber mass by 37, 48, 36 and 40%, respectively. Sandy soil increased dry root mass by 170%. The observations in the current study confirmed those under greenhouse conditions (Mashela, 2018).

Conclusions

Generally, for *M. oleifera*, most plant growth variables were increased under marginal soil types, suggesting that these soils could not be limiting the production of this potential food security crop.

The effect of Moringa leaf extract on growth and development of radish (*Raphanus sativus*) and green beans (*Phaseolus vulgaris*)

Presenter: MC Mabaso (makungumabaso@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MC	Mabaso	University of KwaZulu-Natal, Private bag X01, Scottsville, Pietermaritzburg, 3209
I	Bertling	University of KwaZulu-Natal, Private bag X01, Scottsville, Pietermaritzburg, 3209
S	Tesfay	University of KwaZulu-Natal, Private bag X01, Scottsville, Pietermaritzburg, 3209

Introduction

Over the past decades interest in organically grown vegetables has grown worldwide. As a result, agricultural growing practices have turned towards organic, sustainable environmentally-friendly farming systems. Organic vegetable production is considered as such an environmentally friendly production system, minimizing harm to the ecosystem. The reliance of farmers on inorganic fertilizers as a source of plant nutrition is associated with land and soil degradation and as well as environmental pollution. Today farmers are also aware of the application of organic fertilizers to improve crop production and farmland productivity. Hence, there is a continuous need to search for alternative, safe natural sources of plant nutrients. *Moringa oleifera* leaf extract can, potentially, make a growth enhancing contribution to many crops.

Materials and Methods

Experiment was laid out in a randomized complete block design (RCBD) with five replications using green beans and radish. Three fertilizer regimes were chosen: Moringa leaf extract (MLE) T1 (MLE in methanol 100%), T2 (MLE in methanol 50%) and T3 (commercial inorganic fertilizer, Calmag+B (5g plant⁻¹). Preparations of MLE were performed according to with slight modifications. Bean treatments were applied either at flowering or pod formation and prior to harvest. Radish plants were sprayed during the development of the fourth leaf and prior to harvest. Parameters recorded were leaf size, pod size, number of leaves, fresh and dry mass.

Results and Discussion

Application of MLE increased leaf size, pod size, number of flowers, number of mature leaves and resulted in larger roots compared with the control plants. Among the various MLE treatments, MLE 50% performed best on both radish and green bean plants, producing superior physiological growth and harvest compared with MLE 100% treatment and control plants.

Conclusions

MLE (50%) application significantly improved various yield components of both radish and green bean plants. Findings from the present study further indicate that the application of MLE should be carried out at the flowering and pod formation stages for better growth and higher yields of radish and green beans.

Size, weight and flower count of litchi panicles as influenced by the cultivar, flower stage and season

Presenter: A Mabirimisa (mabirimisaA@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Mabirimisa	ARC-TSC, Private Bag X11208, Nelspruit, 1200
Z	Bijzet	ARC-TSC, Private Bag X11208, Nelspruit, 1200
M	Booyse	ARC-Biometry, Private Bag X5013, Stellenbosch, 7599
MT	Labuschagne	University of the Free State, P.O Box 339, Bloemfontein,9300

Introduction

There is often no relationship between the flower production and the yield in litchi and this is because there is a high rate of premature flower and fruit abscission between floral initiation and fruit maturation. With this information in mind, the aim of this study was to investigate differences in panicle size and determine its potential as future breeding parents.

Materials and Methods

The study was carried out over two seasons at the ARC-TSC (Nelspruit). Six panicles were collected per cultivar from 'Kaimana', 'Mauritius', 'Fay Zee Siu' and 'Kwai May Pink' in all three of the flowering stages (Female=F, Male 1=M1 and Male 2= M2). Four attributes (panicle length, width, weight and flower count) were measured.

Results and Discussion

A highly significant year by flower stage by cultivar interaction (YxFxC) effect ($P < 0.0001$) was found for panicle size (panicle length and width). The longest panicles were recorded during the M2- and F-stages on 'Mauritius' in 2016. In 2015 'Mauritius' and 'Fay Zee Siu' again had the longest panicles but in the M1-stage. In 2016 the F- and M1-stage of Mauritius and Kaimana was in the group with the broadest panicles but in 2015 the F-stage of Mauritius was in the group with the smallest width while the M1-stage of Kaimana was in the group with the second broadest panicles. A highly significant ($P < 0.0001$) flower stage by cultivar interaction (FxC) effect was found for the flower count and panicle weight with the flower count being the highest during the F-stage for all the cultivars except for 'Kwai May Pink' where the F and M1 did not differ significantly. 'Mauritius' and 'Fay Zee Siu' had the most flowers during the F-stage while 'Mauritius' had significantly less flowers during M1 than 'Fay Zee Siu' and 'Kaimana' and did not differ from 'Kwai May Pink'. 'Mauritius' had the heaviest panicles during the F-stage being significantly better than all the other cultivars in the other stages. The panicle weight during M1 was significantly lower for all cultivars except for 'Fay Zee Siu'. Highly significant ($P = 0.005$) year by cultivar (YxC) non-crossover interactions were found for flower count with 'Fay Zee Siu' in 2016 being significantly higher than any of the other cultivars in any of the two season.

Conclusions

There were significant differences with regard to the influence of cultivar, season and flower stage on all panicle attributes measured. However, the effect of panicle size on breeding efficiency has yet to be determined.

Evaluation of tine and disc openers for wheat production in soils of different qualities and through various levels of stubble

Presenter: L Magenuka (mlmagenuka@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Magenuka	Stellenbosch University, Private Bag X1, Matieland 7602
PA	Swanepoel	Stellenbosch University, Private Bag X1, Matieland 7602

Introduction

Conservation agriculture (CA) has been widely adopted by many farmers in the wheat production areas of the Western Cape during the past decade. Producers of the Western Cape following CA practices, rely mostly on tine openers to establish wheat. However, disc opener has not yet been scientifically vindicated under Western Cape conditions. The aim of the study was to evaluate tine and disc openers for wheat production in soils of different qualities and through various levels of residue.

Materials and Methods

The study was conducted in 2016 and 2017 at Langgewens Research Farm in the Swartland. The trial was laid out as a split-plot design with three factors. The whole plot factor comprised two soils (high and low quality) in close approximation to one another. The split-plot comprised openers (tine or disc), and residues (high, medium, low) were randomly allocated within the split-plots. Soil disturbance was determined using the pin profiler immediately after planting. Plant population was determined at 30 days after planting. Ten plants were sampled per plot at 30, 60, 90 days after planting and at maturity to determine aboveground biomass. The number of wheat ear bearing tillers, leaf area index, grain yield, thousand kernel mass and hectolitre mass were determined.

Results and Discussion

In both seasons, no significant difference ($P < 0.05$) between tine or disc openers, and soil quality was recorded with regard to soil disturbance. Similar results might be due to a high stone content on the field and dry soil conditions of 2016 and 2017 seasons. The tine and disc openers performed similarly ($P < 0.05$) in 2016 and 2017 with regards to plant population, leaf area index, ear-bearing tillers, grain yield, and thousand kernels mass regardless of soil quality with residue level. The only difference was found in 2016 at physiological maturity in terms of biomass. On low quality soils where disc openers were used, a significant increase in biomass production was recorded compared to tine openers on medium residues in 2016 season.

Conclusions

A similar grain yield and yield components were obtained over two years of testing tine and disc openers. Therefore, either a disc or tine openers can be used by wheat producers for planting wheat in the Swartland.

Profiling sugar metabolism and accumulation in plums grown in South Africa as related to cultivar difference, postharvest storage regimes and maturity

Presenter: T Majoni (22407197@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Majoni	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University, Private Bag X1 Matieland Stellenbosch 7602
OA	Fawole	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Sciences, Stellenbosch University, Private Bag X1 Matieland Stellenbosch 7602
UL	Opara	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1 Matieland Stellenbosch 7602

Introduction

Japanese plums (*Prunus salicina* Lindl.), classified as climacteric or delayed-climacteric, are largely cultivated in South Africa. During ripening the fruit is subjected to biochemical and physiological modifications that have an influence on the fruit quality including colour, texture, taste and aroma. Taste is associated with the increase in sugars and decline in organic acids. Furthermore, some cultivars are known to exhibit altered sugar metabolism with enhanced sorbitol production (Kim *et al.*, 2015). Sorbitol can be a replacement sugar and recommended for patients suffering from chronic diseases such as diabetes, obesity and cardiovascular diseases. The aim of this study was to determine sugar occurrence and metabolism in different plum cultivars.

Materials and Methods

Twelve cultivars sampled at commercial harvest and analysed at different storage regimes: harvest, end of cold storage (30 days at -0.5°C) and end of shelf life (5 days at 20°C). Sugar analysis was carried out using a gas chromatography coupled with mass spectroscopy (GC-MS).

Results and Discussion

There were significant differences in the composition of plum cultivars investigated. The sum of total sugars (sucrose, fructose, glucose and sorbitol) ranged from 463 g kg⁻¹ (Angeleno) to 1490 g kg⁻¹ (Sun kiss) at harvest, 659 g kg⁻¹ (Flavour king) to 1570 g kg⁻¹ (Green red) at end of cold storage and 544 g kg⁻¹ (Green red) to 1250 g kg⁻¹ (Laetitia) at end of shelf life. At harvest, sucrose was the most dominant sugar in most cultivars, the highest and lowest being in Ruby sun and Inbar, respectively. Sorbitol were the most dominant at end of cold storage; Green red had the highest while Flavour king had the lowest content. Glucose was found to be the most dominant at end of shelf life, with Laetitia and Green red cultivars having the highest and lowest glucose content, respectively.

Conclusions

This study established large variability between cultivars in sugar composition and the storage regimes influenced sugar metabolism. This information could serve as a baseline study for consideration in the future breeding programs and postharvest management of the investigated cultivars for nutritional benefits. This work is based on research supported by the South African Research Chairs Initiative of the Department of Science and Technology and National Research Foundation, and a financial support by the HORTGRO Science.

Critical factors influencing the effectiveness of Fetsa Tlala farmer support programme on subsistence maize producers in Limpopo Province of South Africa

Presenter: MM Makgato (makgatomm@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RG	Lekalakala	Limpopo Department of Agriculture and Rural Development, Private Bag x 9487, Polokwane, 0700, South Africa
TM	Ramokonyane	Limpopo Department of Agriculture and Rural Development, Private Bag x 9487, Polokwane, 0700, South Africa
KA	Tshikolomo	Limpopo Department of Agriculture and Rural Development, Private Bag x 9487, Polokwane, 0700, South Africa

Introduction

The study investigated the factors influencing the effectiveness of Fetsa Tlala farmer support program. It is an approach by government to deal with structural problems of food insecurity aiming at supporting subsistence farmers with production inputs and mechanization services to ensure food security.

Materials and Methods

The study was conducted in the five Districts of Limpopo Province. A questionnaire was used to collect data and covered the whole population of 11366 supported farmers during the 2016/17 planting season. The collected data included gender, age, education, fertilization program, weed control, pest infestation, planting dates and grain yield. Data was analyzed at District level and pooled to Provincial means. It was subjected to descriptive statistics to determine the mean frequency analysis, which were presented as frequency Tables and Figures.

Results and Discussion

The trend shows that 57% of the farmers were females relative to the 43% which were males. Most of them had an education equivalent to primary level in that 71% attended school up to Grade 7. Only 4% had a post-matric education. Approximately 58% of the farmers were older than 60 years of age. About 80% do not apply fertilizers however District comparison showed Vhembe and Mopani with an improved fertilizer use at 60% and 47%, respectively. This trend is directly proportional to the agro-climatic zones of the two Districts, which receives reliable rainfall. Approximately 6% of the farmers did not to weed their fields, whilst 94% planted between December and February when the rain was most reliable. Although, the planting time may seem to be very late, it however reflects a positive correlation with increased rainfall from December to February. There was severe infestation of Fall Army Worm in 10 municipalities. Resulting from the investigated factors, maize production was poor and threatened food security.

Conclusions

The study revealed that smallholder maize farmers requires more than material support packages such as production inputs. Apart from production related challenges, their production is still trapped in the inherent marginal farmlands of the former homelands, which were historically deprived of capital investment, infrastructure growth, agro-services and human development. Government recognizes that further exclusion may lead to chronic development deficit, whilst simultaneously compromising village level food security.

Diversity assessment of ground beetles (Coleoptera: Carabidae) in wheat agroecosystems

Presenter: MM Makwela (makwelam@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MM	Makwela	ARC- Small Grains, Private Bag X29, Bethlehem, 9700, South Africa
A	Jankielsohn	ARC- Small Grains, Private Bag X29, Bethlehem, 9700, South Africa
TJ	Tsilo	ARC- Small Grains, Private Bag X29, Bethlehem, 9700, South Africa

Introduction

Ground beetles are an extremely diverse group of predators found in most agroecosystems. This group contains more than 40 000 described species worldwide. They have been successfully used in different biodiversity and conservation studies as excellent biological indicators of habitat quality with most studies focusing on their response to agroecosystems management (Lövei, 2008, Hoekman *et al.* 2017). The aim of this study was to assess the influence of different agricultural management practices on the diversity of carabid beetles.

Materials and Methods

The study was conducted at Lower-land Farm located in Prieska, Northern Cape (September-December 2017). Three systems under organic, conventional and intercropping were selected. The pitfall trapping method was used for sampling. In each system 12 pitfall traps were set up to capture the ground beetles. A set of four sampling points were randomly selected for sampling, each with three replicate samples (pitfalls) respectively. Individual species were described in terms of abundance, composition, richness and diversity. Diversity was calculated using various diversity indices of Shannon –Wiener index, Margalef's index and Pielou evenness index. Diversity index values were calculated using (PAST 3.0) (Hammer *et al.* 2001, Magurran, 2004). Data were further subjected to one-way Analysis of variance and post-hoc Tukey tests (5%) was performed to test for significant differences in carabid beetles abundance and diversity across different wheat systems.

Results and Discussion

In total 11 species and 1648 individuals were captured and identified. Amongst the carabid species collected, *Casoloma caminara* was the most dominant species contributing 24% in relative abundance. *Graphiptes auratiacus* was the least abundant species accounting 0.4% respectively. Carabid individual abundance and Shannon diversity revealed the statistical and significant difference between the three agroecosystems ($P < 0.05$). The high Carabid ($H' = 2.2$) diversity in organic and organic intercropped was clearly exhibited by high evenness distribution ($J' = 0.9$) and less dominance ($D < 0.01$) of species.

Conclusions

It was concluded that the organic and intercropping practices are sustainable practices that have been recognized to maintain and promote the biodiversity of naturally occurring invertebrates. Since carabid species are documented as bioindicator species, future studies would focus on study of these assemblages under the currently adopted conservation agriculture in South Africa to optimise the sustainability of these systems.

Interactive effects of Nemarioc-AL, Nemafric-BL and *Mosamina phytonematicides* on nematode suppression and plant growth in sweet stem sorghum

Presenter: KG Maleka (jineva102@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KG	Maleka	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727
KM	Pofu	Agricultural Research Council-VOP, Private Bag X293, Pretoria 0001

Introduction

Sweet stem sorghum (*Sorghum bicolor*) is a high brix-crop with potential attributes to produce biofuel (Rooney *et al.*, 2007). The interaction effects of Nemarioc-AL and Nemafric-BL phytonematicides were previously shown to reduce root-knot (*Meloidogyne* species) nematodes in various crops, with limited information on sweet stem sorghum (SSS). The objective of the study was to determine the interaction effects of Nemarioc-AL, Nemafric- BL and *Mosamina phytonematicides* on nematode and growth of SSS cv. 'Ndendane-X1'.

Materials and Methods

A 2 × 2 × 2 factorial experiments, with the first, second and third factor comprising Nemarioc-AL (A), Nemafric- BL (B) and *Mosamina* (M) *phytonematicides*, respectively. The eight treatments, comprising of A0B0M0, A1B0M0, A0B1M0, A0B0M1, A0B1M1, A1B0M1, A1B1M0 and A1B1M1, were arranged in a randomised complete block design, with six replications. Cultural practices were as in commercial sorghum production. Data collected at the end of the season included plant (i.e. mother-plant (MP) stem diameter, MP internode number, MP panicle mass, MP middle brix and sucker 1 stem diameter) and nematode (i.e. second juvenile, eggs, final population density and reproductive potential) variables. The data were subjected to factorial analysis of variance through the Statistix 10 software and described with the focus being on the interactive (rather maybe "interaction") effects.

Results and Discussion

At harvest, the interaction of Nemarioc AL, Nemafric-BL and *Mosamina* had significant effects on plant growth and nematode variables, except for second juvenile and reproductive potential. Relative to untreated control, the interaction of Nemarioc AL Nemafric-BL and *Mosamina* phytonematicide increased MP internode number, MP panicle mass, MP stem diameter, stem diameter of S1 and MP middle brix by 110, 370, 80, 529 and 34%, respectively. Nemarioc AL, Nemafric-BL and *Mosamina phytonematicide* interaction reduced eggs and nematode final population density by 75 and 14% in roots respectively.

Conclusions

In conclusion, the interaction of Nemarioc-AL phytonematicide, Nemafric-BL phytonematicide and *Mosamina* phytonematicide stimulate number of internode, panicle mass, stem diameter and percentage brix, while suppressing population density of root-knot (*Meloidogyne* species) nematodes. Therefore, the interaction of these botanical products on SSS respond to the current growth in global energy demand for production of biofuel.

Effects of land use on stocks and vertical distribution of pools of soil carbon in selected humic soils

Presenter: NM Malepfane (malepfanentwanano@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NM	Malepfane	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P. Bag X01, Scottsville, 3209
P	Muchaonyerwa	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P. Bag X01, Scottsville, 3209
JC	Hughes	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P. Bag X01, Scottsville, 3209
R	Zengeni	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P. Bag X01, Scottsville, 3209

Introduction

Humic soils are unique and are among the most productive soils in South Africa, especially for sugarcane, pasture and maize (Fey, 2010). They are highly weathered, with high OC content (>1.8%). Their contribution to global climate change depends on them as either a C source or C sink and better understanding of soil OC stocks and pools and the effects of land use on C dynamics in humic soils is essential. The aim of this study was to determine the effects of different land uses on stocks and vertical distribution of different pools of soil OC in selected humic soils.

Materials and Methods

Sandy humic soils from Eston and Eshowe both under forestry and sugarcane production, and clayey ones from Karkloof and Cedara, both under grassland, pasture and maize, were used in this study. Soil samples were collected from 0-5, 5-10, 10-15, 15-20, 20-30, 30-40, 40-50, 50-60, 60-80 and 80-100 cm depths. Soils were analysed for bulk density, total C, particulate organic matter C (POM-C) fractions, hot water-soluble C (HWSC), and mineral-associated C. Soil C stocks were calculated to a depth of 100 cm using total C and bulk density. Karkloof and Eshowe soils were also subjected to thermogravimetric analysis.

Results and Discussion

Soil C stock on clayey humic soils were in the order pasture > grassland = maize, while there were no differences between land uses in sandy humic soils with Eston stocks ranging (270-288 Mg ha⁻¹) and Eshowe (360-378 Mg ha⁻¹). Majority of total C was higher than 2% in 0-30 cm depth for clayey soils and to a depth of 100 cm in sandy ones. Cultivation with maize resulted in lower soil OC than other land uses on clayey humic soils with Karkloof soil having higher total C than Cedara. The POM-C, HWSC and mineral-associated C followed the same trend as total C on clayey humic soils. The POM-C in sandy humics was higher in forestry soils than sugarcane. Total C, HWSC and mineral-associated C were higher in 0-10 cm depth under forestry than sugarcane, but declined with depth. Thermogravimetric mass loss ratios were greater in the clayey humics (200–450°C) than in the sandy humics (250–600°C) with significant difference among land uses.

Conclusions

Findings suggest that sugarcane production on sandy humic soils has no negative effects on C stocks but reduces C pools content when compared with forestry. Maize production on clayey humic soils reduces soil C stocks and C pools when compared with pasture.

Short-term change in soil organic carbon and labile carbon pools as attributed by tillage, crop residue and crop rotation management in a sweet sorghum-based cropping system

Presenter: ME Malobane (malobanem@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
ME	Malobane	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa, University of South Africa, Dept. of Agriculture and Animal Health, P/Bag X6, Florida, 1710, South Africa
AD	Nciizah	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
FN	Mudau	University of South Africa, Dept. of Agriculture and Animal Health, P/Bag X6, Florida, 1710, South Africa
ICC	Wakindiki	School of Agriculture, University of Venda, P/Bag X5050, Thohoyandou, 0950, South Africa, University of South Africa, Dept. of Agriculture and Animal Health, P/Bag X6, Florida, 1710, South Africa

Introduction

The change in labile soil organic carbon (SOC) in a given land use is controlled by site-specific conditions such as vegetation, residue management and land use intensity (Kibet *et al.*, 2016). For this reason, inconsistency in the changes in SOC resulting from different land uses exists in the literature (Yu *et al.*, 2017). Thus, the objective of this study was to determine the effect of tillage, crop residue and crop rotation management on SOC and labile carbon pools in a sweet sorghum-based cropping system.

Materials and Methods

The experiment began in November 2016 at the University of Fort Hare experimental farm. It was a split-split plot experiment arranged in a completely randomized block design with two levels of tillage [no-till (NT) and conventional tillage (CT)], two rotations [sweet sorghum-grazing-vetch-sweet sorghum (SVS) and sweet sorghum-sweet sorghum (SS)], and three residue retentions [0%, 15% and 30%]. In March 2018, three random samples collected at 0.1 m depth in each experimental plot were mixed into one composite sample. SOC, cold water extractable organic C (CWEOC), hot water extractable organic C (HWEOC) and soil microbial biomass carbon (MBC) were measured (McGill *et al.*, 1986).

Results and Discussion

After one year of treatments, both SOC and CWEOC were significantly affected by tillage while rotation and residue management had no effect on all measured carbon pools. Under NT, both SOC and CWEOC were higher than CT by 14.17% and 22.1%, respectively. The increase in both SOC and CWEOC may be due to soil re-aggregation, which protect SOC against microbial attack (Villamil *et al.*, 2015). A correlation analysis showed that the SOC concentrations were positively correlated with CWEOC and MBC, and negatively correlated with HWEOC.

Conclusions

No-till soil management can improve SOC and CWEOC in the short term, thus enhancing soil quality.

Characterisation of the relationships between soil physiochemical properties and macrofauna in organic and conventional wheat

Presenter: E Mamabolo (mamaboloe@arc.agric.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
E	Mamabolo	Agricultural Research Council-Small Grain, Private Bag X29, Bethlehem, 9700
A	Jankielsohn	Agricultural Research Council-Small Grain, Private Bag X29, Bethlehem, 9700
TJ	Tsilo	Agricultural Research Council-Small Grain, Private Bag X29, Bethlehem, 9700

Introduction

Collective effects of chemical, physical and biological characteristics of the soil are the foremost interacting components that soil health and productivity is dependent upon. Therefore there is a necessity to develop extensive knowledge about an up-to-date status of soil biological, physical and chemical properties of different land use systems and their relations. This can potentially play a fundamental role in augmenting agricultural production on a sustainable basis. The aim of this study was to characterize the relationship between macrofauna abundance and soil physiochemical properties in organic and conventional wheat ecosystems.

Materials and Methods

Sampling was conducted at Lowerland farm, Prieska, Northern Cape in organic, organic-intercropped and conventional wheat agro-ecosystem from July to December of 2017 to characterize the soil properties and macrofauna abundance in wheat ecosystems, sampling was conducted monthly. Soil samples were randomly taken after clearing the litter layer from four points on each plot replicated six times. The analyses were performed using standard procedures at ARC-SG soil laboratory. Soil macrofauna were sampled using pitfall traps. Data on soil macrofauna and physiochemical properties were first analysed for correlations with Pearson correlation analysis and subjected to the multivariate statistical analysis of canonical correspondence analysis (CCA) constrained to the soil variables.

Results and Discussion

The soil physiochemical properties and macrofauna abundance varied considerably across the three agro- ecosystems, the Bonferroni post-hoc test ($P < 0.05$) revealed several significant differences in some of the properties measured. Bulk density and Sulphur were the only properties which did not differ significantly across the systems ($P < 0.05$). According to the CCA tri-plot; soil pH ($r = 0.66$), Soil organic carbon ($r = 0.88$), Bulk density ($r = 0.66$), Calcium ($r = 0.67$) and Silt ($r = 0.63$), were the main soil properties which significantly influenced macrofauna distribution in the systems. The majority of soil macrofauna taxa and soil properties were associated with the organic system and the intercropped system respectively. Formicidae was the only macrofauna taxa associated with the conventional system and negatively correlated with soil organic matter.

Conclusions

Results obtained from soil characterisation and analysis in this study revealed that the differences in agro- ecosystem management have a significant influence on soil physiochemical properties, which in turn significantly influences the distribution of the macrofauna assemblages. The analysis of the main soil physiochemical properties, in particular, indicates that soils under organic management supports considerably higher soil organic matter, organic carbon and exchangeable basic cations, compared to soils under conventional management.

Overall distribution of essential and non-essential mineral elements on different plant parts of indigenous tea (*Jatropha zeyheri*)

Presenter: LK Mamabolo (katedi611@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LK	Mamabolo	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
KG	Shadung	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
MY	Maila	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa

Introduction

Jatropha zeyheri is an indigenous plant growing naturally in the wild and contains tea brewing and medicinal properties (Mutshekwa, 2017). Mineral composition in tea plays an important role in tea production and quality. Therefore, the objective of the study was to investigate whether leaves, stems and roots of *J. zeyheri* will be equally distributed.

Materials and Methods

Jatropha zeyheri parts were collected from Khureng Village, Lepelle-Nkumpi Municipality, in Limpopo Province, South Africa. Plant parts were collected from a 5 m × 5 m plot arranged in a RCBD with 10 replications. Leaves and stems were separated, while the tuberous stems were cut into smaller pieces prior to drying at 60°C for 48 hours in an air-forced oven dryer. After laboratory preparation, essential mineral elements and non-essential mineral elements were quantified using ICPE-9000. Data were subjected to ANOVA using the statistix 10.0 software. Mean separation was achieved using Fischer's Least Significant Difference Test.

Results and Discussion

Plant parts had highly significant effects on Al, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P and Zn, contributing 85, 84, 85, 82, 75, 97, 88, 96, 72, 82, 79 and 85% in total treatment variation (TTV) of the respective variables, but had significant effects on Ca, contributing 69% in TTV of the variable. Relative to leaves, essential mineral elements increased in K, Mg, Mn and Fe by 240, 125, 663 and 62 respectively from roots whereas relative to leaves, essential mineral elements increased in Ca, Ni, P, Cu and Zn by 56, 60, 69, 24 and 114 respectively from stems. Relative to leaves, non-essential mineral element increased in Cr by 37 from roots whereas relative to leaves, non-essential mineral elements increased in Al, Na, Co by 65, 42 and 63 respectively from stems.

Conclusions

Mineral nutrient elements are maintained in stems rather than in roots, suggesting that stems, in addition to leaves, could also be used to make tea as they contain high levels of mineral nutrients.

Application of hydrogeological information to conceptualize pollution migration from dry sanitation systems in the Ntabelanga catchment area, South Africa

Presenter: MM Mamera (matthewmamera@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
M	Mamera	University of the Free State, Department of Soil, Crop and Climate Sciences. Faculty of Natural and Agricultural Sciences, P.O Box 339, Bloemfontein 9300
JJ	Van Tol	University of the Free State, Department of Soil, Crop and Climate Sciences. Faculty of Natural and Agricultural Sciences, P.O Box 339, Bloemfontein, 9300

Introduction

In developing countries like South Africa, several households use pit latrines. Moreover, many people also rely upon untreated groundwater supplies for their drinking water. The shared utilization of both pit latrines and groundwater resources, can lead to human and ecological health risks from microbial and chemical pollutants. In the Ntabelanga area, 56% of the households use pit latrines and untreated drinking groundwater supplies. This study therefore aimed to interpret hydrogeological soil information to determine the potential of surface and groundwater pollution from pit latrines in the Ntabelanga area.

Materials and Methods

Four hillslopes below the pit latrines (MT1, MT2, MT3, and MT4) occur above first-order tributaries to the Tsitsa River, South Africa, were studied. Soils were described and classified at selected locations below the pit latrines. Undisturbed core samples from representative soil horizons were collected, on which hydraulic properties were determined in the laboratory. Samples were also collected to determine the faecal coliform and other bacterial concentrations during a winter and summer period. Mechanistic modelling with Hydrus 2D for a 121 day period was conducted from the various study sites.

Results and Discussion

Apedal soils, without morphological evidence of saturation, dominated the upper slopes of MT1 and the lower slopes of MT2, thus promoting vertical drainage. Hydromorphic properties were observed at the soil/bedrock interface in the lower parts of MT1 and the entire slope of MT4. This signifies slowly permeable bedrock and the occurrence of lateral flow. High clay contents and strong structured soils were dominant in MT3, indicating slow internal drainage with a large adsorption capacity. The conceptual models derived from morphological properties were verified using soil physical and organic pollutant measurements. In general, hydraulic conductivity values support the interpretations made from soil morphological measurements. Faecal coliforms and E coli bacteria counts were mostly <1 CFU/g soil in MT1, MT2, and MT4; hillslope migrations were detected in MT3 posing pollution risks. As the soil water flow rate increase the mobility of bacteria increase as well. Hydrus simulations fluxes showed that surface water resources are threatened by pollution from MT3 and MT4 due to the prominence of lateral flow.

Conclusions

Use of soil morphological and mechanistic simulation models alone does give a good reference on soil water behaviour mainly in recharge and interflow (soil/bedrock) soils. Limitations were noticeable in the subsurface layers of responsive (saturated and shallow) soils. This approach can be viable in ecological monitoring of organic pollute outbreaks, effectively in advance.

Long-term effects of inorganic fertilizer application on maize yield (*Zea mays* L.) and soil quality

Presenter: SK Maseko (masekosimphiweksm@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
S K	Maseko	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
M	Van der Laan	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
D	Marais	University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA
R	Van Antwerpen	South African Sugarcane Research Institute, Private Bag X02 Mount Edgecombe 4300, RSA

Introduction

Inorganic fertilizers have played an important role in ensuring food security, but their influence on soil chemistry, natural nutrient cycles and potential negative impacts of their export into the natural environment need to be carefully managed. In this study, long-term carbon (C) and nitrogen (N) dynamics in maize (*Zea mays* L.) was investigated using data from a trial that started in 1939 at the University of Pretoria's Experimental farm together with mechanistic modelling with APSIM.

Materials and Methods

Soil samples were collected from the trial and from an adjacent, undisturbed site for model soil parameterization purposes, including initial conditions at the start of the trial. A growth analysis was conducted for the 2016/17 crop to obtain crop parameters and test this aspect of model performance. Soil water content was also monitored during this season for calibration of soil hydraulic properties. Data from the experimental plots with zero and full fertilizer (100 kg ha⁻¹ N, 80 kg ha⁻¹ K, P application discontinued in 1984) treatments was acquired from the trial records and published literature. Soil organic matter (SOM) trends were compared for 1950–2017, and yield data more closely scrutinised from 1990–2017. The model was further used to investigate deep drainage and NO₃⁻ leaching from the different treatments. For the evaluation of a more sustainable long-term management practice, a manure application scenario was simulated.

Results and Discussion

Both observed and simulated results showed a decline in SOM levels over time, with the magnitude of SOM loss higher in the plots receiving zero fertilizer. The APSIM model generally did well in estimating yields, SOM levels, and soil water content for South African Highveld conditions. Higher cumulative drainage volumes in zero fertilizer treatment did not subsequently result in higher NO₃⁻ leaching. According to the model, including 9 t ha⁻¹ of manure in the fertilizer programme can maintain SOM levels at about 88% of initial levels and reduce NO₃⁻ leaching significantly.

Conclusions

Significant losses of SOM were observed in the long-term trial, and losses were higher in the zero fertilizer than full fertilizer treatment. Including manure helped maintain higher SOM levels. The APSIM model can be effectively applied to investigate improved management practices that aim at maintaining the sustainability of our cropping systems.

Using a computer-based model to establish the fit-for-purpose criteria for botanicals in health systems

Presenter: PW Mashela (phatu.mashela@ul.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727

Introduction

The major drawback that limits the successful development and commercialisation of novel botanical drugs is their failure to pass the litmus test: The fit-for-purpose concentration, where botanicals could either be classified as being fit-for-purpose or unfit-for-purpose. Generally, when the botanical is fit-for-purpose, it should do what it was registered for, without inducing significant "side effects", where it would be described as being unfit-for-purpose. The objective of this study was to provide a quick litmus test using the Curve-fitting Allelochemical Response Data (CARD) computer-based model, developed in Australia (Liu *et al.*, 2003), to depict the fit-for purpose concentrations of botanicals in plant health and animal systems for the development of novel drugs.

Materials and Methods

In either plant or animal health systems, target microbial pathogen (e.g. nematodes) and target healthy cells are exposed for a given period to increasing concentrations of a test botanical in geometric series that encompasses three density-dependent growth (DDG) phases. Responses to exposure are measured and treatment mean responses subjected to the CARD computer-based model to generate the biological indices. The indices, regardless of the unit of measurement, quantify concentration ranges for stimulation (Dm-Rh), neutral (Rh-D0) and inhibition (D0-D100) phases, which could not be superimposed for pathogen and healthy cells.

Results and Discussion

In plant health systems, pathogen fit-for-purpose concentration should, in context of DDG phases, be within the stimulation and/or neutral phase for the concentration range of healthy cells. In contrast, when pathogen fit-for-purpose concentration falls beyond the two phases, it becomes phytotoxic to the latter and therefore unfit-for-purpose. In animal health systems, pathogen fit-for-purpose concentration is exclusively within the neutral phase for host-fit-cells (healthy cells) concentration range. Instances where the pathogen fit-for-purpose concentration coincides with that of the stimulation phase of host-fit-cells, the product would be cancerous and therefore, unfit-for-purpose. In contrast, when it coincides with that of inhibition phase of host-fit-cells, it would invariably be cytotoxic.

Conclusions

Due to the wide concentration range (Dm-D0) for fit-for-purpose in plant health systems and the narrow one (Rh-D0) in animal health systems, most botanicals are highly adaptable for use in plant health systems as opposed to animal health systems. Using the CARD model, the suitability of a botanical for use in health systems could be established rapidly.

Growth and yield responses of maize to sole and combined winery solid waste compost and inorganic fertilizer application rates

Presenter: MM Masowa (masowmm@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MM	Masowa	Food Security and Safety Niche Area Research Group, Faculty of Natural and Agricultural Sciences, North-West University, P/Bag X2046, Mmabatho, 2735
FR	Kutu	School of Agricultural Sciences, University of Mpumalanga, P/Bag X11283, Mbombela, 1200;
OO	Babalola	Food Security and Safety Niche Area Research Group, Faculty of Natural and Agricultural Sciences, North-West University, P/Bag X2046, Mmabatho, 2735
AR	Mulidzi	ARC-Infruitec/Nietvoorbij, P/Bag X5026, Stellenbosch, 7599

Introduction

The need to improve crop growth environment, yield and soil health through the use of affordable alternatives to inorganic fertilizer has resulted in increased interest in the use of organic-based fertilizer materials on crop fields. However, sole use of organic fertilizers has been reported to be inadequate to support crops growth due to delayed nutrient mineralization with huge quantities often required to meet crop's nutrient requirements. This study assessed the optimum winery solid waste composts (WSWCs) and inorganic fertilizer combination rate for best maize performance.

Materials and Methods

Two WSWCs were produced from filter material and waste plant material in a 40:60 mix ratio (dry volume basis) with and without effective microorganism (EM) inoculation. The WSWCs were initially evaluated through a 7 week greenhouse maize pot trial at 0, 5000, 10000, 20000 and 40000 kg ha⁻¹ application rates. An estimate of the optimum rate was obtained based on maize dry matter yield. Thereafter, a field trial was conducted to evaluate the effects of combined application of inorganic nitrogen and phosphorus fertilizers (INPF) and WSWCs on maize growth and yield. The INPF and WSWCs were combined in different ratios (0:0, 75:25, 50:50, 25:75 and 0:100, w/w) in such a way that the total mineral N and P supplies from both sources were equal to that supplied by the greenhouse established optimum rate of WSWCs. Optimum 200 kg N ha⁻¹ and 90 kg P ha⁻¹ INPF rate was included as a standard check. The INPF used were limestone ammonium nitrate (28%) and single super-phosphate (10.5%). The treatments were arranged using a split-plot arrangement fitted in a RCBD with three replicates.

Results and Discussion

Significant ($P < 0.05$) WSWCs x application rate interactions were observed on plant height and leaf area index at tasseling stage. Combined application of WSWCs and INPF significantly increased plant height compared to the un-amended control at tasseling stage. Stem girth was significantly influenced by WSWCs x application rate interaction effect at physiological maturity. There was no significant difference in grain yield between the un-amended control and the different combinations of WSWCs and INPF. Treatment with EM inoculated WSWCs without INPF (0:100) gave significantly higher ear weight, grain number ear⁻¹, biomass, grain weight ear⁻¹, 1000-seed weight than the control at harvest.

Conclusions

The current findings suggest that the use of EM inoculated WSWCs improve the performance of maize. However, further field trials are required for proper recommendations.

Effect of glucose pulsing on early season 'hass' skin colour development during ripening

Presenter: N Mathaba (NhlanhlaM@ppecb.com)

Initials	Surname	Authors Company/Organisation and Postal Address
K	Shikwambana	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
TP	Mafeo	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
N	Mathaba	Perishable Produce Export Control Board, 45 Silwerboom, Platteklouf, Cape Town, 7550

Introduction

In 'Hass' avocado fruit, the conundrum of poor skin colour development is dominantly an early season phenomenon. In our previous studies, it was postulated that low exocarp glucose plays a role in poor 'Hass' avocado fruit skin colour development during ripening. Glucose is recognised as a regulatory molecule controlling gene expression which is related to plant metabolism, chilling stress resistance and biosynthesis of pigments responsible for skin colouration of fruit (Bolouri-Moghaddam *et al.*, 2010). In 'Hass' avocado fruit, skin colour change is through an increase anthocyanin, especially cyanidin-3-O-glucoside (Cox *et al.*, 2004). Therefore, this study aimed at investigating the effect of postharvest glucose pulsing on 'Hass' avocado fruit skin colour development and pigment during ripening.

Materials and Methods

Avocado fruit 'Hass' were pulsed with distilled water, glucose concentrations of (1, 5 and 10 mg L⁻¹) and un-pulsed fruit with 5 cm pedicle were used as the control, stored at 5,5°C for up to 28 days. Fruit were ripened at 25°C and evaluated every after 2 days for weight loss, firmness, electrolyte leakage (EL), chilling injury (CI), objective colour parameters (lightness-L*, chroma-C* and hue angle-h*), subjective colour (eye colour rating), total chlorophyll, total carotenoids and total anthocyanin.

Results and Discussion

The results showed that glucose pulsing reduced membrane permeability of 'Hass' avocado fruit (P<0.05), reducing electrolyte leakage and chilling damage during cold storage. Chilling injury and electrolyte leakage showed a strong positive correlation (R²=0.89). In addition, glucose pulsing (P<0.05) increased the subjective colour measurement (eye colour) when compared to control and distilled water during ripening. The results showed that fruit pulsed with glucose concentrations (1, 5 and 10 mg L⁻¹) changed skin colour from green to purple then black (eye rating scale 5-purple and 6-black) during ripening. Furthermore, pulsing fruit with 1, 5 and 10 mg L⁻¹ glucose increased the total anthocyanin content in the skin of 'Hass' avocado fruit during ripening.

Conclusions

The result indicated that glucose sugar application at postharvest improved skin colour of 'Hass' avocado fruit by increasing the accumulation of skin pigment anthocyanin during ripening.

Selection of wheat for biomass allocation to improve drought tolerance and carbon sequestration into soils

Presenter: I Mathew (isackmathew@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
I	Mathew	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X54001, Scottsville 3209, Pietermaritzburg
H	Shimelis	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X54001, Scottsville 3209, Pietermaritzburg
M	Mutema	Agricultural Research Council-Institute of Agricultural Engineering, Private Bag X529, Silverton, Pretoria
Ar	Clulow	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X54001, Scottsville 3209, Pietermaritzburg, South Africa
R	Zengeni	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X54001, Scottsville 3209, Pietermaritzburg
V	Chaplot	Laboratoire d'Océanographie et du Climat: Expérimentations et approches numériques (LOCEAN). UMR 7159, IRD/C NRS/UPMC/MNHN, IPSL, 4, place Jussieu, 75252 Paris, France

Introduction

Biomass allocation to shoots and roots is key in carbon, water and nutrients cycles. Greater allocations to roots foster the transfer of atmospheric carbon to soils. Several studies have investigated the root to shoot ratio (R:S) biomass of existing crops but variation within a crop species constitutes an important information gap for selecting genotypes to increase soil carbon stocks for climate change mitigation and food security. The objectives of this study were to evaluate agronomic performance and biomass allocation between roots and shoots, in response to different soil water levels to select promising genotypes for breeding for drought tolerance and carbon sequestration.

Materials and Methods

Field and greenhouse experiments were carried out on 99 wheat and a triticale genotypes under drought and non-stressed conditions. The experiments were set up using a 10*10 alpha lattice design with two replications. The number of days to heading (DTH), number of productive tillers per plant (NPT), plant height (PH), days to maturity (DTM), spike length (SL), kernels per spike (KPS), thousand kernel weight (TKW), root biomass (RB), shoot biomass (SB), root to shoot ratio (R:S) and grain yield (GY) were recorded. Analysis of variance (ANOVA), correlations and hierarchical clustering were performed in Genstat 18th edition (Payne *et al.*, 2017).

Results and Discussion

Significant ($P < 0.05$) variation in biomass and its allocation was found among the test genotypes, reflect diverse genetic background and their importance in developing drought tolerant and enhanced C sequestering varieties. LM52 had the highest grain yield of 247.3 g m⁻² and the least was in Sossognon with 30 g m⁻². Shoot biomass ranged from 830 g m⁻² (Arenza) to 437 g m⁻² (LM57), whilst root biomass ranged between 603 g m⁻² for Triticale and 140 g m⁻² for LM15. Triticale also recorded the highest R:S of 1.2, while the least was 0.30 for LM18. Water stress reduced biomass production by 35% and R:S by 14%. Differences in performance among genotypes reflect diverse genetic background. Yield was strongly correlated to shoot biomass ($r > 0.50$; $P < 0.001$) presenting a conflict between food production and efforts to increase soil C input via root biomass.

Conclusions

It is possible to simultaneously select for high yield and root biomass to satisfy both food production and C sequestration needs, especially under drought stress. R:S is inadequate as a sole predictor for drought tolerance, biomass productivity or soil C input by wheat due to its low correlations with biomass variables under both water regimes.

Growth, yield and yield components of two *Amaranthus* species in response to poultry manure application

Presenter: LE Matshona (matshonale@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LE	Matshona	Madzivhandila College of Agriculture ,P/Bag X 5024 , Thohoyandou 0950
VI	Ayodele	University of Limpopo, P/Bag X 1106, Sovenga , 0727
FR	Kutu	University of Limpopo , P/bag x 1106, Sovenga, 0727

Introduction

Amaranthus is locally known as Marogo/Thepe/Vowa/Common pigweed/Imbuya/Utyutu it belongs to the family Amaranthaceae. The objective of this study was to provide quantitative information on the effect of poultry manure on the growth and yield of *Amaranthus hybridus* and *Amaranthus hypochondriacus*.

Materials and Methods

Two sets of field experiments were conducted at two different areas of Limpopo Province (Syferkuil and Lwamondo experimental farms). Each experiment was a 2 x 6 factorial arranged in split-plot and fitted into Randomized Complete Block Design replicated three times. The main plot was the poultry manure rate and the sub-plot was the amaranth species. Six rates of poultry manure were used at Syferkuil and Lwamondo namely 0, 50, 75, 100, 125, 150 kg ha⁻¹ N. Six rates of organic (poultry) manure application were similarly used in both trials for homogeneity namely 0, 50, 75, 100, 125, 150 kg ha⁻¹ N.

Results and Discussion

Poultry manure application to soil increased amaranth growth. Significant interactions between amaranth species and rate of poultry manure application on plant height were obtained. Number of leaves per plant increased significantly from 4 weeks after transplant (WAT) to 12 WAT with increased fertiliser rates. The interactions between *Amaranthus* species and poultry manure application rate in relation to leaf size were significant ($P \leq 0.05$). Leaf size increased with age of amaranth. Significant interactions were obtained between *Amaranthus* species and poultry manure rate in relation to number of branches produced. *Amaranthus* marketable yield increased with age of the plant and also with increasing level of poultry manure application. The interactive effect of amaranth species and poultry manure application rate on fresh leaf mass of *Amaranthus* was significant ($P \leq 0.05$). The lowest amaranth fresh leaf mass of 9.8 g was recorded in *A. hypochondriacus* at 4 WAT, while the significantly highest average value of 91 g at 12 WAT was found in *A. hybridus* at 150 kg ha⁻¹ N treatment.

Conclusions

Plant height, number of leaves per plant, number of branches, chlorophyll content and leaf area all increased with increased rate of poultry manure application. This is attributed to the fact that poultry manure contributed to the fertility of the soil by adding organic matter and nutrients such as nitrogen. The resource poor farmers can therefore use poultry manure for improved production of the crop.

Leachate migration potential of a duplex soil type at the Bloemfontein Southern solid-waste landfill

Presenter: SSW Mavimbela (mavssw@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
SSW	Mavimbela	University of the Free State, PO Box 339, Bloemfontein, 9300
OO	Ololade	University of the Free State, PO Box 339, Bloemfontein, 9300
JJ	Van Tol	University of the Free State, PO Box 339, Bloemfontein, 9300
MP	Aghoghovwia	University of the Free State, PO Box 339, Bloemfontein, 9300

Introduction

Direct dumping of solid waste at the soil surface is a common practice in most municipal landfills of South Africa (MMM, 2016). In this work, the capacity of the underlying soil-type to contain pollutants leaching from the decaying waste was investigated at the Bloemfontein southern landfill (BSL) of the Mangaung municipality, Free State province.

Materials and Methods

Six soil-profile pits surrounding the dump were prepared and classified according to the Soil Classification Working Group (1991). Soil sampling taken from each horizon were analysed for particle size distribution and bulk density using the pipette and core soil sampling method, respectively. Water contents, drained upper limit (DUL) and steady state hydraulic conductivity (Ks) were also determined. Soil pH (1:2.5 soil water suspension), exchangeable basic cations (Ca, Mg, K and Na), and heavy metals (As, Cd, Cr, Cu, Fe, Pb, Hg, Zn, Ni, Mn, and Hg) were analysed using the respective standard method and DTPA soil test (Non-Affiliated Soil Analysis Work Committee, 1990).

Results and Discussion

The results showed that all the profile pits was representative of the Sepane soil form belonging to the group-D land type. The apedal A- pedocutanic-B and C-horizon had respective mean clay content of 32, 41 and 36% with corresponding bulk density and DUL volumetric water contents of 1.45, 1.47 and 1.53 g cm⁻³ and 0.26, 0.28 and 0.38 mm mm⁻¹, respectively. Saturated hydraulic conductivity decreased with depth from 21 to 3 mm hour⁻¹ and restricted migration of leachates beyond the C-horizon. Elevated levels of exchangeable Ca and Mg, and heavy metal elements like Fe, Cu, Mn and Cd from the subsurface horizons was indicative of the high leachate containment properties of clayey horizons that caused accumulation of the various elements. High concentration levels in excess of the norm and for some elements above the intervention target values for a standard soil were observed in soil profiles either in close proximity (<5 m) to the dump or surface runoff collecting area.

Conclusions

Findings confirmed that solid-waste landfills are leading sources of exchangeable cations, heavy metals, and surface runoff was the dominant form of leachate migration due to the high clay content (≥32%) and low Ks (≤21 mm hour⁻¹) of the Sepane soil form. The application of duplex soil-types, constituting more than 10% of the provincial landscape, as containment of landfill leachates offers great prospect for environmental protection especially when coupled with effective control of surface runoff.

Effect of granular and liquid applied nitrogen fertiliser topdressings on yields and yield parameters of spring wheat (*Triticum aestivum* L.) under controlled glasshouse conditions

Presenter: MM Mbangcolo (Mongezi.Mbangcolo@drdar.gov.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MM	Mbangcol	Dohne ADI, DRDAR, Private Bag X15, Stutterheim, 4930
PJ	Pieterse	University of Stellenbosch, Private Bag X1, Matieland 7602

Introduction

Liquid (foliar) application of nitrogen (N) on cereal grains is becoming a common practice world-wide due to benefits associated with the practice. There are however, mixed results with liquid nutrient applications, with some of the results showing positive effects, others negative and sometimes no responses depending on crop species and nutrients applied. The aim of this study was to evaluate the effect of granular and liquid N topdressings on grain yield and yield parameters of wheat (*Triticum aestivum* L.) under glasshouse conditions.

Materials and Methods

Studies were conducted for three years under glasshouse conditions using pots at Welgevallen Experimental Farm, Stellenbosch, South Africa (33°56'33"S, 18°51'56"E, 136 m.a.s.l.). The design was a Randomized Complete Block Design with 10 treatments replicated six times. At planting, LAN (28) was applied at a rate equivalent to 30 kg ha⁻¹. At tillering stage, N was applied at rates equivalent to 30 and 60 kg ha⁻¹ using granular soil applied (LAN and Urea) and liquid foliar applied (UAN and Urea) applications. Soil samples were collected and analysed at pre-plant to determine soil chemical properties. At physiological maturity, plant biomass pot⁻¹ (PBPP), number of ears pot⁻¹ (NEPP), mass of ears pot⁻¹ (MEPP), and grain yield pot⁻¹ (GYPP) were measured. Data was analysed using the Statistica software program (Version 13.2).

Results and Discussion

The results showed that UAN and urea solutions at 60 kg N ha⁻¹ significantly ($p \leq 0.05$) improved PBPP compared to other treatments. For NEPP, the responses showed a variation between treatments but applications at 60 kg N ha⁻¹ promoted higher NEPP. In terms of MEPP, the results indicate that liquid N topdressings were superior compared to granular N with responses increasing with increasing N rate. The results of the study showed that UAN at 60 kg N ha⁻¹ was consistent in the significant improvement of GYPP compared to other treatments. This could be attributed to higher N uptake of foliar applied N compared to granular soil applied N. Liquid fertilisation assist in direct uptake of nutrients and requires low consumption of energy and the process is less dependent on environmental factors.

Conclusions

The study showed that the application of liquid N (UAN at 60 kg N ha⁻¹) produced significantly better results compared to other treatments and was consistent in all the years in terms of grain yield. These results indicate that liquid N sprays could be an alternative to supplement N following the applications of granular N at sowing.

Assessing soil C sequestration potential and decomposition rates of different wheat residues

Presenter: NO Mbava (nozinyezini@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NO	Mbava	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
R	Zengeni	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Introduction

Sequestration of atmospheric carbon (C) into plants and ultimately to soils is a credible strategy to mitigate against climate change, and restore C reserves of degraded land. Incorporation of crop residue can therefore be done to improve soil productivity. As these residues decompose in soil, they release mineral nutrients such as carbon, nitrogen, phosphorus and sulphur among others. Wheat is an important food crop to the South African economy. It is produced intensively as an irrigated crop on commercial farms. Not much is known however about the potential of its residues to sequester soil C or improve fertility once incorporated into the soil. The objective of the study was to assess soil C sequestration potential and decomposition patterns of wheat residues of different varieties upon incorporation into the soil.

Materials and Methods

About 0.25 g of either wheat root or shoot from variety 5 wheat varieties (BW152, BW162, BW140, LM70 and LM75) were thoroughly mixed with 100 g of soil then transferred into an air tight PVC pot. Samples were wetted slowly to 50% field capacity moisture. A vial containing 25 ml NaOH solution was also placed inside the incubation pot to trap CO₂ released during decomposition. The pots were covered with polyethylene sheets and incubated for 120 days with periodic sampling twice a week. At the end of each incubation period, the trapped CO₂ was precipitated with BaCl₂ then excess NaOH was titrated with 0.5 M HCl using phenolphthalein as an indicator. After titration 2 g of moist soil from each pot was extracted with 20 ml of 1M KCl to analyse for NH₄⁺ and NO₃⁻ through a flow injection analysis.

Results and Discussion

CO₂ emission was higher in soil with shoots (283.3 mg kg⁻¹) than in soil with roots (160.6 mg CO₂ mg kg⁻¹). Among the wheat varieties, LM70 shoots produced the highest CO₂ emission (380.55 mg kg⁻¹ soil) and LM70 roots produced lowest CO₂ (165.80 mg CO₂ kg⁻¹). LM70 shoots with soil increased by 137% cumulative CO₂ compared to control. Generally NH₄⁺ was higher (60.32 mg kg⁻¹ soil) than NO₃⁻ (46.89 mg kg⁻¹). Highest NH₄⁺ was produced by LM70 shoots (92.32 mg kg⁻¹), whilst highest NO₃⁻ was produced by BW140 shoots (64.49 mg kg⁻¹). Lowest NH₄⁺ and NO₃⁻ amount were produced by BW152 roots with values of 23.78 mg kg⁻¹ and 24.78 mg kg⁻¹ respectively.

Conclusions

From these findings, it can be concluded that wheat residues have a potential for improving soil fertility and carbon sequestration.

Determining breeding values of parental genotypes for sugarcane biomass yield

Presenter: NW Mbuma (ntombi.mbuma@sugar.org.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NW	Mbuma	South African Sugarcane Research Institute, Mt Edgecombe, Durban, South Africa, 2 Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa
MM	Zhou	South African Sugarcane Research Institute, Mt Edgecombe, Durban, South Africa, 2 Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa, 3 School of Agriculture, Earth and Environmental Sciences, UKZN, Pietermaritzburg, South Africa
R	Van der Merwe	Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa

Introduction

Breeding values (BV) refer to the ability of a genotype to produce superior progenies when crossed with other genotypes. The breeding values are used to predict the breeding performance of parental genotypes in sugarcane breeding. The objective of this study was to use best linear unbiased prediction (BLUP) to determine breeding values of parental genotypes for cane yield.

Materials and Methods

Data were collected from a family (cross) evaluation (40 female, 26 male parents) trial planted in the Midlands region of KwaZulu-Natal in 2013. The design was randomised complete block design with three replications per family. Cane biomass yield was estimated from stalk numbers, height and diameter measured from the first 20 progenies per plot. BLUP analysis, which provides a comparison of genotypes with population means, was done using statistical analysis software mixed models.

Results and Discussion

There were significant female ($P=0.0003$) and male ($P=0.0145$) variances indicating that large genetic variability among progenies was associated with parents. Genotypes 00B1741 (6.35, $P<0.0001$), 82H0397 (5.71, $P<0.0001$), 90H0525 (2.21, $P=0.0273$), 85H0428 (2.81, $P=0.0050$), N52 (2.94, $P=0.0033$), 01B0742 (3.98, $P<0.0001$), 95H0464 (2.43, $P=0.0152$) and 86H0437 (1.98, $P=0.0473$) had significantly higher breeding values. Progenies from cross combinations of diverse parents with 00B1741 (+10%), 82H0397 (+16%), N52 (+16%) and 93H0460 (+26%), produced higher cane yield. Genotypes N52 (14-38%), 82H0397 (16-33%) and 85H0428 (20-45%) when crossed with diverse parents from coastal, Midlands humic and sandy soil regions produced higher cane yields suggesting broad general combining ability.

Conclusions

Testing breeding values of genotypes with diverse populations is expected to identify parents suitable in breeding for general adaptability and for use as tester parents in sugarcane breeding.

Quantifying the soil alteration response following irrigation with diluted winery wastewater in soils of dissimilar textures

Presenter: AH Meyer (meyera@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
AH	Meyer	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
I	Van Huyssteen	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
AR	Mulidzi	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa

Introduction

The need to re-use treated winery wastewater for vineyard irrigation may be increasing due the severe water scarcity in the Western Cape. Sustainable water management, nevertheless, requires striking a balance between water use and the environment. Research is required to ensure irrigation with winery wastewater does not compromise soil fertility and sustainability. Furthermore, it is uncertain whether or not vineyard soils of dissimilar textures may respond differently to wastewater irrigation, what the soil alteration response would be after multiple irrigation cycles, or what the effect on the soil may be with increasing soil depth. To obtain clarification, a pot trial was conducted to determine the soil alteration response after multiple irrigation cycles with diluted winery wastewater, and of irrigating with good quality (municipal) water, on differently textured vineyard soils, using an enzyme-based soil alteration index (AI₃).

Materials and Methods

Soils originating from four vineyard areas were irrigated, in pots, over four simulated seasons with municipal water, and with winery wastewater diluted to a chemical oxygen demand of 3000 mg L⁻¹. The soils were: alluvial sand, aeolian sand, as well as shale and granite derived soils. Pot soil samples were taken from the 0-15 cm and 15-30 cm layers after each season. AI₃ indices were generated using the formula by Puglisi *et al.* (2006). Each of the soil and water treatments was replicated in four blocks in a fully randomized split-plot design.

Results and Discussion

Soil enzyme activity was stimulated in treatments where wastewater was used for irrigation compared with irrigation with municipal water, possibly due to the supply of easily decomposable organic material in wastewater, through a priming effect. Differently textured soils responded differently to winery wastewater irrigation in accordance with their clay and organic matter contents. The AI₃ also accurately reflected gradients in mineralizable substrates, with the top layer being consistently more fertile than the subsoil layer. The AI₃ scores differed from season 3 to 4 implying that the soils had undergone an alteration due a temporal effect.

Conclusions

Vineyards may benefit from winery wastewater as an alternative source of water for irrigation. Winery wastewater inputs provide the added advantage of enhancing soil microbial enzyme activity and improves soil fertility, the extent of which may differ depending on the soil texture and on the irrigation cycles.

The efficacy of priming with *Moringa oleifera* leaf extract for Bambara groundnut (*Vigna subterranea* L.) seed invigoration of a landrace with different seed coat colours

Presenter: SP Miya (slindilemiya@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
SP	Miya	University of KwaZulu-Natal, Rabie Saunders Building, King Edward Avenue, Scottsville, Pietermaritzburg 3201

Introduction

Bambara groundnut is generally ignored for crop improvement which has led to cultivated accessions occurring in various seed coat colours. Seed performance is strongly linked to its morphology, including seed coat characteristics, which affect seed germination and dormancy. Seed priming is an important technology to influence seed performance. The objective of this study was to evaluate the effect of seed priming on Bambara groundnut landrace characterised into Cream, Light Brown and Brown seed coats.

Materials and Methods

Priming with distilled water (control) was compared with moringa (*Moringa oleifera*) solutions at nine levels. Treatments of 3% moringa extract for 1, 12 and 24 h (M3-1, M3-12, M3-24, respectively), 10% moringa extract for 1, 12 and 24 h (M10-1, M10-12, M10-24, respectively) and 15% moringa extract for 1, 12 and 24 h (M15-1, M15-12, M15-24, respectively) were used. Seed coat thickness, electrical conductivity (EC) and final germination percentage (FGP), germination vigour index (GVI), mean germination time (MGT), seedling dry weight (SDW), seedling vigour index (SVI), seedling length, root length and shoot length were determined as indicators of seed and seedling vigour. The associations between seed vigour and seedling vigour qualities were also assessed using correlation co-efficient.

Results and Discussion

The results of this study showed that except for the influence of seed coat colour on seed coat thickness, seed priming treatments, seed coat colour and their interaction thereof significantly influenced seed coat thickness, EC, FGP, GVI, MGT, SDW, root, shoot and total seedling lengths as well as SVI. Darker seeds (brown followed by light brown) had superior seed and seedling vigour compared to cream seeds. Moringa priming treatment M3-12 was the most optimum in promoting FGP, SVI, seedling, root and shoot lengths. Moreover, M3-24 on seed coat thickness, M3-1 on GVI, MGT and seedling length showed superior performance. Only the seed coat thickness had no interrelationship with other seed and seedling vigour traits.

Conclusions

Priming seeds with moringa at lowest concentration (3%) result in consistent improvement across all seed quality indices which should be used to improve seed quality and seedling vigour. All other seed and seedling vigour indicators except seed coat thickness may be used as a reliable predictive factor for seed and seedling vigour. Moringa effect on non-expressive physiological processes of Bambara groundnut seed germination requires further investigation.

Poultry litter application increases N and P availability and CO₂ emission from humic soils

Presenter: NP Mkhonza (pertuniamkhonza88@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NP	Mkhonza	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P.O Bag X01, Scottsville 3209
P	Muchaonyerwa	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P.O Bag X01, Scottsville 3209
N	Buthelezi	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P.O Bag X01, Scottsville 3209

Introduction

Humic soils have a high concentration of generally stable organic matter and application of poultry litter could potentially accelerate decomposition of soil organic carbon (SOC). Globally, SOC management has received attention due to its contribution to atmospheric carbon dioxide (CO₂) concentrations. Information on carbon (C) and nitrogen (N) mineralisation from poultry litter (PL) application on humic soils is limited. The objective of this study was to determine the effects of application rate of PL on C and N mineralization in two humic soils.

Materials and Methods

Incubation studies were done with humic soils of the Magwa form from Eston and Eshowe, KwaZulu-Natal. Poultry litter was applied at rates equivalent to 0, 10 and 30 t ha⁻¹ to soil from 0- 10 and 10-20 cm depths, adjusted to 100% water holding capacity and incubated at 25°C. The amended soils were sampled after 0, 7, 14, 21, 28, 56, 84 and 112 days of incubation and analysed for pH and ammonium- and nitrate-N, in the first experiment, and for carbon dioxide (CO₂), in the second.

Results and Discussion

Soil pH increased from day 0-7 and decreased thereafter. Ammonium- and nitrate-N increased with increase in rate of PL. Ammonium-N peaked after 14 days for all treatments on both soils. Ammonium-N was greater in the 0-10 than 10-20 cm depths for both soils. The Eston soil had higher levels of ammonium than Eshowe soil in the top 0-10 cm depth. Nitrate-N increased with incubation time, with a corresponding decrease in ammonium-N. The Eston soil reached a maximum of 268 mg kg⁻¹ while for Eshowe the maximum was 169 mg kg⁻¹, at 0-10 cm depth. The high ammonium-N could be the result of mineralization of N from the litter and, possibly resident organic matter due to addition of labile C, while nitrification of the ammonium-N could have increased nitrate-N. The results of CO₂ followed the same trend as ammonium-N. The Eston soil had lower CO₂ evolution than the Eshowe soil. The increase in CO₂ emission could be an indication of decrease SOC in humic soils.

Conclusions

Application of PL to humic soils increases availability of nitrogen and phosphorus, which could increase crop productivity at least in the short term. The increased CO₂ emissions could be an indication of decrease soil C and contribute to climate change.

Integrating seasonal forecast information with crop models for improved climate variability management in farming

Presenter: S Mkuhlani (siyabusa@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mkuhlani	Climate Systems Analysis Group, Environmental and geographical Sciences Department, Univesity of Cape Town, South Africa
O	Crespo	Climate Systems Analysis Group, Environmental and geographical Sciences Department, Univesity of Cape Town, South Africa

Introduction

Climate variability has led to recurrent crop yield losses with consequences to household food security in South Africa. Linking of seasonal forecast information to crop models can be utilized as a tool to inform decision making in climate variability management (Hansen *et al.*, 2009). This has been successfully conducted in the America; Europe, Australia and East Africa (Cantelaube and Terres, 2005; Shafiee-Jood *et al.*, 2014). This study evaluated variability management strategies based on seasonal weather forecast information for their potential to improve smallholder farmers' preparedness to seasonal weather variability.

Materials and Methods

The study was based on Lambani, Limpopo, South Africa an area predominated by small-scale farmers. Small scale farmers were grouped into different categories: social welfare dependant, enterprising pensioners, struggling subsistence, horticultural dependant and cooperative crop farmer based on the predominant socio- economic characteristics. Maize yields simulations were conducted using the DSSAT crop model (Jones *et al.*, 2003) for each farmer type and different climate variability management strategies based on the 2017/18 seasonal forecast (CFSV2) (Yuan *et al.*, 2011). Some of the strategies evaluated in this study are: different planting dates, different cultivars, organic amendments.

Results and Discussion

Seasonal forecasts are more accurate in predicting temperature than rainfall. Across all farmer types, the highest maize yields of at least 2t/ha are expected when the crop is sown before 9-January-2018, with 17- December-2017 being the optimum sowing date for the 2017/18 season. Sowing on seasonal forecast recommended sowing dates led to higher yields compared to the farmers' traditional sowing dates. Long seasoned varieties gave high maize yields compare to short seasoned varieties. Use of cattle manure and irrigation increased maize yields in resource endowed farmers. Mulch relatively increased yields in resource constrained farmers.

Conclusions

Researchers can use the outputs in designing future research. Effectiveness of research is increased through identifying and evaluating user specific climate risk management strategies. Policy makers can promote the provision of seasonal forecasts to farmers thus enabling them to timeously prepare before commencement of the rainy season.

Effect of pre-treatment on the quality attributes of dried pomegranate arils during long shelf

Presenter: FM Mokapane (17930596@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
FM	Mokapane	South African Research Chair in Postharvest Technology, Stellenbosch University, Private Bag X1 Matieland, Stellenbosch
OA	Fawole	South African Research Chair in Postharvest Technology, Stellenbosch University, Private Bag X1 Matieland, Stellenbosch
UL	Opara	South African Research Chair in Postharvest Technology, Stellenbosch University, Private Bag X1 Matieland, Stellenbosch

Introduction

The use of physical and chemical pre-treatments has been used to improve drying of fruit with waxy surfaces such as pomegranate arils. While pre-drying treatments reduce drying rate and maintain colour of dried products through inactivation of enzymes, certain bioactive compounds may be sensitive to high temperatures associated with these treatments. The objective of this study was to determine the effects of chemical (citric acid and ascorbic acid) and blanching treatments on the keeping quality of dried pomegranate arils stored over a period of 6 months.

Materials and Methods

Fresh pomegranate arils were blanched for 20 s at 85 and 100°C, respectively. For chemical treatment, arils were dipped separately for 15 min in ascorbic acid (AA) and citric acid (CA) treatments at concentrations of 1.0 and 0.4%, respectively. Arils were then oven-dried at 60°C and stored in craft paper pouches at ambient conditions of 22-25°C and 55% relative humidity. Sampling was done every month and quality of dried arils was based on water activity, colour, texture, total soluble solids/ titratable acidity (TSS/TA), antioxidant activity and total phenolics (TP).

Results and Discussion

Storage duration and pre-treatments had a significant effect on colour of dried samples. Specifically, redness (a^*) was highest for untreated, AA and CA treated arils. Whereas, values for TSS/TA, antioxidant activity and TP decreased over time, with 100°C blanching treatment having the lowest value for these quality parameters. A gradual increase in water activity was found, however values were within acceptable range for safe consumption.

Conclusions

Under ambient storage conditions, pre-drying treatments and storage duration were found to have a significant effect on the keeping quality of dried pomegranate arils. Although colour and texture of dried arils improved over time, the overall taste (TSS/TA) and nutritional value (antioxidant activity and TP) decreased significantly.

Quality loss assessment and changes in vitamin C content of sweet peppers in the Tshwane market supply chain

Presenter: RG Monama (monamagloria10@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RG	Monama	Tshwane University of Technology, Private bag X 680, Pretoria, 0001
D	Sivahuma	Tshwane University of Technology, Private bag X 680, Pretoria, 0001

Introduction

Sweet bell pepper (*Capsicum annuum* L.) is a popular fruit, used mostly with other vegetables in fresh salads and cooked dishes. It is highly perishable, especially in its processed form, and has a limited shelf life. The postharvest quality loss of green bell peppers were investigated directly after transportation, storage and on simulated retail shelves on days 0, 3 and 7 respectively in the urban fresh produce market supply chain. This study can potentially identify the causes of quality loss, which in turn would facilitate improved measures to retain fruit quality at the market supply chain.

Materials and Methods

The study was conducted at the Tshwane Fresh Produce Market supply chain with fruit from two provinces, Gauteng and Limpopo, selecting five commercial farmers from each province. Five replicate boxes, each containing 20 fruits from each province, were drawn randomly from each point of the supply chain and at different day intervals: transport (day 0), storage (3 and 7 days) and retailer shelf (3 and 7 days) for quality loss assessment. Data on weight loss, firmness, decay, green skin colour retention and vitamin C at market supply chain points were subjected to analysis of variance (ANOVA).

Results and Discussion

Directly after transport the fruit was still in perfect condition. Weight loss increases significantly over time. Weight loss was significantly higher at the retailer shelf (18.87% and 52.67%) compared to storage conditions (11.64% and 44.03%) after 3 and 7 days respectively, accompanied by significant loss of firmness over time. Firmness was the highest after transport (3.34%) than retailer shelf (2.18% and 0.97%) and storage (2.50% and 1.42%) after 3 and 7 days respectively. Quality loss due to decay was significantly higher at the retailer shelf (16.93% and 31.24%) compared to storage (1.30% and 8.67%) after 3 and 7 days respectively. Directly after transportation no decay was visible as the produce was still fresh. There is a greater decrease of green colour retention at retailer shelf than storage. Vitamin C was the lowest after 7 days on the retailer shelf (90.0 mg 100 g/FW), after starting at a significantly higher value just after transport (118.5 mg 100 g /FW), with a steep decrease until it eventually reaches the consumer.

Conclusions

The Tshwane Fresh Produce Market is recommended to adopt multiple postharvest policies or strategies to extend shelf life and reduce postharvest losses occurring at the market supply stages.

Seasonal variations of yield and essential oil constituents of *Artemisia afra* growing wild along the selected in-land regions of the Eastern Cape Province

Presenter: B Mpambani (Babalwa.Ntwana@drdar.gov.za)

Initials	Surname	Authors Company/Organisation and Postal Address
B	Mpambani	Döhne Agricultural Development Institute, Private Bag X 15, Stutterheim, 4930
BK	Eiasu	Department of Agronomy, Faculty of Science and Agriculture, University of Fort Hare, Private Bag X1314, Alice, 5700
MAT	Poswal	Döhne Agricultural Development Institute, Private Bag X 15, Stutterheim, 4930
AM	Ras	Döhne Agricultural Development Institute, Private Bag X 15, Stutterheim, 4930

Introduction

Traditional medicine plays an important role in the health care system of South Africa. The majority of the medicinal plants in the country, such as *Artemisia afra* are collected from the wild. The essential oil components of *A. afra* fluctuate enormously in plants collected from different geographical regions. However, seasonal variations within the same geographical area and between different regions have not yet been established. Hence, this issue was the objective of the current study.

Materials and Methods

The study was conducted to determine yield and characterise essential oil composition of *A. afra* collected from five selected in-land regions of the Eastern Cape. Fresh shoot samples were collected from Indwe, Kolomana, Barkley East, Sterkspruit and Adelaide in four seasons over a two-year period (2016-2018). Essential oils were extracted from fresh plant material, using steam distillation and they were weighed to determine oil yield (%). Gas chromatography (GC), with mass spectrometry was used for the identification of chemical components. For quantification, GC, using a flame ionization detector (FID) was used. The GC temperature program had an initial temperature of 60°C and a temperature ramp of 3°C minute⁻¹ to 245°C. Essential oil components were identified using the NIST mass spectra library and confirmed by their retention index using the extensive essential oil identification dictionary of Adams (2007). Cross referencing with other oils containing known compounds were done for confirmation of identified components.

Results and Discussion

Although there were no significant differences observed among seasons, essential oil content tended to be the highest in summer and the lowest in winter. Significantly higher yield (0.46%) was recorded in samples from Indwe while the lowest (0.22%) was recorded for samples from Kolomana. 1.8-Cineole content was significantly the highest and lowest in samples from Adelaide (14.61%) and Sterkspruit (3.44%), respectively. The highest levels were obtained in autumn. Levels of cis- and trans-Thujone were significantly lower in Barkley East (1.86 % and 0.50% respectively). cis-Chrysanthenyl acetate (61.12%) was a major essential oil component obtained from Barkley East samples compared with that of samples from the other four areas in which less than 0.2% was recorded.

Conclusions

Essential oil yield and major constituents of *A. afra* were highly affected by the locality, seasons and season x location interaction. This study revealed that populations from some locations had lower levels of cis- and trans-thujone. Further evaluations regarding the presence of cis-chrysanthenyl acetate should be conducted as higher levels were only recorded in one geographic area regardless of the season.

Assessing the vulnerability and adaptive capacity of water, energy and agriculture sectors in Southern Africa

Presenter: S Mpandeli (sylvesterm@wrc.org.za)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mpandeli	Water Research Commission of South Africa, 4 Daventry Street, Lynnwood Manor, Pretoria 0081, South Africa
D	Naidoo	Water Research Commission of South Africa, 4 Daventry Street, Lynnwood Manor, Pretoria 0081, South Africa
T	Mabhaudhi	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, South Africa
L	Nhamo	International Water Management Institute, Southern Africa (IWMI-SA), 141 Cresswell Street, Silverton, 0184, Pretoria, South Africa
C	Nhemachena	International Water Management Institute, Southern Africa (IWMI-SA), 141 Cresswell Street, Silverton, 0184, Pretoria, South Africa
S	Liphadzi	Water Research Commission of South Africa, 4 Daventry Street, Lynnwood Manor, Pretoria 0081, South Africa

Introduction

The water–energy–food (WEF) nexus has become a central theme in sustainable development as the interconnections between these three vital commodities are increasingly recognized. Southern Africa is most vulnerable to climate change impacts due to already existing poverty, inequality and resource scarcities. The aim of the study was to assess vulnerability of the WEF sectors to climate change and recommend adaptation and mitigation strategies using a WEF nexus perspective.

Materials and Methods

A mixed-method review approach, which included combining quantitative and qualitative research or outcomes with process studies, was used to review literature on water, energy and agriculture sectors. Scientific journal articles, book chapters, technical reports and other forms of literature were used. The review focused primarily on literature describing southern Africa; these countries share similar climatic and hydrological conditions.

Results and Discussion

Southern Africa is highly vulnerable to climate change due to its dependence on climate sensitive sectors of agriculture, water and hydropower. Annual rainfall continues to decrease, and the region records the highest number of drought events in the world. The impacts of climate variability and change on WEF sectors have significant implications on southern African countries' economies. Besides the resource scarcity worsened by climate change, the demand for WEF resources continues to increase due to increasing population, urbanisation and economic development. Agricultural production varies a lot annually due mainly to climate risks that affect productive potential. Increased frequency and intensity of droughts is already causing acute water shortages in some parts of the region (especially the marginal western parts). One way to improve adaptation and create resilient communities is to develop early warning systems that give enough lead time for stakeholders and decision-makers to prepare. The WEF nexus is an approach that enhances adaptation and mitigation measures through taking into consideration synergies and trade-offs among the three sectors.

Conclusions

The recognition of the fact that food, energy and water production and consumption are strongly interlinked has given rise to a growing need for integrated natural resource management. The three cannot be considered in isolation as water is essential to energy and food production. The WEF nexus is particularly relevant for Southern Africa as resources are transboundary in nature and shared among countries. The WEF nexus perspective to climate change adaptation in the water, energy and food sectors contributes to sustainable natural resource management and facilitates establishment of climate resilient sectors.

Simulated rainfall-induced soil surface crusting and its effects on infiltration, runoff and soil loss

Presenter: K Mrubata (mrubatak@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
K	Mrubata	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
IIC	Wakindiki	School of Agriculture, University of Venda, P/Bag X5050, Thohoyandou, 0950, South Africa
AD	Nciizah	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa

Introduction

Soil crusting is a major land degradation driver in arid regions because of variations in rainfall characteristics. The current study aimed to determine the effects of rainfall intensity and slope steepness on the crustability of soils with different texture and mineralogy.

Materials and Methods

A rotating disc rainfall simulator was used to apply varying rainfall intensity (RI: 45, 70 and 100 mm h⁻¹) to six soils (K1, K2, K3, S1, S2 and S3) at two slopes (5° and 8°). The effects of these factors on crusting (crust strength (CS) and thickness (CT)) and subsequent effects on infiltration rate (IR), runoff (RO) and erosion / soil loss (SL) were determined.

Results and Discussion

The high clay smectitic soils (S1, S2 and S3) developed the strongest crust with S2 showing significantly ($\alpha \leq 0.05$) higher CS of 18.54 Kpa at 45 mm h⁻¹ at 8°. Soil K3 had the lowest CS (5.4 Kpa) at 100 mm h⁻¹ and 8°. K1, K2 and K3 are non-swelling sandy loams, which means good drainage and low crustability (Medinski *et al.*, 2009; Habel, 2013). IR generally decreased between 45 and 70 mm h⁻¹ and increased again to 100 mm/h, and the effect of slope was soil dependent. However, the highest (33.32 mm h⁻¹) and lowest (7.97 mm h⁻¹) values were obtained at 70 mm h⁻¹ and 5° for soils K3 and S3, respectively. The higher infiltration rate at the highest intensity compared to the medium one can be attributed to poor seal development due to lower slaking forces under high-energy rainfall (Assouline and Ben-Hur, 2006). RO expectedly showed an opposite trend to that of IR, being highest at 70 mm h⁻¹ and 5°. SL increased with intensity and slope for the low-medium clay kaolinitic soils with K1 being most erodible (468.2 kg ha⁻¹) at 100 mm h⁻¹ and 8°. Soils S3 (1248.13 kg ha⁻¹) and S2 (1145.55 kg ha⁻¹) were statistically ($\alpha \leq 0.05$) similar and the most erodible at 100 and 70 mm h⁻¹, respectively.

Conclusions

The study showed that high clay smectitic soils are vulnerable to crusting and that the reduction of slaking forces at high-energy rainfall reduces seal development. The interactive nature of the factors involved in crusting suggests that a study of other parameters could provide further illumination.

Apple rootstocks influence leaf gas exchange responses to water stress

Presenter: L Muchena (lindsmuchena101@gmail.com)

Initial	Surname	Authors Company/Organisation and Postal Address
L.	Muchena	Department of Horticultural Science, University of Stellenbosch, Private Bag X1, Matieland, 7602
S J E	Midgley	Department of Horticultural Science, University of Stellenbosch, Private Bag X1, Matieland, 7602
E	Lötze	Department of Horticultural Science, University of Stellenbosch, Private Bag X1, Matieland, 7602
S	Dzikiti	Council for Scientific and Industrial Research (CSIR), Natural Resources and Environment, 11 Jan Cilliers Street, Stellenbosch, 7600

Introduction

Irrigation water supply in South Africa is under pressure from the growing competition for limited surface water and aggravated by climate change. There is a current effort to provide apple growers with a wider range of rootstock options, especially in the more dwarfing range suitable for intensive cultivation. Information on the sensitivity of different apple rootstocks to water deficits is critical for better irrigation scheduling and development of water saving strategies. The aim of this study was to understand the influence of apple rootstocks of varying vigour on water-use dynamics and leaf gas exchange of trees under water stress.

Materials and Methods

A field experiment was conducted at the rootstock evaluation trial site at Paardekloof, Witzenberg valley, in the 2017/2018 growing season. Full-bearing 'Rosy Glow' apple trees on RN29, MM109/M9, G222, M7 and M793 rootstocks were subjected either to two three-week drought cycles (no irrigation) in January-February (cycle 1) and in March (cycle 2), or normal irrigation. Soil volumetric water content and canopy temperature were measured continuously, and diurnal leaf gas exchange and leaf water potential were quantified prior to, during and after the water stress cycles. Data were analysed using two-way ANOVA (rootstock x irrigation treatment, five blocks).

Results and Discussion

The largest differences between rootstock responses to water stress were in reduced stomatal conductance and transpiration rates, in both cycles. During cycle 1 we detected a possible anisohydric response to water stress for the more vigorous M793 and M7 rootstocks, as opposed to a more isohydric response for the more dwarfing rootstocks (chiefly, RN29). Reductions in net CO₂ assimilation rate (A) in the drought-stressed trees during cycle 1 were associated with reduced stomatal conductances in all rootstocks. No effects on A were found during cycle 2. Diurnal trends in leaf water potential displayed lower plant water status in the drought-stressed trees on all rootstocks compared to the well-watered trees, with trees on M793 tolerating the most negative leaf water potential in cycle 1, and trees on RN29 and G222 showing increasing stress in cycle 2.

Conclusions

Preliminary results show that trees on RN29 and G222 were the most sensitive to water stress. Further data analysis is required to understand the response mechanisms.

Effect of Rainfall Variability on Maize Varieties: A case of Smallholder Farming in Hwedza, Zimbabwe

Presenter: H Mugiyo (mugiyoh@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
H	Mugiyo	University of KwaZulu-Natal P

Introduction

Increasing rainfall variability associated with mid-season dry spells largely contributes to low and variable maize yields in Zimbabwe. The objective of the study was to determine the effect of rainfall variability on maize yields of smallholder farmers in Hwedza. The study involved a survey of farmers' current cropping practices, analyses of climatic data (daily rainfall, and daily minimum and maximum temperature) from Hwedza station and simulation of maize yield response to climate variability using the (DSSAT) crop model.

Materials and Methods

The study involved a survey of farmers' current cropping practices, analyses of climatic data (daily rainfall, and daily minimum and maximum temperature) from Hwedza station and simulation of maize yield response to climate variability using the Decision Support System for Agro-technology Transfer (DSSAT) crop model. The climatic and maize yield data were analysed using mean correlation and regression analyses to establish relationships between rainfall characteristics and maize yield.

Results and Discussion

Results of the survey showed that maize was the staple food grown by 100% of farming households while 8.7% also grew sorghum. The survey showed that 56.2% of farmers grew short-season varieties, 40.2% medium- season varieties and 3.6% long-season varieties. The result of the correlation analysis showed that number of rain days had a strong positive relationship ($p=0.0049$) with maize yield. Non-significant yield differences ($P<0.05$) between maize variety and planting date were detected using planting date criteria, DEPTH (40 mm in 4 days), based on farmer's practices, the AREX criterion of the Agricultural Research Extension (25 mm rainfall in 7 days) and the MET criterion of the Department of Meteorological Services (40 mm in 15 days). Highest yields were obtained under the combination of medium-season maize variety and the DEPTH criterion for all simulations. The range of simulated station average yields of 0.4 t ha^{-1} to 1.8 t ha^{-1} formed the basis for the development of an operational decision support tool (cropping calendar). The methodology used can be used to select potential maize varieties that can be grown in area before establishing costly field experiments and can also be used to determine the optimum planting dates.

Conclusions

The range of simulated station average yields of 0.4 t ha^{-1} to 1.8 t ha^{-1} formed the basis for the development of an operational decision support tool (cropping calendar). The methodology used can be used to select potential maize varieties that can be grown in area before establishing costly field experiments and can also be used to determine the optimum planting dates.

Effect of time-based hot air drying method on mineral elements of *Jatropha zeyheri* tea

Presenter: N Mutshekwa (mutshekwan@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
N	Mutshekwa	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
MS	Mphosi	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
KG	Shadung	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
PW	Mashela	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727

Introduction

Jatropha zeyheri leaves are sun-dried, boiled and drunk as tea for their aphrodisiac properties (Van Wyk and Gericke, 2000), with limited information on its mineral content. Also, during sun-drying, various minerals could be lost, but these could be conserved through the time-based hot air drying (TBHAD) method. The objective of this study was to investigate the mineral content of *J. zeyheri* leaf tissues post- preservation using the TBHAD method.

Materials and Methods

The *J. zeyheri* leaves were collected from Khureng Village, Limpopo Province, in cooler boxes and transported to the laboratory for preservation using the TBHAD method for 24, 48 and 72 hours, with sun-drying used as a standard, replicated 5 times, were arranged in CRD. Leaves were powdered in a Wiley mill. Approximately 1 g leaf tissue was incubated into 50 ml conical tube and 40 mL 5% of HNO₃ was added. The macronutrient elements (Mg, K, P, S and Ca), micronutrient elements (Al, Co, Cu, Mn, Na, Ni, Si and Zn) were quantified using ICPE-9000. Data were subjected to analysis of variance and means separated using LSD test.

Results and Discussion

The treatment effects were significant on Mg, K, P, S, Al, Co, Mn, Si, Na, Ca, Ni and Zn, contributing 73, 46, 425, 743, 320, 700, 635, 469, 100, 113, 100 and 567%, in total treatment variation of the respective variables. Relative to the sun-drying standard, the TBHAD treatment was not consistent in affecting the mineral elements. For instance, TBHAD increased Mg at all exposure periods, but decreased Ca and Ni at all exposure times. However, relative to the standard, TBHAD increased Na, K, S, Al, Co, Mn and Si at 72 h exposure period, whereas Zn was reduced at 24 and 48 h, but increased at 72 h. Due to the presence of heavy metals, *J. zeyheri* tea could encounter challenges, unless the sources of these compounds are identified and ameliorated accordingly. These essential minerals ensure a healthy body responsibility of everything from establishment of bones and teeth to regulating metabolism to keeping proper nerve transmissions.

Conclusions

In conclusion, TBHAD method increased Mg, K, P, S, Al, Co, Mn, Si and Zn content and inversely decreased Na, Ca and Ni quantities.

Growth and yield response of sweet potato to nitrogen fertilizer in soils of Ladysmith, Kwazulu-Natal, South Africa

Presenter: NG Mvula (40531279@mylife.unisa.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NG	Mvula	University of South Africa, Private Bag X6, Florida, 1710
MC	Makungu	University of South Africa, Private Bag X6, Florida, 1710
SA	Kanu	University of South Africa, Private Bag X6, Florida, 1710

Introduction

Sweet potato (*Ipomea batatas* LAM) is one of the most important staple food crops globally, and it is a good source of vitamins required for healthy living (Barber *et al.*, 1979) for many people in Ladysmith, KwaZulu-Natal. The frequency and rate of application of nitrogen fertilizer to sweet potato is a major constraint to maximizing yields in Ladysmith. The main objective of this study was to evaluate and compare the effect of different levels of nitrogen fertilizer on growth and yield of two sweet potato cultivars in sandy soils of Ladysmith, KwaZulu-Natal.

Materials and Methods

A field study was conducted at the experimental site of the Zamani Madoda project at Ladysmith. Vine cuttings of two sweet potato cultivars (Beauregard (B1) and Ndou (B2)) were used in this study. The experimental treatments were six nitrogen levels (a single application of 0, 13, 23, 33, 43 and 53 kg N ha⁻¹ (N1-N6) and two cultivars arranged in a randomized complete block design with three replications. Limestone Ammonium Nitrate (NH₄NO₃) 28% N was employed as the N source.

Results and Discussion

In general, there was a steady increase in growth (vine length and shoot biomass) as the N fertilizer level increased from 0 kg ha⁻¹ to 53 kg ha⁻¹. A two way analysis of variance revealed a significant (P<0.05) interaction between cultivar and nitrogen fertilizer level at 110 days after transplanting, for example, B1N6 had vine lengths of 3.63 m (longest) and 2.75 m (shortest) compared to B2N2, which had vine lengths of 1.64 m (longest) and 1.23 m (shortest) per plant. Similarly, the yield of the two sweet potato cultivars increased significantly with increase in N. The number of tuberous roots of B1N6 ranged from 12.00 to 4.67 compared to B2N1 with 8.00 - 3.67 tubers per plant. These findings are in agreement with results of a similar study conducted by Masibuka (2016) in loamy sand soils at Tumbi, Tabora, Tanzania.

Conclusions

Overall growth and yield of both sweet potato cultivars (Beauregard and Ndou) increased with increase in N fertilizer levels. In soils of Ladysmith, 53 kg N ha⁻¹ (N6) is the optimal application rate to increase yield of sweet potato.

Smallholder Irrigation scheme Farmers' Performance in Tshiombo Irrigation Scheme Limpopo Province, South Africa

Presenter: L Mwadzingeni (libomwadzi@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Mwadzingeni	School of Agricultural, Earth and Environmental Sciences, UKZN, Pietermaritsburg
PL	Mafongoya	School of Agricultural, Earth and Environmental Sciences

Introduction

Smallholder irrigation farming has received international recognition for playing a pivotal role in reducing hunger, ensure food and nutrition security, improving the welfare of rural communities and generating employment. In South Africa, smallholder irrigation is the scope for rural communities. With increased dynamics in irrigation farming systems, focusing on the performance of scheme farmers will create viable alternatives that will match the dynamic nature of irrigation schemes and ensure economic and financial sustainability of scheme for a better welfare of the current and future generation. This study focused on the performance of farmers in Tshiombo irrigation scheme, which is one of the largest smallholder irrigation schemes in Limpopo province of South Africa.

Materials and Methods

Gross margin of crops grown in the scheme was employed as a performance indicator in relation to this study. Ordinary Least Square (OLS) with gross margin for sweet potato, which is the main crop grown in the scheme was used to estimate factors that affect the performance of scheme farmers. This study encompasses administering of structured questionnaires, focus group discussions (FGDs) and key informant interviews (KIIs). A representative sample of 148 farmers was selected randomly and interviewed from seven blocks of the irrigation scheme which comprises of the head, mid and tail end of the scheme.

Results and Discussion

Factors which affect the performance of scheme farmers where identified and computed. The extent to which these factors impacted the performance of scheme farmers from achieving to their best were noted and discussed. The study identifies cabbage and onions as potential crops with higher gross margin compared to maize and sweet potatoes which are main crops grown the scheme. Performance of scheme farmers was found to be significantly influenced by age of the farmer (-0.022), labor availability (-0.185), size of the cultivated area (-0.130), pesticide subsidy (0.138), market price (6.090), and of the plot from the main canal (0.191).

Conclusions

Focus on encouraging young farmers to join scheme farming as well as helping aged scheme farmers, providing subsidies that suit farmer production needs like pesticide by inquiring from them, promote production of crops with higher gross margin such as cabbages, and encouraging farmers to utilize most of their land have the potential to deeply boost performance of scheme farmers.

The detection of unripe banana flour adulteration with wheat flour using near infrared spectroscopy and chemometrics

Presenter: PF Ndlovu (NdlovuP@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PF	Ndlovu	Postharvest Laboratory, Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit, South Africa
OC	Wokadala	Postharvest Laboratory, Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit, South Africa
SZ	Tesfay	Discipline of Crop and Horticultural Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3201, South Africa
RR	Mphahlele	Postharvest Laboratory, Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit, South Africa
LS	Magwaza	Discipline of Crop and Horticultural Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3201, South Africa

Introduction

Unripe banana flour (UBF), characterised by high resistance starch and gluten free contents, confers beneficial properties for human health (Sarda *et al.*, 2016). However, methods to identify and monitor UBF adulteration practices in the food market are still lacking. The main objective of the study was to develop visible-near infrared spectroscopy (Vis-NIRS) models for identifying and predicting adulteration levels of wheat flour (0-80% w/w) in UBF.

Materials and Methods

Fully matured hard green fruit of twenty-four different dessert and plantain banana cultivars grown at the Agricultural Research Council- Tropical and Subtropical Crops (ARC-TSC) campus were sourced. Hand peeled green banana fruit was sliced and dried at 50°C for 15 hours using a commercial scale convective hot-air dryer (AD3000 Agri-Dryer, Dryers for Africa, Limestone Hill, SA). Dehydrated banana chips were ground in a laboratory milling machine (S8 Range, Drotsky Aktief (Pty) Ltd, South Africa) fitted with 0.8 mm sieve. The wheat flour, was procured from a local supermarket. Eighty-two spectra datasets were acquired using a portable Vis-NIR spectrometer (F-750 Produce Quality meter, Felix Instruments, Camas, WA 98607, USA). The collected spectral data were subjected to Unscrambler software, where principal component analysis (PCA) was applied to classify groupings of adulterated UBF samples from pure samples and partial least squares regression (PLSR) was employed to develop prediction models.

Results and Discussion

Preliminary results on PCA scores plot revealed five clusters, namely 0% (pure UBF); 2-20%; 22-40%; 42-60% and 62-80% (adulterated samples), showing 95% distribution of variation explained by the first two principal components (PC) (PC1=92% and PC2=3%). The optimal PLSR model to predict wheat flour adulteration degrees in UBF was obtained using 2nd derivative Savitsky-Golay (19-point smoothing, 2nd order polynomial), showing highest R_c^2 (0.991); R_v^2 (0.993); RPD (12.021) and lowest RMSEC (2.226) and RMSEP (1.993) values.

Conclusions

The results of this research have demonstrated the ability Vis-NIR spectroscopy to non-destructively detect different degrees of wheat flour in unripe banana flour. The developed Vis-NIRS PLSR models could facilitate quality control standards of unripe banana flour and derived products in milling and processing industries.

Improving smallholder vegetable marketing in Gauteng province: Results from a value chain analysis

Presenter: PN Ndou (ndoup@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
P	Ndou	Agricultural Research Council (ARC)- Vegetable and Ornamental Plants (VOP)
B	Taruvinga	Agricultural Research Council (ARC)- Vegetable and Ornamental Plants (VOP)
IN	Hlerema	Agricultural Research Council (ARC)- Vegetable and Ornamental Plants (VOP)
K	Mphafi	Agricultural Research Council (ARC)- Vegetable and Ornamental Plants (VOP)
M	Mokwala	Gauteng Department of Agriculture and Rural Development

Introduction

Agricultural markets are increasingly growing efficient, with competition taking place between entire value chains rather than between individual businesses. The spread of the profit margin across the suppliers, producers, distributors, customers, and other elements of the value system depends on the structure of the value system. Although smallholders engage in growing horticultural crops for food security, the significant number that produces for the market are among those that have suffered exclusion from the high value chain. Conducting a value chain analysis of the horticultural crops in the Gauteng Province would assist with the identification of core competencies among the players in the value chain system and consequently positioning themselves in the market place according to their competitive abilities. Since value chain management takes into account profitability, customer satisfaction, and ability to adapt to variations in the market demand, chain analysis will shed light on current practices and reveal clear opportunities for improvement and participation by smallholders.

Materials and Methods

The study made use of both primary and secondary data. Primary data collection was conducted through the administration of a questionnaire and in-depth interviews among the key value chain players aimed at covering three basic links in a simple value chain v.i.z., production, marketing and consumption. Multi-stage sampling was employed to cater for both structure and function variations among different key players. Data was analysed using SPSS.

Results and Discussion

The results confirm that the smallholders obtain small profit margins largely obtained from informal markets. Several bottlenecks and opportunities were identified in the vegetable value chain. Constraints include poor coordination among actors in the value chain, lack of grades and standards and postharvest technology among farmers which in turn, influences the saleability of their produce to formal markets as well as first-stage collection inefficiencies. The formal high-value chain markets indicated a willingness to procure vegetables from the smallholder farmers based on their capability to maintain consistency in supplies, supply of good quality produce, value addition particularly washing of vegetables and provided that retailers will not incur a rise in transport costs in the process.

Conclusions

Improvement in the value chain performance will demand increasing the regularity and continuity of production, improving product quality and minimising transactional costs. Policy makers have a role to play in ensuring an enabling environment including access to modern technologies of production by the smallholder farmers, business skills development as well as access to information for informed decision-making.

Pre-harvest illumination of cherry tomato reduces the ripening period, enhances fruit carotenoid content and overall fruit quality

Presenter: BL Ngcobo (213516834@stu.ukzn.ac.za/bongalewisfuze@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
BL	Ngcobo	King Edward Ave, Scottsville, Pietermaritzburg, 3209
I	Bertling	King Edward Ave, Scottsville, Pietermaritzburg, 3209
A	Clulow	King Edward Ave, Scottsville, Pietermaritzburg, 3209

Introduction

Tomato is one of the most-consumed fruit vegetable in the world; it is recognized as a good source of carotenoids, particularly β -carotene and lycopene, as well as of ascorbic acid (Tommonaro *et al.*, 2008). The prevention of chronic diseases, such as cancer, cardio-vascular and neuro-degenerative forms, has been related to a healthy diet associated with the consumption of tomatoes (Giovannucci, 1999; Rao and Agrawal, 2000). The demand of high quality tomatoes has, therefore, increased rapidly. As a climacteric fruit, tomato will ripen to final colour postharvest.

Materials and Methods

Trusses of mature green (negative a^* values) greenhouse tomatoes of a red and a yellow cultivar were used for the experiment. Just prior to illumination with a certain light source, a^* values were recorded to ensure that fruit were at a similar stage of colour development. Twenty-four trusses, twelve of each cultivar, were illuminated with red LED light (RL) and a further twenty-four trusses, twelve of each cultivar, were illuminated with blue LED light (BL).

Results and Discussion

Pre-harvest RL and BL treatments significantly affected fruit quality attributes of both cultivars, with colour and pigments most significantly affected. Both light treatments enhanced the accumulation of lycopene, more so in red tomatoes than in yellow tomatoes. Additionally, β -carotene concentrations increased following red and blue light exposure, particularly in fruit of the red cultivar. This synthesis must, however, be accompanied by the breakdown of chlorophylls (Tomato Genome Consortium, 2012; Fantini *et al.*, 2013). Red and blue lights did not significantly affect sugar concentrations, total soluble solids (TSS) and size of tomato fruit. Both light treatments enhanced colour change in both cherry tomato cultivars. Light treatments not only affect colour, size and pigments, but were able to prevent spoilage associated with tomato diseases. This proves that with more antioxidants, particularly carotenoids, fruit are able to fight pathogens and diseases.

Conclusions

Based on the observation of this research, pre-harvest illumination with blue and red light treatments are able to retain key cherry tomato quality attributes for 20 to 25 days. Plant growth and development is controlled by light via various photoreceptors. Therefore, not to compromise, but maximise yield and nutritional quality of vegetables, growers must ensure that plants are provided with suitable light conditions.

Does target-site resistance occur in South African wild oats (*Avena fatua*) biotypes?

Presenter: H Nienaber (DeWetH@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
H	Nienaber	ARC-Small Grain, Private Bag X29, Bethlehem, 9700, South Africa
SL	Sydenham	ARC-Small Grain, Private Bag X29, Bethlehem, 9700, South Africa

Introduction

Wild oats (*Avena fatua*) is considered one of the world's worst agricultural weeds. It invades and lowers the quality of field crops, typically wheat and oat and exerts all the characteristics of a competitive weed. They can also act as hosts for nematodes and crown rot. If wild oats are left uncontrolled, wheat yields can be reduced by up to 80% (<https://www.agric.wa.gov.au>). Wild oats can easily develop resistance to herbicides. It is listed as the second most herbicide resistance prone weed in the world (Heap, 2018). The first case of herbicide resistant wild oats in South Africa was reported in 1986. Resistance to multiple herbicides were noted. There are several ways that a weed can become resistant to herbicides. One of these resistance mechanisms is target-site resistance. Target-site resistance is when herbicides are unable to bind to the target-site it was intended for. This is due to a DNA sequence mutation, the herbicide is therefore unable to inhibit that specific biochemical /enzymatic pathway, and the plant survives. Limited research has been done on the mechanism of resistance in wild oats in South Africa. The aim of this study was to try to determine if target-site resistance causes herbicide resistance in South African wild oats populations.

Materials and Methods

Green leaf material from 61 wild oats samples were received from producers suspecting resistance on their farms in Western Cape, South Africa. DNA was extracted and quantified (123 replicates), which were then followed by dCAPS PCR and specific restriction enzyme digests. Research groups in Australia and Europe have developed several specific derived cleaved amplified polymorphic sequences (dCAPS) and cleaved amplified polymorphic sequences (CAPS) markers to target each of the specific ACCase or ALS codon mutations. Finally, samples were run on a 2% Agarose gel at 100 volts for three hours. Digital photos were taken and allele sizes were visually compared and scored against a 100bp molecular weight ladder.

Results and Discussion

The most prevalent mutations in the wild oats biotypes were identified as ALS mutations 205 and 574 (rendering all Group B herbicides useless) and ACCase mutations 2027 and 2078 (indicating limited herbicide choice within the 'fops', 'dims' and 'den' herbicides). These two mutations have also been identified in combination.

Conclusions

One of the mechanisms of resistance in wild oats biotypes from the Western Cape, South Africa, proved to be target-site resistance. Other mechanisms of resistance can however not be excluded.

No Soil, no Vegetation, no Wildlife, and no Eco-tourism - a case study of Kleins' Camp Concession (KCC) in the Serengeti National Park, Tanzania

Presenter: GP Nortjé (nortjgp@unisa.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
GP	Nortje	Unisa, Science Campus, CNR of Pioneer & Christiaan de Wet ave, Florida, 1709

Introduction

Beyond, an Eco-tourism company manages the Kleins' Camp Concession (KCC) area of 10 000 hectares, comprising a natural wildlife area in the north-eastern corner of the Serengeti National Park, Tanzania. The concession shares part of the area with the local Maasai pastoralists, who traditionally graze their domestic animal herds alongside the wildlife. However, problems arise when these domestic animals compete with the wildlife in the area for grazing. Severe overgrazing caused widespread soil erosion, surface crusting, and encroachment with negative results for eco-tourism. Off-road driving (ORD) also negatively affects the soil and vegetation. Wildlife and cattle do not mix well together in the same area competing for the same grazing. In this study, soils were mapped, road network determined, and rehabilitation of degraded areas commenced

Materials and Methods

The soil map was created with the use of satellite imagery from Google Earth Pro, and a Digital Elevation Model (DEM) created to generate a base map for the soil survey. A total of 145 soil profiles and auguring points were strategically identified, mechanically excavated to a depth of approximately 1200 mm or down the restricted layer, and the soil forms described. Both the South African classification system (SCWG, 1991) and the WRB (1998) classification systems were used to classify the soil forms. The soil forms were divided into land use classes, according to their sensitivity/resilience.

Results and Discussion

The soil map of the KCC area indicating the soil forms and overlaid by the road network was completed during 2017. The soil forms were then divided into land use classes, according to their sensitivity/resilience to specific eco-tourism land uses. The road network will be planned and adapted according to these classifications, as well as records of predator sightings. Rehabilitation of degraded areas and roads have commenced, and different rehabilitation methods are used.

Conclusions

Soil research should form an integral part in any conservation efforts in wildlife protected areas. Severe soil erosion, surface crusting and sub-soil compaction affect large areas in protected areas. The management recommendations focus on erosion prevention, road network planning, and rehabilitation. The following is recommended: • Do not allow overgrazing or ORD; • design/re-design road networks according to the soil map such as to minimize soil and vegetation degradation, while sustainable eco-tourism without need for ORD; • prohibit ORD in Ramsar pans, vleis, soils with Prismatic B-horizons (so-called 'sodic' sites), barren areas with no grass cover - 'Solonetz' soils; rehabilitation of damaged areas.

The dual-purpose of orange-fleshed sweet potato (*Ipomoea batatas* var. Bophelo) for improved nutritional food security

Presenter: MK Nyathi (mnyathi@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MK	Nyathi	Agricultural Research Council, Vegetables and Ornamental Plants (ARC-VOP), Private Bag X 293, Roodeplaat, Pretoria, 0001, South Africa
CP	Du Plooy	Agricultural Research Council, Vegetables and Ornamental Plants (ARC-VOP), Private Bag X 293, Roodeplaat, Pretoria, 0001, South Africa
GE	Van Halsema	Water Resource Management Group, Wageningen University and Research, Droevendaalsesteeg 3a, 6708 PB Wageningen, The Netherlands
PC	Struik	Centre for Crop Systems Analysis, Wageningen University and Research, P.O. Box 430, 6700 AK Wageningen, The Netherlands
TJ	Stomph	Centre for Crop Systems Analysis, Wageningen University and Research, P.O. Box 430, 6700 AK Wageningen, The Netherlands
JG	Annandale	Department of Plant and Soil Sciences, University of Pretoria, Private Bag X 20, Hatfield, Pretoria, 0028, South Africa

Introduction

Orange-fleshed sweet potato (OFSP) leaves can provide a fresh green leafy vegetable additional to the storage roots, hence the “dual-purpose”. The objectives of the study were to (i) evaluate the effect of vine harvest on selected plant parameters (storage roots, leaf and root nutrient concentrations, nutritional yield, and nutritional water productivity), and, (ii) assess the effect of irrigation regimes and soil fertilisation on these selected parameters.

Materials and Methods

Field experiments were conducted at ARC-VOP, Pretoria, South Africa, during the 2013/14 and 2014/15 seasons. Treatments included irrigation regimes [well-watered (W1) and supplemental (W2)], soil fertility levels [well-fertilised (F1) and no fertiliser application (F2)], and vine harvest [no vine harvesting (H1) and vine harvesting (H2)].

Results and Discussion

For the 2014/15 season, the well-watered regime improved total dry storage roots biomass yield (W1 = 13 t ha⁻¹; W2 = 7.5 t ha⁻¹). Under the practice of vine harvesting, soil fertility treatments did not affect (total and marketable) storage root production. Our results further revealed that vine harvesting reduced storage root nutrient concentrations (-23% for iron; -14% for zinc; -12% for β -carotene). Despite the reduction in nutrient concentrations of storage roots due to vine harvesting, total nutritional yields (NYsTotal) increased. The highest NYsTotal were under the high input optimization (W1F1) for iron, zinc, and β -carotene. Calculations showed that 100 g of boiled aboveground edible biomass could potentially provide 15% of iron, 2% of zinc, and 97% of vitamin A to the daily-recommended nutrient intake (DRNI) for children aged between 4 to 18 years. More water was needed to meet the DRNI with OFSP grown as a storage root crop only than when grown as a dual-purpose crop.

Conclusions

Our research shows that there is a scope of utilising OFSP as a dual-purpose crop for rural resource-poor households in order to achieve nutritional food security. More research is needed to assess the effect of vine harvest on a range of OFSP varieties and should be conducted on farm.

Enhanced learning of undergraduate agronomy students through creation of social media items aimed at technology transfer to small-scale farmers

Presenter: M Oberholster (monicaober@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
M	Oberholster	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
M	Van der Laan	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
I	Louw	Centre of Academic Development, University of Pretoria, Pretoria 0002, South Africa
R	Hay	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa

Introduction

Sub-Saharan Africa (SSA) is one of the world's poorest and most food insecure regions with many agricultural challenges. Participatory Action Learning and Action Research (PALAR) was used as the pedagogical model to enhance the teaching and learning of undergraduate students taking the large second year course Sustainable Crop Production and Agroclimatology at the University of Pretoria. PALAR allows both the student and researcher to effectively respond to constantly changing technological, social, ecological, economic and political challenges in the Information Age (Zuber-Skerritt 2011). The aim of this project was that students not only learn about agronomic concepts, but that they also be inspired to improve their science communication skills and community outreach.

Materials and Methods

Working in groups of three, students were required to create a 3-5 min media item of their choice (video, podcast, narrated slideshow, simple app etc.) on a specific aspect of crop production aimed at technology transfer to small-scale farmers in SSA. Data was collected through student surveys and interviews, and by keeping detailed notes on the research teams' observations and reflections.

Results and Discussion

Using the action research experiential learning cycle, issues and challenges experienced were identified and addressed as the project progressed. Positive results and student projects, along with the steps taken to obtain them, are discussed. The data indicated that 85% of the students felt that sufficient direction was provided and 89% felt that the support they needed was sufficient and available. In terms of the knowledge and skills gained, the students had the option to agree or disagree with a list of 17 statements, such as, this project taught me to "exhibit initiative in solving real problems", "sensitized me to be a lifelong learner", and "see myself as an emerging leader in my profession", and 92% of students either strongly agreed or agreed that they would be able to transfer the abovementioned knowledge to new situations in the future. Suggestions for the implementation of future projects of a similar nature are also made.

Conclusions

Through the implementation of this project and disseminating scientific information, the data suggests that students gained important science communication and lifelong learning skills. In doing their own research on the topic, we believe students also became more sensitized to the challenges of small-scale farming in SSA. Examples of these projects are continually posted on a Facebook page created by the students themselves called 'Ingesta: Farming for the Future' (<https://www.facebook.com/Ingesta-Farming-for-the-Future-530650287278629/>).

Effect of seeding rates and threshing regime on the yield and quality of sesame (*Sesamum indicum* L.) seeds in the Southern Guinea Savannah region of Nigeria

Presenter: AK Orbunde (gailorbunde@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AK	Orbunde	Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland, 7602
MR	Le Roux	Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland, 7602
PJ	Pieterse	Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland, 7602

Introduction

Nigeria is the third largest producer of sesame in Africa. However, contamination of Nigerian sesame seeds by aflatoxin producing storage fungi, especially the *Aspergillus* species, hampers export opportunities. There is thus a need to try to improve the quality of sesame produced in Nigeria to increase export opportunities.

Materials and Methods

A field experiment was conducted in 2017 within the Southern Guinea Savannah of Nigeria. The aim was to investigate the effect of crop density and the period of post-harvest threshing on the yield and quality of sesame seeds. The experiment consisted of two sesame varieties viz. E8 and Ex-Sudan; three seeding rates at 3, 5 and 7 kg ha⁻¹; three threshing regimes at one week after harvest (1 WAH), 2 WAH and 3 WAH at three locations (Akwanga in Nasarawa State, Makurdi in Benue State and Tor Musa in Taraba State). The experiment was a 2 x 3 x 3 x 3 factorial laid out in a randomized complete block design (RCBD) and replicated four times. Data was collected on vegetative growth parameters, grain yield, 1000 seed weight, total crude protein, total fat and oil and incidence of aflatoxin. ANOVA analyses was carried out to test for differences between treatments.

Results and Discussion

Significant variety x seed rate x threshing regime interaction effects occurred for yield. There was significant location x threshing regime interaction effect on the 1000 seed weight. A high 1000 seed weight was generally observed for seeds harvested in Makurdi location especially among those threshed at 3 WAH (3.4 g) and 2 WAH (2.6 g). It was also observed that the total amount of fat and oil was a function of variety x seeding rate x location x threshing regime interactions. However, the crude protein content was not influenced by any of the factors under study. Aflatoxin contamination was highest at 3 WAH (4.30 ug kg⁻¹) but lower at 2 WAH (1.9 ug kg⁻¹) and lowest at 1 WAH (0.99 ug kg⁻¹), similar to 1000 seed weight. Prolonged drying of sesame seeds may expose the seeds to absorption of atmospheric moisture during the night and its interaction with high day temperatures may encourage growth of aflatoxin producing fungi.

Conclusions

Delaying threshing after harvest for longer than 2 WAH resulted in increased weight of 1000 seeds and higher aflatoxin contamination. Threshing should therefore preferably be completed within 2 WAH.

***Plectranthus esculentus* response to environment is affected by ploidy level**

Presenter: M G Penter (mark@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
M G	Penter	Private Bag X11208, Nelspruit, 1200
KF	Hannweg	Private Bag X11208, Nelspruit, 1200

Introduction

Much of sub-Saharan Africa's agricultural production is based on rainfed and subsistence agriculture, and the impact of climate change is felt more by smallholder farmers with limited availability of resources. This could be partially ameliorated by the development of indigenous species with potential to withstand the vagaries of climate change. *Plectranthus esculentus* is an indigenous tuberous crop distributed throughout the African Continent. Hannweg *et al.* (2015) recently induced polyploidy in *P. esculentus* and showed that polyploid plants are more tolerant of root-knot nematodes. As a continuation of the development of this crop, the response of these polyploid plants to various environmental parameters was studied, as a prelude to determining whether tetraploidy offers advantages in terms of response to adverse environments.

Materials and Methods

The study was conducted using a portable infra-red photosynthesis system (ADC LCpro SD). Responses of diploid and tetraploid plants to light, humidity and temperature were initially determined at ambient conditions. A CO₂ response study was then conducted using the optimal conditions for each parameter (light level = 800 $\mu\text{mol m}^{-2} \text{s}^{-1}$, leaf chamber temperature = 25°C and water vapour pressure in the air = 0.6 kPa). The CO₂ response was examined over the range 0 ppm to 800 ppm CO₂ (double the ambient CO₂ level). This was repeated for two leaves per ploidy level.

Results and Discussion

At ambient CO₂ and saturating light levels, diploid plants had a 40% higher assimilation rate than tetraploids on a leaf area basis. Photosynthetic rate per cell correlates with DNA content, and the rate per unit leaf area is dependent on concomitant changes in cell size and, thus, cell numbers per unit leaf area (Warner and Edwards, 1993). Cell size in the *P. esculentus* studied is yet to be determined. Neither the tetraploid nor diploid plants reached saturation in assimilation at elevated CO₂, although assimilation in the diploid plants increased more rapidly in response to increases in CO₂. It was found that the tetraploid plants had significantly lower transpiration rates than the diploid plants at all assimilation rates. It is yet to be established whether this affords the tetraploids any advantages when grown under conditions of limiting soil water.

Conclusions

Tetraploid *P. esculentus* plants showed lower assimilation rates than diploid plants, regardless of CO₂ level. Tetraploid plants also showed lower transpiration rates than diploids at any given assimilation rate. Further work is required to determine whether the tetraploids have an advantage under conditions of restricted water availability.

Spatial variability of cations in cultivated and fallowed soils following irrigation with treated wastewater

Presenter: ML Phadu (moedishamaphuti@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
ML	Phadu	University of Limpopo, Private Bag X1106 Sovenga 0727
PM	Kgopa	University of Limpopo, Private Bag X1106 Sovenga 0727

Introduction

The use of treated wastewater (TWW) for irrigation has become vital in water stressed regions (AL-Jaboobi *et al.* 2014). There is a shortage of information and knowledge concerning soil variability as affected by irrigation with TWW, therefore further investigations is required as variation in soil properties must be monitored to allow better management. The objective of the study was to investigate the effects of irrigation with TWW on the spatial variability of cations in cultivated field (CF) and fallowed field (FF).

Materials and Methods

The study was conducted at the University of Limpopo (UL) Experimental Farm, located in Limpopo province. The study comprised of 3 fields (virgin field (VF), cultivated field (CF) and fallowed field (FF)) which were 6.4 ha in size. Grids of 40 × 40 m² were created in each field and soil samples were collected in each grid at 0 – 20 cm depth. Data collected were particle size distribution, soil pH (H₂O and KCl), electrical conductivity (EC) and cations (calcium (Ca), magnesium (Mg), sodium (Na), potassium (K)). Cation exchange capacity (CEC), sodium adsorption ratio (SAR), exchangeable sodium percentage (ESP) and exchangeable potassium percentage (EPP) were calculated. Data were summarised using descriptive statistics and spatial variability maps were created through interpolation by ArcGIS 10.3. Analysis of variance was computed.

Results and Discussion

Results showed that all the chemical properties were highly significant ($p \leq 0.05$) and increased due to irrigation with TWW except for %clay and ESP%. The chemical properties were either positively skewed (%clay, soil pH (H₂O and KCl), Ca, Mg, Na, CEC and ESP) or negatively skewed (%sand, K and EPP) and only soil pH (H₂O), CEC and ESP were normally distributed after irrigation with TWW. Also %clay and Na were highly variable (C.V < 35%) while %sand, Ca, Mg, K, SAR and ESP were moderately variable (C.V = 15 – 35%). Soil pH (H₂O and KCl), CEC and ESP showed low variability after irrigation with TWW.

Conclusions

In conclusion, it was evident that spatial variability among the chemical properties were higher on the CF and FF which were irrigated with TWW.

Concentration and application interval of Nemarioc-AL phytonematicide for managing root-knot nematode population densities in potato production

Presenter: KM Pofu (MarthaP@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
KM	Pofu	Agricultural Research Council – Vegetable and Ornamental Plants, Private Bag X293, Pretoria, 0001
SL	Venter	Agricultural Research Council – Vegetable and Ornamental Plants, Private Bag X293, Pretoria, 0001
D	Oelofse	Agricultural Research Council – Vegetable and Ornamental Plants, Private Bag X293, Pretoria, 0001
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre, Private Bag X1106, Sovenga 0727

Introduction

Potato is highly susceptible to root-knot (*Meloidogyne* species) nematodes, with no known potato cultivars that are resistant to nematodes. Various alternatives to methyl bromide, including the use of crop rotations, biocontrol agents and phytonematicides had been internationally tested against *Meloidogyne* species, with inconsistent results (Sikora *et al.*, 2005; Mashela *et al.*, 2017). Although cucurbitacin-containing phytonematicides have been developed and researched in South Africa with promising results, the challenge has been phytotoxicity, which was resolved using the Curve-fitting Allelochemical Response Data (CARD) computer model to establish the amount to be applied. The latter is technically referred to as the Mean Concentration Stimulation Point (MCSP). The MCSP, indicating the non-phytotoxic concentration, is used along with the nematode cycle to derive the application interval. The objective of this study was to investigate the MCSP of Nemarioc-AL (A = cucurbitacin A, L = liquid formulation) on potato cultivar 'Sifra'.

Materials and Methods

One sprouted tuber was set 10-cm deep per pot with each pot filled with steam-pasteurised soil and Hygromix at 3:1 (v/v) ratio under microplot conditions, conducted during autumn (February-April) and spring (August- October) in 2017. To establish MCSP after 100% emergence, each pot was inoculated with 5000 *M. javanica* eggs and second-stage juveniles (J2). Seven treatments, namely, 0, 2, 4, 8, 16, 32 and 64% Nemarioc-AL phytonematicide, were arranged in a randomised complete block design, with 11 replications each. Cultural practices were as in commercial potato production systems.

Results and Discussion

At 56 days after inoculation, treatments had significant ($P \leq 0.05$) effects on chlorophyll content, dry shoot mass and dry tuber mass, with the means used in CARD model to generate biological indices (Dm, Rh, D0, D50, D100), where MCSP [$= Dm + (Rh)/2$] was equal to 2.98%, with overall sensitivity (Σk) = 3, with nematode numbers significantly reduced (Seshweni, 2017). In the application interval trial, all procedures were as in the MCSP trial, except that 2.98% Nemarioc-AL was applied on all plants at intervals derived using the concept 1, 2-, 3-, and 4-weeks \times 30-days/month as the x-axis. At 56 days after applying 2.98% Nemarioc-AL phytonematicides, plant growth was optimised at 2.43 weeks, which translated to 18 days [(2.43 weeks/4 weeks) \times 30 days]. Nematode variables were significantly reduced compared to the standard.

Conclusions

Nemarioc-AL phytonematicide on potato should be applied at 2.98% (i.e. 2.98 L phytonematicides/100 L water) every 18 days for successful suppression of population densities of *Meloidogyne* species without inducing phytotoxicity.

The effect of Cloprop on pineapple yield and fruit quality

Presenter: EC Rabie (erabie@mtuba.co.za)

Initial	Surname	Authors Company/Organisation and Postal Address
EC	Rabie	ARC-TSC, P.O. Box 194, Hluhluwe, 3960
BW	Mbatha	ARC-TSC, P.O. Box 194, Hluhluwe, 3960

Introduction

Treating pineapples with cloprop for fruit enlarging is a general practice applied on Queen pineapples. It does not only enlarge the fruit but increases the yield, it also yields a more marketable product. Cloprop is registered for application at 4 L ha⁻¹ in a spray volume of 1000 to 2000 L ha⁻¹, but farmers often apply smaller dosages seeing that at this high dosage, burning of tops can occur especially during the hot summer months. A trial was done to determine the effect of spray volume as well as the efficacy of different dosages applied as single application or as a split application.

Materials and Methods

Different dosages (1, 2, 3 and 4 L ha⁻¹) as well as split applications of the latter 3 dosages (applied one week apart), were applied as 8 treatments plus an untreated control in a statistical trial to determine the effect of cloprop on yield, fruit size and fruit quality. Treatments were applied with a spray boom at a spray volume of 1000 L ha⁻¹ except for the 3 L ha⁻¹ treatment that was also applied in a 2000 L ha⁻¹ spray volume. Treatments were applied at dead petal stage and fruit was harvested about 90 days later.

Results and Discussion

The use of cloprop for fruit enlargement can give an increase in yield from 10 to 30 t ha⁻¹. Treatment with cloprop gave an increase in the percentage fruit weighing 700–1200 g with a subsequent decrease in the percentage fruit weighing 500g and less. There is not a huge difference in yield when applying 2 L ha⁻¹ or more. Cloprop extended the period from flower induction to harvest with at least 2 weeks due to a slower increase in total soluble solids (TSS) of the fruit. Black spot and winter speckle increased in cloprop treated fruit. Cloprop also reduced the top weight yielding less bulk to be packed in a box and therefor increases the actual weight of fruit per box. Spray volume and split application of the dosage did not have an effect on efficacy, but split application of the dosage did have an effect on the TSS of the fruit. Burning of tops did not occur in this trial.

Conclusions

Cloprop can be successfully applied to increase yield and to produce a more marketable fruit at lower dosages. Dosages higher than 2 L ha⁻¹ did not increase yield proportionally.

Impact of drape nets on avocado (*Persea americana* Mill.) cultivars yield

Presenter: O Rathumbu (rathumbuchandukoowen@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
O	Rathumbu	Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa
H	Fotouo	Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa
D	Sivakumar	Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa

Introduction

Studies conducted during 2015 to 2017 showed that avocado marketable yield improved under permanent shade net structures (Tinyane *et al.*, 2017); but the total yield was affected mainly due to a reduced population of the pollinators within the nets. Drape nets have similar advantages as permanent net structures, that is, to protect crops from hail, sunburn, wind and insect damage. Moreover, drape nets are cost effective and retractable and could exert a positive influence on the yield (Stander and Cronje, 2016) Therefore, this study aims to investigate the effect of two colored drape nets (white and black), permanent white net and open field on yield, of two avocado cultivars ('Hass' and 'Pinkerton').

Materials and Methods

Two drape nets (white and black) with 20% shading, a permanent white shade net with 20% shading and an open field (uncovered trees) production will be used in the study at Lombard Avocado farm in Tzaneen and each treatment consisted of three replicates. Permanent net was only applied to 'Hass' cultivars. Fruits were harvested at the commercial maturity stage and classified according to market standards (class 1, 2, and 3) to determine the total and marketable yield. Fruits with damages and defects were considered as waste. Waste was further divided into different physical damages (hail, strong winds and sunburn) and weighed.

Results and Discussion

The white drape net significantly improved the total and marketable yield while the black drape net had lower yield compared to the control (open field) for both cultivars. The permanent white shade net yielded similar amount of 'Hass' fruit as the black drape net, however had higher amount of 'class 1' fruits compared to other net treatments. In case of 'Pinkerton', the white drape net had similar amount of 'class 1' fruits as the open field while the black drape net had the lowest amount of 'class 1' and the highest amount smaller fruit (class 3). The smallest 'Hass' fruits were mainly recorded in open field. Sunburn and corky lenticels incidence in 'Hass' significantly higher in open field. In 'Pinkerton' lenticel damage was also significantly higher in the open field but the sunburn was higher in black drape net.

Conclusions

White drape net considerably improved fruits yield, decreased the lenticel damage in both cultivars; and sun damage in 'Hass' cultivar. Permanent white net had the lowest incidence of physical damages.

Determination of Pre-symptomatic biochemical markers related to Peteca spot in 'Eureka' lemon

Presenter: MM Rikhotso (murielrikhotso@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MM	Rikhotso	University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, South Africa
LS	Magwaza	University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, South Africa
A	Mditshwa	University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, South Africa
SZ	Tesfay	University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, South Africa

Introduction

Before export, South African citrus fruit undergo quarantine inspections and cold treatment at -0.6°C for ± 14 days for prevention of fruit flies (*Ceratitis* sp.) (Ncama *et al.*, 2018). However, lemon is sensitive to low temperatures and tends to develop Peteca spot which causes a major economic loss in the South African citrus industry (Cronje, 2015). The biochemical profile or changes occurring in the rind of lemon fruit that could lead to the susceptibility to Peteca spot is not fully understood. Identifying these biochemical markers and correlation with the disorder constitute the principal framework of this research towards understanding different biological mechanisms influencing the incidence of Peteca spot, which may lead to a pre-symptomatic detection and prediction of the disorder. The aim of this study was to determine pre-symptomatic biochemical markers related to Peteca spot in 'Eureka' lemon.

Materials and Methods

A total of 200 mature 'Eureka' lemon were harvested from Malowe orchard farm in KwaZulu-Natal (Latitude: $30^{\circ}14'S$, Longitude: $29^{\circ}56'E$) from the outside (OC) and inside canopy (IC) positions. Fruit were stored at 3°C in order to induce the incidence of peteca spot according to Undurraga *et al.* (2009). Sampling was done at 3 week intervals for a period of 12 weeks. Each week, rind physico-chemical properties including colour, vitamin C, carotenoids, sucrose, glucose and fructose were measured. Peteca spot incidence was also scored at 3 week intervals. Data was subjected to analysis of variance using Genstat.

Results and Discussion

Results showed that fruit from the IC had higher incidence of the disorder compared to those from OC. The effect of canopy position was highly significant for sucrose, glucose and fructose ($P < 0.001$) with OC having higher concentrations than IC. Sugars in plants play a protective role against stress conditions which means they were not abundant enough to protect the fruit from Peteca spot in the IC. Canopy position significantly affected the total carotenoids of 'Eureka' lemon with $p = 0.017$. The IC fruit had a poor rind colour and low carotenoids compared to the outside canopy fruit, which also contributed to a high incidence of peteca spot in the IC.

Conclusions

Canopy position is an important factor that affects the concentration of physico-chemical properties and the development of rind disorders. Biochemical profile could be used as pre-symptomatic biochemical markers for predicting the susceptibility of 'Eureka' lemon to Peteca spot.

Effects of edible coatings on storage life and quality attributes of plums

Presenter: SC Riva (18298605@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
SC	Riva	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University
OA	Fawole	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Science, Stellenbosch University
UL	Opara	Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Science and Food Science, Stellenbosch University

Introduction

Plum consumption increases annually, as consumers grow more interested in maintaining a healthy diet. The fruit's perishable nature however limits its commercial success; fruit is often exposed to very long handling chains during export. Edible coatings have shown great potential in maintaining quality and extending the shelf life of fresh produce, and thus their application to plums as a postharvest technology appears promising.

Materials and Methods

The effect of four edible coatings was investigated on the storage life and quality of 'African Delight' plums. Fruit was treated with alginate (2%), chitosan (1.5%), gellan gum (0.5%) and gum arabic (2%) coatings and stored at $-0.5 \pm 1^\circ\text{C}$, $80 \pm 5\%$ RH for 35 days and then at $21 \pm 1^\circ\text{C}$, $95 \pm 5\%$ RH for 20 days, resembling the cold storage shipment period and commercial shelf life period respectively. Physico-chemical testing took place at regular intervals, assessing weight loss, fruit firmness, and colour changes, as well as respiration rates and ethylene evolution. Physiological disorders such as shrivel occurrence were assessed, as well as pathological decay. Phytochemical changes over the storage period were also investigated, including total phenolic content, total flavonoid content, ascorbic acid content and more.

Results and Discussion

The investigated edible coatings showed different effects, with gum arabic having the most effective performance on the plums. Fruit coated with gum arabic had the least weight loss (4.9%), as opposed to 9.5% in the uncoated fruit. In addition, the coating prolonged storage life by delaying fruit ripening and decreasing respiration rate and ethylene production. Furthermore, shrivel incidence was significantly ($P < 0.05$) lower in fruit coated with gum arabic (17%) compared to the uncoated fruit (70%).

Conclusions

Gum arabic as an edible coating showed the most promising effects on the storage life and quality of 'African Delight' plums, by retarding the respiration rate and thereby delaying senescence. Further research work needs to be conducted to understand the efficiency of gum arabic for commercial application.

Crop response to sulfate salinity

Presenter: ZD Ronquest (zdronquest@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
ZD	Ronquest	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
JG	Annandale	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
PD	Tanner	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
NO	Dlamini	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
SN	Magwaza	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
SE	Ndlangamandla	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa
NM	Shabangu	Department of Plant and Soil Sciences, University of Pretoria, Pretoria 0002, South Africa

Introduction

The majority of mine-affected waters contain large quantities of calcium and magnesium sulfate, with some dominated by sodium sulfate. The availability of large volumes of mine impacted waters and large tracts of unfarmed land owned by mines, creates an opportunity to utilise these waters for irrigation. Not only will this drastically reduce mine water treatment costs, it will create sustainable livelihoods and food production, particularly post-mine closure. The aim of this experiment was to determine salt tolerance and response parameters for selected cool season crops in three main growth stages to enable reliable water and salt balance modelling to support decisions around responsible mine water use.

Materials and Methods

The crops evaluated included temperate annual pastures and cereal small grain crops, namely barley, oats, stouling rye, annual ryegrass and wheat. Crops were grown in water culture at five levels of salinity with an EC range of 120 to 2000 mS m⁻¹, spanning at least twice the published threshold E_{ce} values of these crops (Maas and Grattan, 1999). A combination of a nutrient solution, gypsum (CaSO₄.2H₂O) and Epsom salts (MgSO₄.7H₂O) was used to make up the salt solutions for each EC treatment. The effect of salinity on the germination percentage was determined using the paper roll method. For seedling and vegetative salt response, germinated seedlings were secured with a foam strip into a lid into which holes had been drilled and suspended above an aerated plastic container half filled with the respective treatment solutions. Treatment solutions were replaced weekly and topped up daily with tap water to ensure solution EC did not fluctuate more than 50 mS m⁻¹.

Results and Discussion

Germination percentage decreased as EC increased, with almost all five crops having 0-1% germination at the highest EC (2000 mS m⁻¹). For ECs higher than 1000 mS m⁻¹, the germination percentages fluctuated between 60 and 70%, with only oats (30%) and wheat (1%) being more susceptible. Seedlings did not survive ECs above 1000 mS m⁻¹. Foliage yellowed and senesced because of the roots inability to take up water uptake in highly saline solutions. The threshold values found ranged from 500 to 1000 mS m⁻¹.

Conclusions

It was clear that these crops would be suitable to be grown with many of the sulfate saline waters emanating from many local coal mines, as gypsum precipitation tends to keep salinity levels of these waters relatively low.

Integrating a crop model with a farm focused greenhouse gas calculator to identify low carbon agricultural intensification options for smallholder farmers in rural South Africa

Presenter: F Rusere (farirairusere@gmail.com)

Initia	Surname	Authors Company/Organisation and Postal Address
F	Rusere	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, P Bag X3, Rondebosch, 7700, Cape Town South Africa
LV	Dicks	2School of Biological Sciences University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, UK
S	Mkuhlani	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, P Bag X3, Rondebosch, 7700, Cape Town South Africa
O	Crespo	Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, P Bag X3, Rondebosch, 7700, Cape Town South Africa

Introduction

Approaches such as sustainable and ecological intensification have gained momentum to intensify in smallholder agricultural systems in sub Saharan Africa (SSA). However, few studies have examined the sustainability of these intensification models in reducing the impacts of agriculture on the climate system. The aim of this study was to assess the impact of ecological farming practices on greenhouse gas (GHG) emissions and support mitigation decisions at farm type level.

Materials and Methods

The study was carried out in two rural districts in Eastern Cape and Limpopo, South Africa. We designed a framework which encompasses a farm typology to assess the contribution of various ecological intensification options to the GHG footprint at farm level. We couple two well-known models, DSSAT a crop model to estimate crop yields and Cool FARM Tool (CFT) a greenhouse gas calculator to estimate the impact of these practices on GHGs emission at farm level. An expert-based farm typology identified five farm types and three farm types in the Eastern Cape and Limpopo respectively. The DSSAT model of was then used to assess and simulate the impact of changing farming practices on crop yields on five different crops at the farm type level, and the (CFT) was used to estimate the impact of changing farming practices on GHG emissions at the farm type level.

Results and Discussion

Farms were found to be net sources of GHGs. The simulated result indicated that conventional practices increase GHG emissions per hectare but reduce GHG emissions per every tonne produced. Ecological farming practices sequester and mitigate GHG emissions both per hectare and per every tonne produced.

Conclusions

We conclude that the framework proposed in this study was helpful identifying low carbon agricultural intensification options that can maintain or increase crop yields while reducing GHG emission at farm level.

Arthropod diversity in Bt and non-Bt soybean trial plots in South Africa

Presenter: N Schutte (nadineschutte2@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NC	Schutte	North-West University, Potchefstroom 2520, Unit for Environmental Sciences
J	Van den Berg	North-West University, Potchefstroom 2520, Unit for Environmental Sciences

Introduction

Soybean is attacked by many different pest species in South Africa. Although soybean is one of the country's most important crops very little is known about the arthropod communities associated with soybean agro- ecosystems in South Africa (Dlamini *et al.*, 2014). The planting of genetically modified (GM) soybean with insecticidal traits against the Lepidoptera pest complex of soybean could contribute towards reduced pesticide application, similar to what was experienced with Bt maize. Before the approval and commercialization of any GM crop, risk assessments have to be done. In this study the possible effects of Bt soybean on the diversity of non-target arthropod species was assessed.

Materials and Methods

This study was conducted at four different localities with two treatments and six replicates at each locality. The treatments were: T1: Conventional soybean and T2: Bt soybean. Each replicate consists of six 5-m rows at a stand of 350,000 – 400,000 plants per hectare. Arthropods were sampled between February and April 2018 by means of yellow sticky traps and a beating sheet method, where the arthropods were dislodged from the plants by vigorously shaking them (Southwood & Henderson, 2000). Arthropods were collected once at each trial site with each method. The samples were then grouped into morphological species. Diversity indices were used to analyse the differences in species diversity between the two treatments for both sampling methods.

Results and Discussion

The sticky trap results showed no significant difference between arthropod diversity in Bt soybean and conventional soybean ($P=0.98$). The Shannon-Wiener Diversity index values for Bt soybean and non-Bt soybean were 0.608 and 0.605. The beating sheet method yielded a total of 57 morphological species. The Shannon- Wiener Diversity index for Bt soybean was 1.703 and 1.425 for non-Bt soybean, but this difference was not significant ($P=0.718$). These results are supported by similar studies on soybean in other countries and similar studies on maize in South Africa (Yu *et al.*, 2014).

Conclusions

Bt soybeans are still under assessment in South Africa and could possibly add to the toolkit that would enable producers to reduce the use of insecticides and increase yield. This study found that no significant differences in arthropod communities occurred between Bt and conventional soybeans. There were no negative effects observed in arthropod communities associated with Bt soybeans during this single season field trial.

Impact of long-term production management practices on wheat grain yield under a semi-arid climate

Presenter: KM Seepamore (klaasseepamore@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KM	Seepamore	Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300, Republic of South Africa
CC	Du Preez	Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300, Republic of South Africa
GM	Ceronio	Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300, Republic of South Africa

Introduction

Crop residue retention and conservation tillage can improve soil quality in the long term compared to crop residue removal and conventional tillage. This improvement of soil quality does not always translate to higher wheat yields under all conditions. Thus, it is important to determine which production management practices of wheat can increase grain yield under local conditions to ensure sustainability.

Materials and Methods

The study was initiated to determine the impact of different wheat production management practices over 37 years on wheat grain yield in a long-term trial near Bethlehem in the Eastern Free State. The treatments were two residue management practices (burn and no-burn), three tillage methods (no tillage, stubble mulch and conventional), three nitrogen rates (20, 30 and 40 kg N ha⁻¹ until 2003, thereafter 20, 40 and 60 kg N ha⁻¹) and two methods of weed control (chemical and mechanical), arranged randomly in three blocks. All treatment plots were cropped annually with winter wheat without any rotation with a summer crop.

Results and Discussion

The grain yield of wheat neither decreased nor increased over the long term but was subjected to annual variation. However, rainfall did not have any significant effect on grain yield due to poor correlation between annual rainfall and grain yield. Our results indicate that wheat grain yield did not benefit from no residue burning and conservation tillage. Wheat grain yield was significantly higher with residue burning and conventional tillage than with no residue burning and conservation tillage, respectively. Significant two-way interactions between no residue burning and conservation tillage, and other treatment combinations were few and did not show any yield trend. Grain yield increased slightly with higher nitrogen levels. The effect of different nitrogen fertilizer application rates on grain yield of wheat was also subjected to annual variation. Yield differences between the two weed control methods were small, and therefore insignificant.

Conclusions

The improvement of soil quality that resulted from the applied production management practices did not reflect significantly in the wheat grain yields, probably due to their site-specific nature.

Effect of harvesting methods, plant density and nitrogen application rate on nitrogen use efficiency and yield of *Amaranthus tricolor* L.

Presenter: KA Seetseng (kseetseng@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
HT	Araya	Agricultural Research Council (ARC) - Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa
SO	Amoo	Agricultural Research Council (ARC) - Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa
CP	Du Plooy	Agricultural Research Council (ARC) - Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa

Introduction

In South Africa, semi-domesticated leafy vegetables such as *Amaranthus tricolor* L. are being promoted for commercial production, yet there are no locally-determined recommendations for plant densities and fertilizer use. Major soil nutrients (N:P:K), whether in combination or applied as sole nutrients are added to soil to improve and maintain growth, yield and quality of plants (Hafsi *et al.* 2011). Nitrogen influences chlorophyll formation and photosynthesis efficiency, which is responsible for 26-41% of crop yield (Ivonyi *et al.* 1997). A field experiment was initiated to determine the response of *Amaranthus tricolor* L. to plant density, harvesting methods and nitrogen application rates.

Materials and Methods

Open field trials were conducted in the 2012/13 and 2013/14 summer seasons at Agricultural Research Council- Vegetable and Ornamental Plants Campus in Pretoria, South Africa. The trials involved a 4x 3x 2 factorial experiment arranged in a randomized complete block design, which was replicated four times. The treatment combination included four nitrogen application levels (0, 50, 100 and 150 kg N ha⁻¹), three plant density (111 111, 133 333 and 222 222 plants ha⁻¹) and two harvesting methods (tipping and cutting). Total fresh biomass and marketable leaves and dry mass were recorded. Mineral contents were analysed and the agronomic efficiency, physiological efficiency, agro-physiological efficiency, apparent recovery efficiency and nutrient efficiency ratio were determined.

Results and Discussion

Harvesting through cutting method improved yield at a plant density of 111 111 plants ha⁻¹ when nitrogen was applied at a rate of 150 kg N ha⁻¹. A significant (p<0.0001) total fresh marketable leaf yield of 33.7 t ha⁻¹ was recorded compared with other treatments. This same treatment combination gave a total dry-mass of 5 327.16 kg ha⁻¹. Nitrogen uptake was significantly (P<0.05) affected by plant density, when it increases i.e., 111 111 plants ha⁻¹ had an uptake of 204 kg ha⁻¹ at the control and decreased to 133.88 kg ha⁻¹ at 222 222 plants ha⁻¹ treatment. Nutrient efficiency ratio, Agronomic efficiency, Physiological efficiency and Agro- physiological efficiency increased with increased nitrogen application rate. Apparent recovery efficiency decreased with increased nitrogen application rate.

Conclusions

Nitrogen rate of 150 kg ha⁻¹, increased yield, the results indicated that the rate can be increased further to determine the response curve for this particular vegetable. A plant density of 111 111 plants ha⁻¹ is recommended for *A. tricolor* L. using the cutting method for harvesting and a minimum nitrogen application of 150 kg ha⁻¹ is thus recommended.

Response in growth and total aboveground biomass of selected *Amaranthus* species to commercial compost application as a source of nitrogen

Presenter: KA Seetseng (kseetseng@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
HT	Araya	Agricultural Research Council (ARC)- Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa
SO	Amoo	Agricultural Research Council (ARC)- Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa
CP	Du Plooy	Agricultural Research Council (ARC)- Roodeplaat, Vegetable and Ornamental Plant (VOP). Private Bag X293, Pretoria 0001, South Africa

Introduction

Amaranthus has been an important popular leafy vegetable because of its nutritional contentment. It was discovered that there is an increase in acceptance and utilization of indigenous vegetables in the east and southern Africa (Jansen van Rensburg *et al.* 2004). These species are recognized as vegetables that need to be cultivated in small sectors of the farm such as kitchen gardens and along the rows of staple crops (Chweya, 1997). An experiment was initiated to determine the response of *Amaranthus* species to commercial compost application rates.

Materials and Methods

Open field trials were conducted in the 2015/16 and 2016/17 summer seasons at Agricultural Research Council- Vegetable and Ornamental Plants Campus in Pretoria, South Africa. The trials involved a 4x7 factorial experiment arranged in a randomized complete block design, which was replicated four times. The treatment combination included four *Amaranthus* species (*Amaranthus tricolor* Lin, *Amaranthus retroflexus*, *Amaranthus tricolor* and *Amaranthus gangenticus*) and seven compost (8:1:1 (10) was used as a source of nitrogen) application rates (50, 100, 200, 300, 400, 500 kg N ha⁻¹ and 0 kg N ha⁻¹ serving as the control). Plants were ready for the first harvest at 21 days after transplanting, they were cut and weighed for total aboveground fresh biomass (stems+leaves). The leaf area (cm²) was measured using leaf area meter (LI-3100 area meter, USA). Leaves and stems were dried in an oven at 50°C for dry mass determination. Data were subjected to analysis of variance (ANOVA) using the statistical program GenStat (2003).

Results and Discussion

Amaranthus retroflexus had the highest total aboveground fresh biomass accumulation (38,5 tons ha⁻¹) when 300 kg N ha⁻¹ was applied. The lowest total aboveground fresh biomass accumulated was that of *Amaranthus gangenticus*, its highest total aboveground biomass was 25,8 t ha⁻¹ obtained when compost was applied at 200 kg N ha⁻¹. The biomass was reduced as the rate on N kg ha⁻¹ compost increases above 200 kg N ha⁻¹. *Amaranthus tricolor* Lin. showed total aboveground fresh biomass increasing linearly up to 500 kg N ha⁻¹ application rate and the biomass ranged between 17,8 t ha⁻¹ of the control to 30,9 tons ha⁻¹ at 500 kg N ha⁻¹ application rate, however results showed no significant (P<0.05) difference within application rates in *Amaranthus tricolor* species.

Conclusions

It is concluded that yields of *Amaranthus* species could be improved by applying the correct compost application rate for each species.

Seasonal variation of essential and non-essential mineral elements of indigenous tea (*Jatropha zeyheri*)

Presenter: AM Sehlapelo (boreadimankutu@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AM	Sehlapelo	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
KG	Shadung	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
MS	Mphosi	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa

Introduction

Jatropha zeyheri is a perennial, densely hairy herb producing stems up to 30 cm long. The leaves of this plant are boiled and the extract is drunk with sugar as (beverage or herbal) tea (Van Wyk and Gericke, 2000). Tea is traditionally harvested in early autumn or late spring depending on the flowering period of the species, although the harvesting period can be extended to late summer due to the increasing demand of teas. The objective of this study was therefore to determine whether harvesting time would have effects on chemical composition in *J. zeyheri* leaf tissues.

Materials and Methods

The study was conducted at Khureng village, Lepelle-Nkumpi Municipality, in Limpopo Province South Africa. Five treatments constituting harvesting dates (February, March, April, May and June) were arranged in a randomised complete block design, with 10 replications. Leaves were harvested on a monthly basis and oven-dried at 60°C for 24 hrs. The dried leaves were ground through a 1 mm sieve using a grinder prior analysis. Essential and non-essential mineral elements were analysed using ICPE-9000. Data were subjected to ANOVA using the Statistix 10.0. Mean separation was achieved using Fischer's Least Significant Difference Test.

Results and Discussion

Harvesting time had highly significant effects on Cr, Fe, K, Mg, Ni, P and S, contributing 58, 65, 73, 62, 55, 67 and 69%, respectively, in total treatment variation (TTV), but were significant on Ca, Cu, Mn, Al, Co and Na, contributing 62, 58, 66, 53, and 57%, respectively, in TTV. Essential and non-essential mineral elements over increasing harvesting time responded in a density-dependent growth pattern. Using the optimisation relationship ($x = -b_1/2b_2$) from the quadratic equation, harvesting of *Jatropha zeyheri* was optimised at 2.75 months.

Conclusions

The results suggested that the chemical compositions in leaves of *J. zeyheri* had seasonality effects. Harvesting of this indigenous tea was optimised at 2.75 months, hence harvesting of *J. zeyheri* leaves in April - May is recommended for enhanced quality tea.

Stimulatory effects of plant growth regulators on kiwifruit (*Actinidia* spp.) stem cuttings at low, medium and high concentration levels

Presenter: MK Sekhukhune (msekukhune6@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MK	Sekhukhune	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa
MY	Maila	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa

Introduction

Worldwide the genus *Actinidia*, with over 50 species, commonly known as kiwifruit plants, is difficult to propagate. Sexual propagation techniques result in genotypic variability, high incidences of seed-borne diseases and a prolonged juvenile phase where gender cannot be segregated for inter-planting purposes. Most of these challenges could be overcome through vegetative propagation techniques. However, the use of plant growth regulators (PGRs) on semi-hardwood stem cuttings (SC) in *Actinidia* species resulted in inconsistent results that included complete lack of response (Ercisli *et al.*, 2002; Ono *et al.*, 2000) due to factors that had not been explained. Among other factors, we hypothesise that the concentrations of PGRs used were outside the stimulation phase for callus formation in the genus *Actinidia*. The objective of the study was therefore to investigate the potential responses of kiwifruit SC treated at concentrations straddling low, medium and high PGR levels.

Materials and Methods

Semi-hardwood SC of *A. arguta* and *A. chinensis* were harvested from commercially cultivated mature kiwifruit plants. The bases of the SC were treated with different concentrations of PGRs and raised in suitable growing media and conditions for the assessment of formation of callus, with subsequent transfers for rooting and shooting in different growing media with appropriate PGRs. Finally, at harvest, fresh shoot and root mass were collected and oven-dried at 90°C, dry mass measured and data were subjected to analysis of variance using SAS software. Means were separated using Fisher's Least Significant Difference test at the probability level of 5%.

Results and Discussion

Higher survival percentage of SC (85%) was achieved in *A. arguta* at the highest IBA concentration of 10000 ppm, whereas in *A. chinensis* maximum survival of stem cutting (40%) was obtained at the IBA concentration of 7500 ppm. Surviving *A. arguta* SC (40–65%) developed adventitious roots only, whereas 35–60% SC developed both callus and roots. Increasing the concentrations to 5000–10000 ppm IBA resulted in more callus formation on *A. arguta* SC. In *A. chinensis*, 5000–10000 ppm IBA treatments resulted in callus development, but without the development of adventitious roots. Similarly, at lower IBA concentrations (2500 ppm) *A. arguta* did not root as observed in other *Actinidia* species (Ercisli *et al.*, 2002; Ono *et al.*, 2000).

Conclusions

Findings in the current study demonstrated that semi-hardwood cuttings of *A. arguta* responded to all IBA treatments, whereas *A. chinensis* did not respond to any treatment level except for callus formation.

Assessing variability in resource use efficiencies of smallholder potato farms: A case of Gert Sibande in Mpumalanga Highveld and EThekweni in KwaZulu Natal

Presenter: El Sekoboane (2009052578@ufs4life.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
EI	Sekoboane	University of the Free State, Department of Soil, Crop and Climate Sciences, PO Box 339, Bloemfontein, 9300
AC	Franke	University of the Free State, Department of Soil, Crop and Climate Sciences, PO Box 339, Bloemfontein, 9300

Introduction

Smallholder potato farmers in South Africa have a huge variability in resource use efficiencies, which is often not well understood. The objective of the study was to quantify and explain variability in resource use efficiencies of smallholder potato farmers through surveys and compare those with the resource use efficiencies of large scale potato farmers (Steyn *et al.*, 2016) in two geographically distinct areas in South Africa.

Materials and Methods

EThekweni district in KwaZulu and Gert Sibande in Mpumalanga were chosen as the study areas. For data collection, a questionnaire was employed. A stratified sampling technique was used in which smallholder farmers with good resource use efficiencies were grouped and compared with the ones with poor resource use efficiency. Resource use efficiencies and input rates of smallholders were compared with those recorded by large scale farmers. The survey was conducted for two weeks in each region, June 2018 for EThekweni and August 2018 in Gert Sibande. For statistical analysis, the correlation matrices was used to identify interesting relationships. Simple linear regression was used to assess the proportion of variability. T test was used to compare the data recorded by smallholders with the average of large-scale farmers. To quantify carbon footprint, potato Carbon footprint tool was used.

Results and Discussion

Smallholder farmers based in KwaZulu Natal have better resource use efficiency compared to those in Mpumalanga. Those with good yields are generally characterised by good resource use efficiencies and are comparable with large scale potato farmers and those with poor yields are characterised by poor resource use efficiency and compare poorly with large scale farmers.

Conclusions

Variability in yields and resource use efficiency is largely attributed to poor management and use of input resources. Majority of smallholder farmers are economically and environmentally unsustainable due to poor use of resources.

Effect of methyl jasmonate on skin colour change of 'hass' avocado fruit during ripening

Presenter: L Setagane (lethabosetagane@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Setagane	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
K	Shikwambana	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
TP	Mafeo	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
N	Mathaba	Perishable Produce Export Control Board (PPECB), 45 Silwerboom, Platteklouf, Cape Town, 7550

Introduction

Avocado 'Hass' change skin colour from green to purple then to black during ripening, which is associated with chlorophyll degradation; concurrently, an increase in anthocyanin content (cyanidin 3-O-glucoside) in the fruit skin occurs (Cox *et al.*, 2004). Methyl jasmonate (MJ) applied postharvest has been shown to increase the biosynthesis of colour pigments, such as anthocyanins and β -carotene in fruit skin (González-Aguilar *et al.*, 2001). Thus, this study investigated the effect of MJ on skin colour change of 'Hass' avocado fruit during ripening.

Materials and Methods

Avocado fruit 'Hass' were dipped into MJ concentrations of 10 and 100 $\mu\text{mol L}^{-1}$ for 2 minutes and allowed to dry for 60 minutes. Untreated fruit were used as control, thereafter, fruit were stored at 5.5°C for 28 days before being ripened at 25°C and evaluated every second day for mass loss, firmness, electrolyte leakage (EL), chilling injury (CI), objective colour parameters (lightness- L^* , chroma- C^* and hue angle- h^*), subjective colour (eye colour rating), total chlorophylls, total carotenoids and total anthocyanins concentration.

Results and Discussion

The results showed that dipping fruit into 10 $\mu\text{mol L}^{-1}$ significantly ($P < 0.05$) reduced mass loss and firmness during ripening. MJ treatments (10 and 100 $\mu\text{mol L}^{-1}$) reduced EL and CI in the skin of 'Hass' fruit during cold storage and ripening. The treatments had a significant effect ($P < 0.05$) on colour parameter L^* , h^* and eye colour rating, but did not affect ($P < 0.05$) chroma- C^* . Fruit treated with 10 and 100 $\mu\text{mol L}^{-1}$ MJ reached the purple skin colour (eye rating scale 5) during ripening. Moreover, results indicated that treatments had no effect ($P < 0.05$) on skin colour pigments (total chlorophyll, total carotenoids and total anthocyanin) during ripening. However, fruit treated with 10 $\mu\text{mol L}^{-1}$ MJ had a higher total anthocyanin concentration during ripening.

Conclusions

The results of this study indicated that MJ treatment at 10 $\mu\text{mol L}^{-1}$ effectively improved 'Hass' skin colour development during ripening.

Early generation selection of wheat genotypes for drought tolerance and agronomic traits

Presenter: KW Shamuyarira (kwameswilson@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KW	Shamuyarira	University of KwaZulu-Natal, African Centre for Crop Improvement, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Introduction

Early generation selection can be used to efficiently identify and advance better performing families in plant breeding programs. This study aimed to evaluate F3 families of wheat and their parents for drought tolerance and agronomic traits and to select the best performing families for genetic advancement.

Materials and Methods

Seventy-eight genotypes consisting of 12 parents and their 66 F3 families were evaluated using a 13 x 6 alpha- lattice design with two replications in two contrasting water regimes under greenhouse and field conditions in the 2017/2018 growing season. The following agronomic traits were assessed: number of days to heading (DTH), days to maturity (DTM), plant height (PH), tillering number (TN), spike length (SL), spikelets per spike (SPS), kernels per spike (KPS), thousand kernel weight (TKW), fresh biomass (BI) and grain yield (GY).

Results and Discussion

Highly significant differences ($P < 0.05$) were observed for DTH, DTM, PH, TN, KPS and TKW among the genotypes under the two water regimes. Variance components and heritability estimates among agronomic traits and yield showed high values for days to heading and fresh biomass under drought stress. Genetic advance values of 29.73% and 37.61% were calculated under drought-stressed and non-stressed conditions, respectively, for fresh biomass. The families LM02 x LM05, LM13 x LM45, LM02 x LM23 and LM09 x LM45 were relatively high yielding in both stressed and non-stressed conditions and are recommended for genetic advancement preferably using the single seed descent selection approach.

Conclusions

The study has confirmed the effectiveness of early generation selection of wheat for days to heading and fresh biomass for selection.

Striga resistance and compatibility of maize genotypes with *Fusarium oxysporum* f.sp strigea

Presenter: AIT Shayanowako (shayanowako@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AIT	Shayanowako	University of KwaZulu-Natal, School of Agriculture, Earth and Environmental Sciences, P/Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
H	Shimelis	University of KwaZulu-Natal, School of Agriculture, Earth and Environmental Sciences, P/Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
M	Laing	University of KwaZulu-Natal, School of Agriculture, Earth and Environmental Sciences, P/Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Introduction

The objective of this study was to investigate the combined effect of host resistance and FOS in suppressing *Striga asiatica* (L) kunz in maize. Eighteen maize genotypes were evaluated under glasshouse and field conditions with and without Striga infestation and FOS treatment. The results showed that genotype by FOS treatment interaction significantly ($P < 0.05$) affected all traits except anthesis to silking interval, ear aspect score and Striga emergence count at 8 weeks after planting. FOS treatment caused significant differences ($P < 0.001$) on all maize and Striga traits although its efficacy seemed to be genotype dependent. Mean grain yield was 4.2 t ha^{-1} for the control, 2.63 t ha^{-1} in FOS coated genotypes and 2.17 t ha^{-1} in uncoated genotypes. The study highlights the potential of integrating host resistance and FOS compatibility to enhance Striga suppression.

Materials and Methods

The eighteen selected maize populations were evaluated at two locations under three Striga treatments using a 9×2 alpha lattice design with 2 replications. The three treatments were, 1) maize genotypes sown without Striga infestation and FOS coating (control), 2) maize genotypes grown under Striga infestation and; 3) FOS coated maize genotypes sown under Striga infestation.

Results and Discussion

Interaction of genotypes with FOS application was significant ($P < 0.05$) for KRC, KR, GY, SEM, SR1 and SR2. The interaction of genotypes with the sites was only significant ($P < 0.05$) for KRC and GY, while FOS by site and genotype x FOS x site interaction was highly significant for all traits recorded. Positive effects of FOS application and its compatibility with some maize genotypes with synergistic suppression of Striga infestations was observed. Application of FOS resulted in significant improvement in grain yield under Striga infestation on most genotypes across the three study sites. In maize, the benefits of FOS application arise from the reduction in Striga numbers and host damage symptoms resulting in more assimilates being channelled to the grain sink.

Conclusions

The present study established that application of *Fusarium oxysporum* f.sp. strigae (FOS) resulted in less emerged Striga parasites and subsequent reduction in damage symptoms on biocontrol treated genotypes. This culminated in reduction in yield loss of FOS coated genotypes relative to uncoated treatments under Striga infestation.

Seed germination and emergence of two *Cyrtanthus* species

Presenter: NN Sibande (halelua@live.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NN	Sibande	Randwater Central Depot Private Bage x15, Mondeor, 2110
R	Kleynhans	Tshwane University of Technology, Private Bag x 680, Pretoria, 0001
B	Matsiliza-Mlathi	Tshwane University of Technology, Private Bag x 680, Pretoria, 0001

Introduction

Cyrtanthus is a genus of perennial herbaceous ornamental and medicinal plants in the Amaryllidaceae family, native to central and southern Africa. *Cyrtanthus* species are valuable medicinal and ornamental plants native to the southern African region. All members of this genus exhibit a certain degree of horticultural potential, but because of their fastidious nature in cultivation, gardeners shy away from them. Thus, propagation methods that are simpler and inexpensive are necessary to increase the production of *Cyrtanthus* species.

Materials and Methods

A 5x2x2x2 factorial experiment was conducted with temperature as main plot and the other factors [two species (*C. mackenii*, *C. epiphyticus*), 2 seed ages (>12 months, 6 - 12 months) and seed pre-treatment (distilled or smoke water)] as subplots within each temperature. A 5x3 Youden square design was used for the five temperatures (10, 15, 20, 25 and 30°C). In a second experiment, a third seed age (<6 months) and various other seed pre-treatments were added (GA₃, warm water, smoke water, mechanical scarification and control soaked in distilled water). A randomised complete block design (3 replicates) was used for the second trial and seeds were incubated at 20°C. Seeds were germinated in Petri dishes on top of moistened filter paper. A third trial was conducted as a complete randomised block design with 8 growth media treatments replicated five times. Only young seeds were used in this trial. Germination and emergence was monitored every third day.

Results and Discussion

C. mackenii germinated faster than *C. epiphyticus* but the seed of the latter species had a significantly higher germination percentage (9%) than seed of *C. mackenii* (3%). Six to twelve month old seeds had a significantly higher germination percentage (9%) than older seed (3.7%). Temperature and smoke water did not affect the germination percentage significantly, but the best germination was observed at 20°C. In the second trial the <6 months -old seed resulted in an increased germination percentage (37%). The control treatment resulted in the best germination percentage (29.2%) but was not significantly different from the smoke (27.1%) and the GA₃ (25.7%) pre-treatments. The emergence of seed in all eight media for both species was 100% after 28 days and did not differ significantly. The improved emergence can be because of unstable moisture conditions in the petri dishes, but also relate the use only fresh seed thus eliminating the low germination of the older seed that affected the overall averages negatively in the first two experiments.

Conclusions

The use of fresh seed (<6 months) is imperative for the germination of *Cyrtanthus* species and temperatures of 20°C can be recommended.

Evaluation of apple rootstocks planted in different locations in South Africa

Presenter: XI Sibozza (xolani@hortgro.co.za)

Initials	Surname	Authors Company/Organisation and Postal Address
XI	Sibozza	HORTGRO Science, PO Box 12789, Die Boord 7613, Cape Town, South Africa; Dept. of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602
WP	Kotze	Dutoit Agri, PO Box 236, Ceres 6835, Western Cape, South Africa
NC	Cook	Prophyta, PO Box 17, Elgin, 7180, Western Cape, South Africa
WJ	Steyn	HORTGRO Science, PO Box 12789, Die Boord 7613, Cape Town, South Africa; Dept. of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602

Introduction

In South Africa, commercial apple (*Malus × domestica* Borkh) production can be a challenge due to the Mediterranean-type climate, associated with warm winters, high soil temperatures, woolly apple aphid and apple replant disease. The Geneva® apple rootstocks, bred for fire blight resistance, exhibit good traits such as high precocity with high cumulative yields, strong disease and pest tolerance (Fazio *et al.*, 2015; Reig *et al.*, 2018). The standard apple rootstocks in South Africa, viz. MM.109, M.793, and M.7 are vigorous and of low precocity with poor tolerance to woolly apple aphid and apple replant disease. The objective of this study was to evaluate new dwarfing, semi-dwarfing and semi-vigorous rootstocks from the Geneva® rootstock series to identify more precocious and productive replacements for the South African industry standard rootstocks.

Materials and Methods

During the 2013 season, identical apple rootstock trials with ‘Fuji’ as a scion were established at three localities (Oak Valley Estate, Breëvlei, and Helderwater) in South Africa. In each locality, M.9 EMLA, M.9 Nic29, G.222, M.7, MM.109/M.9 EMLA, MM.109/G.222, M.793/M.9 EMLA, M.793/ G.222, G.778/M.9 EMLA, and G.778/G.222 were planted in 7 blocks of 3 trees per rootstock as the “more dwarfing site”. The trees on M.7, G.202, G.778, M.793, MM.109, and G.228 were planted in 10 blocks of 3 trees per rootstock as the adjacent “more vigorous site”. All experimental trees were planted in a randomised complete block design with rootstocks randomly allocated in each of the 7 or 10 blocks of 3 trees per rootstock. All trials were managed differently, but according to standard commercial practice. All experimental trees were evaluated for production performance and vegetative growth, according to Reig *et al.* (2018).

Results and Discussion

The Geneva® rootstocks seemed to impart greater precocity compared to industry standard rootstocks of comparable size. The standard industry rootstocks used in South Africa, i.e. MM.109, M.793, and M.7 were the least precocious and productive of all the rootstocks included in the trial. The MM.109 and M.793 performed poorly compared with G.778. At this preliminary stage, South African apple producers could benefit by converting to Geneva rootstocks.

Conclusions

The trees have filled their productive space, yet it is still early days for recommendations. G.778 has potential to replace the current vigorous industry standard M.793 and MM.109 rootstocks.

Long-term impact of no-till conservation agriculture on soil aggregate stability, infiltration and distribution of c in different size fractions

Presenter: NJ Sithole (nkanyisoj@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NJ	Sithole	University of KwaZulu-Natal, School of Agriculture, Earth and Environmental Sciences, Private Bag X01, Pietermaritzburg; Scottsville 3209
LS	Magwaza	University of KwaZulu-Natal, School of Agriculture, Earth and Environmental Sciences, Private Bag X01, Pietermaritzburg; Scottsville 3209

Introduction

Soil degradation associated with the loss of soil organic carbon (SOC) has been a major concern in sub-Saharan Africa. It is not fully understood how long-term addition of C through biomass and N-fertilizers impact on C distribution in soil aggregates and its effects on soil aggregate stability and infiltration in sub-tropical maize monocropping system.

Materials and Methods

The study therefore assessed long-term changes in total SOC (TSOC), aggregate associated C, particulate organic C (POC), aggregate stability (MWD) and infiltration in the 0-10, 10-20 and 20-30 cm depths under different tillage systems after 13 years of implementation of the trial. The three tillage systems were no-till (NT), rotational tillage (RT) both with permanent residue cover and conventional tillage (CT) with residue removed. N- fertilizer was applied at a rate of 0, 100 and 200 kg ha⁻¹ as a lime ammonium nitrate.

Results and Discussion

On average, TSOC did not vary ($P < 0.05$) across the tillage treatments, 27.1 t ha⁻¹ NT vs 26.0 t ha⁻¹ RT and 26.6 t ha⁻¹ CT, but varied with depth where it was stratified in the 0-10 cm depth in NT and RT. Particulate organic C, however, varied significantly ($P < 0.05$) across the treatments where it decreased with increase in tillage intensity but only in the 0-10 cm depth. Carbon associated with large aggregates ($> 2000 \mu\text{m}$) differed marginally ($p = 0.085$) with tillage treatment with NT having 38.0 t ha⁻¹, RT 36.6 t ha⁻¹ and CT 29.7 t ha⁻¹. However, differences ($P < 0.05$) were observed in small macroaggregates (250-2000 μm) with NT having 37.8 t ha⁻¹, RT 33.5 t ha⁻¹ and CT 30.4 t ha⁻¹ in the surface depth. The results found a strong effect of residue retention in NT and RT in the soil surface with aggregate stability which was correlated with high rate of infiltration in these treatments. However, weak interaction between SOC/residue retention and fertilizer application rates was observed.

Conclusions

The results of this study indicated that SOC takes time to improve in conservation agricultural practices in a semi-arid environment and its increase is only confined to the soil surface. Nevertheless, reduced soil disturbance improves physical protection of SOC, soil structure and infiltration. Weak interaction between residue retention and fertilizer rates highlighted the need for a better scientific understanding of carbon stabilization across different semi-arid of 1:1 clay minerals in sub-tropical soils.

Effect of cover crop utilisation on wheat production

Presenter: EH Smit (rensagri@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
EH	Smit	Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7600, South Africa, Stellenbosch University, Department of Agronomy, Stellenbosch, Private Bag X1, Matieland, 7602, South Africa
JA	Strauss	Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7600, South Africa
PA	Swanepoel	Stellenbosch University, Department of Agronomy, Stellenbosch, Private Bag X1, Matieland, 7602, South Africa

Introduction

In Mediterranean regions hot and dry summers restricts cover crop production to the same season when cash crops are cultivated. Cover crops thus replaces a cash crop which add to the cost of cover crop production. Utilising cover crops can generate an income and have the potential to make cover crop production economically viable. This study aims to identify the effect of utilising cover crops on the functional role of cover crops in a Mediterranean climate.

Materials and Methods

The trials were conducted on Langgewens Research farm in the Swartland region of the Western Cape in 2016 and 2017. Two different cover crop mixtures (mainly leguminous and mainly cereal) were planted. These mixtures were utilised as either grazing or hay or rolled as mulch. All the cover crop plots were planted to wheat in the following season. Cover crop biomass samples were taken during and at the end of the growing season. The biomass samples were analysed for nutritional value and mineral content. Wheat yield and quality was recorded at harvest.

Results and Discussion

These two cover crops mixtures can be a good source of fodder as it had 19% crude protein, 10 MJ kg⁻¹ metabolisable energy and 80% *in vitro* digestibility. The concentration of nitrogen, phosphorus, calcium, magnesium, sodium, iron, zinc, manganese, boron, aluminium and sulphur in the cover crop residue was improved ($P < 0.05$) following regrowth in the grazed plots. This indicates that grazing is not just the removal of material and minerals, but also causes a change in the quality of cover crop residue. When the two mixtures were interpreted separately it is clear that grazing had a smaller effect on the mainly legume mixture. In the wheat following cover crops there was no difference in wheat following different cover crops and different utilisation treatments. Wheat protein content was higher in wheat following mainly leguminous cover crop irrespective of utilisation method ($P < 0.05$).

Conclusions

High quality fodder provided by cover crops can be utilised as grazing and lead to an increase in the mineral content of cover crop biomass with regrowth. The effect of grazing cover crops can be influenced by the botanical composition of the cover crop and also have an effect on the quality of wheat. The utilisation of cover crops may not influence wheat production or quality. Cover crops can give wheat producers the opportunity to increase biodiversity in their systems through mixtures and have the added benefit of the integration of livestock

Ecological sustainability of potato production systems in the North West Province

Presenter: JM Steyn (martin.steyn@up.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
JM	Steyn	University of Pretoria
AC	Franke	University of the Free State
N	Radebe	University of the Free State
A	Mukiibi	University of Pretoria

Introduction

Resource use efficiencies are popular indicators of ecological sustainability in crop production. A survey by Steyn *et al.* (2016) assessed the use efficiencies of inputs among potato growers in all growing regions of South Africa. Major differences in resource use efficiencies between regions were identified, likely related to variability in climate, soils, management and disease pressure. In spite of high yields, nutrient and water use efficiencies in North West were relatively low, probably due to the sandy soils. Individual growers within regions also differed widely in efficiencies. While factors explaining resource use efficiencies were identified, exact reasons for within-region variability were hard to pinpoint. The objective of this project was to conduct detailed nutrient and water balances for potato fields to help explain differences in resource use efficiencies.

Materials and Methods

Six potato fields in Louwna district of North West were monitored. Surveys and field measurements were conducted regarding type, rate and method of fertilizer application. Flow meters and pressure transducers were used to monitor irrigation amounts. Drainage and suction lysimeters were installed to monitor drainage and nutrient leaching losses. Leachate was regularly extracted to analyse for nutrient concentrations. Soil samples for nutrient analysis were collected and final tuber yields determined.

Results and Discussion

Results revealed that all potato fields received relatively large quantities of N, P, K and Ca and lower amounts of Mg, S and Zn. Application rates of major macro-nutrients were relatively uniform across farms, with average values of 295 kg ha⁻¹ N, 223 kg ha⁻¹ P and 342 kg ha⁻¹ K. The total amount of irrigation water applied ranged between 823 and 977 mm, with an average of 918 mm per season. Potato yields differed substantially between farms, ranging from 60 to 93 t ha⁻¹, with average of 84 t ha⁻¹. Substantial drainage was collected from one field, while a chalky layer deeper in the profile probably limited drainage from other fields. Differences in potato tuber yields in spite of similar fertilizer and irrigation amounts resulted in substantial variability in nutrient and water use efficiencies between fields.

Conclusions

High potato yields were generally achieved, although substantial variability occurred between farms. All growers applied high levels of nutrients and water, which were not necessarily proportional to potato yields achieved. This suggests that other factors, such as soil conditions (especially drainage), management, pest and disease control probably played a role in the final yields, and therefore resource use efficiencies achieved.

Diverse management in conservation agriculture cropping systems improve weed management and sustain wheat yields whilst reducing inputs

Presenter: JA Strauss (johannst@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
C	MacLaren	Centre for Agroecology, Water & Resilience, Coventry University, Coventry, UK
J	Storkey	Rothamsted Research, Harpenden, UK
JA	Strauss	Department of Agriculture, Western Cape
P	Swanepoel	Department of Agronomy, University of Stellenbosch
K	Dehnen-Schmutz	Centre for Agroecology, Water & Resilience, Coventry University, Coventry, UK

Introduction

Intensive cropping systems based on monoculture production select for a low diversity of weeds which are resistant to chemical control, leading to persistent weed-crop competition, declining biodiversity, yield losses and increased input costs. Crop rotation can mitigate this by introducing variable filters on the weed community through increasing management diversity. In this study, we investigate the effect of increased diverse management in long term conservation agriculture systems.

Materials and Methods

An analyses of the weed seedbank composition, herbicide, fertiliser and yield data (over a 12 year period) from a trial utilising eight rotation systems with different crop sequence diversities, of which four included grazed forage phases was done to answer the research question on the effect of diverse management on conservation agriculture systems. Linear mixed models and ordination were used to assess how weed abundance, diversity, and community composition responded to management filters, defined in terms of levels of disturbance strength and diversity (grazing and herbicides), and resource availability and diversity (inorganic fertilisers, legumes, and manure). All analyses were undertaken in R version 3.4.3 (R Core Team, 2017), using the packages lme4, afex, lsmeans, effects and vegan. Prior to analyses, weed abundance was converted to the natural logarithm of the abundance plus one.

Results and Discussion

Grazed rotation systems had less herbicide applied than ungrazed rotation systems, and had the lowest weed abundance and highest weed diversity. Herbicides and grazing apply contrasting selection pressures on weeds, and this combination was more effective in reducing weed pressure than increasing herbicide quantity or mode- of-action diversity. Lower resource availability and higher nitrogen source diversity in grazed systems may have further reduced weed abundance and promoted diversity. Crop sequence diversity also reduced weed abundance and promoted weed diversity, indicating that variable crop-weed interactions can enhance weed management. In addition, yields in the main cash crop (wheat) were highest where crop diversity was highest, regardless of whether the system contained grazed phases.

Conclusions

Diverse rotation systems produced high yields, and the inclusion of grazed forage phases maintained these yields at lower applications of herbicides and fertilizers: integrated livestock can therefore improve the sustainability of no-till systems. The role of grazing as a filter imposing a contrasting selection pressure to other weed control options could be further explored to improve weed management in different farming systems.

High Density Sludge from Acid Mine Drainage Treatment as a Soil Amendment: Soil and Crop Response

Presenter: BH Sukati (bhsukati@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
BH	Sukati	X20, Hatfield, 0028, South Africa
PC	De Jager	X20, Hatfield, 0028, South Africa
JG	Annandal	X20, Hatfield, 0028, South Africa
PD	Tanner	X20, Hatfield, 0028, South Africa

Introduction

High density sludge (HDS) generated by Acid Mine Drainage (AMD) treatment has limited use as it is sometimes classified as hazardous due to its chemical composition. This material has the potential to be used in agriculture as it is dominated by gypsum (a source of S and Ca), followed by ferric hydroxide (a sequester of salts) and contains residual alkalinity. Hence, the objective was to assess crop and soil response when used as a soil amendment.

Materials and Methods

A greenhouse pot trial was used to consider the use of sludge dominated by gypsum and Fe (GypFe - pH 5.5) sourced from a treatment process using limestone (CaCO_3) alone and sludge dominated by gypsum (Gyp - pH 9.4) from a process using a combination of CaCO_3 plus lime ($\text{Ca}(\text{OH})_2$). The sludges were applied at 10 and 20 t ha^{-1} to an acid soil (pH 3.8) and P was added at 40 and 100 kg ha^{-1} . Nitrogen and K were applied at recommended rates. Controls included limed (pH 6.0) and unlimed soil. Maize was planted and grown to physiological maturity.

Results and Discussion

Sludges only increased soil pH marginally due to low residual alkalinity. GypFe and Gyp increased pH by 0.41 and 0.26 pH units when applied at the maximum rate, with P also at the highest level. Soil salinity (7.8 mS m^{-1}) was increased by both sludges, Gyp and GypFe increased it by 973 and 720 mS m^{-1} when applied at the maximum rate, but increasing P reduced salinity. The solubility of salts from sludges exceeded the sequestration capacity of ferric hydroxide, especially with GypFe. Crop response showed that applying either sludge had the potential to reduce germination due to metal toxicity, salinity and low soil pH. Plant height, above ground biomass and leaf area index (LAI) were increased by liming more than any other treatment but adding either sludge reduced these parameters. In terms of nutrient uptake, Ca, S, Fe, Mn including Pb concentrated mostly in leaves. But applying either sludge increased Ca and S concentration in other plant parts, but reduced Fe, Mn and Pb concentrations. Grain was only produced in treatments receiving P. Sludges contributed mostly to grain yield with Gyp and P applied at maximum exhibiting the highest grain yield (20.7 t ha^{-1}).

Conclusions

Both sludges showed marginal influence on soil pH increase, but significantly increased soil salinity. Sludges facilitated S and Ca uptake, retention of trace elements and contributed mostly to grain yield.

Chasing wheat yields in challenging environments

Presenter: SL Sydenham (Sydenhams@arc.agric.za)

Initial	Surname	Authors Company/Organisation and Postal Address
SL	Sydenham	ARC-Small Grain Institute, Private Bag X29, Bethlehem, 9700
A	Barnard	ARC-Small Grain Institute, Private Bag X29, Bethlehem, 9700

Introduction

Yield is one of the most complex traits of wheat that is controlled by multiple gene clusters that interact with one another and are significantly influenced by the environment. Several strategies have been proposed worldwide to increase wheat production. A number of reports have identified significant QTL/genes linked to various traits associated with various yield components. This project was accepted as an aligned contributing project (AP06) of the International Wheat Yield Partnership (IWYP) in 2017. With the aim of identifying germplasm with higher yielding genetic potential, by taking a holistic whole plant approach (from roots to kernels) while using targeted marker assisted selection for yield component related genes.

Materials and Methods

The favourable alleles of certain target yield component genes related to kernel size, kernel weight, grain number (GN) and overall contribution to better TKM, have been identified from literature. Initially, 35 different markers with known associations to 19 different spike-yield component genes were screened on a sub-set of cultivars and lines. The polymorphic markers were then genotyped on 209 germplasm entries selected from 20 different international nurseries. As a point of reference, the three ARC crossing blocks, namely, Western Cape, Irrigation, and Free State were also genotyped. Normal statistical and generic genetic analytical paths were followed.

Results and Discussion

The test panel, planted under the same supplementary irrigation conditions, out-yielded local ARC-Small Grain cultivar checks by between 30% and 50% within each nursery. The selected test entries yielded from 27% to 144% above the relevant nursery yield means. Seven yield component markers gave reliable data on all test entries. No strong correlations across all genotypes were observed between yields and the presence of different yield component genes. However, altered trends were observed in the different yield groups. Yield component genes, TaGS-D1, TaGS5-3A, Hap-6A, TACWI-4A and TaGW2-6B appear important. A complete favourable haplotype across these target genes is rear.

Conclusions

It appears there are obvious trade-offs between certain favourable alleles for the different yield component genes in certain genotypes. The preliminary data suggests different favourable alleles gene combinations will be prevalent/required in different wheat production areas. We hope the material identified in this project will assist with developing higher-yield wheat cultivars for the South African industry.

Group cohesion and member retention for enhanced production in agricultural community-based projects in Gauteng

Presenter: B Taruvinga (TaruvingaB@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
B	Taruvinga	Agricultural Research Council – Roodeplaat, Vegetable and Ornamental Plants (ARC- VOP), Private Bag X293, Pretoria 0001
P	Ndou	Agricultural Research Council – Roodeplaat, Vegetable and Ornamental Plants (ARC- VOP), Private Bag X293, Pretoria 0001
K	Mphafi	Agricultural Research Council – Roodeplaat, Vegetable and Ornamental Plants (ARC- VOP), Private Bag X293, Pretoria 0001
I N	Hlerema	Agricultural Research Council – Roodeplaat, Vegetable and Ornamental Plants (ARC- VOP), Private Bag X293, Pretoria 0001
R	Seturumane	Gauteng Department of Agriculture and Rural Development, P O Box 8769, Johannesburg, 2001

Introduction

Commercialization of smallholder and emerging farmers is receiving increasing support from the government in South Africa. Commercialization is advocated because it plays a vital role in minimizing poverty and food insecurity, and in enhancing food production and income generation, which boost the overall development of the agricultural sector (Department of Agriculture Forestry and Fisheries, 2010; Khapayi and Celliers, 2016). However, commercialisation of individual farmers has proven impractical in certain instances, due to an array of challenges that are faced by the farmers in both production and marketing (Khapayi and Celliers, 2016). In such cases, farmers are often encouraged to operate in cooperative organizations, which are also known as Community-Based Projects (CBPs). Although there are anticipated overall benefits from CBPs, a significant number of CBPs have failed to meet the intended objective of commercialization. This research investigated the factors that influence member commitment to their CBP and their willingness to remain part of the organization, and the impact of such on the functioning and performance of the organization.

Materials and Methods

A survey methodology was employed to collect primary data, where a semi-structured questionnaire was utilized for data collection. Twelve community-based projects were selected randomly from the list of projects obtained from the Gauteng Department of Agriculture and Rural Development, and all members belonging to the 12 CBPs were interviewed, giving a total of 92 respondents. The Perceived Cohesion Scale (PCS) and Hierarchical-regression analysis was used for analysing member commitment, willingness to belong to an organization and group cohesion in CBPs.

Results and Discussion

The results of the study indicated that there is a significant relationship between production performance of a CBP and the organization's ability to provide economic and social benefits, and to build and maintain trust and confidence amongst members. Furthermore, the results have revealed that trust among members in a CBP has positive effects on group cohesions. Thus, trust is able to instil a sense of belonging and commitment to perform economic activities. Members that were driven by trust were willing to nature the functionality of the cooperative organization, and remained part of the organization for longer periods. On contrary, members that were driven by economic benefits often exited the organization with the availability of other options offering better financial gains.

Conclusions

People join agricultural cooperative organizations to pursue different goals; therefore, group composition and performance has an effect on the sustainability of the organizations.

Effects of growth media on the growth of Mmupudu (*Mimusops zeyheri*) seedlings in the nursery

Presenter: AC Tautsagae (angwako@buan.ac.bw)

Initials	Surname	Authors Company/Organisation and Postal Address
AC	Tautsagae	BUAN P/Bag 0027, Gaborone, Botswana
VE	Emongor	BUAN P/Bag 0027, Gaborone, Botswana

Introduction

Mimusops zeyheri Sond belongs to the family Sapotaceae, commonly known as Transvaal red milkwood (Eng.); moepel (Afr.); mmupudu (Northern Sotho); umpushane (Zulu); nhlantswa (Tsonga); mubululu (Venda). *Mimusops zeyheri* is an indigenous fruit bearing tree native to Africa. Top-ranked for its edible fresh fruit qualities (Mashela and Mollel, 2001). *Mimusops zeyheri* grows in marginal areas such as rocky hillsides and kloof and riverine vegetation (Venter and Venter, 1996). It is widely distributed in Sub-Saharan Africa (SSA) though found in other parts of the globe. In SSA its distribution stretches from South-Eastern Botswana through northern South Africa, Swaziland, Zimbabwe, Mozambique and northwards to East Africa (Ledwaba, *et al.*, 2008). Soil type plays a major role in the productivity of *M. zeyheri* seedlings. Most environmental factors could have an effect on the morphology of the *M. zeyheri* (Maputla, 2002). It has been identified in South Africa, Botswana and Israel as having commercial potential due to its environmental adaptability and nutritional attributes. However, the domestication and commercialization of this multipurpose tree is limited by its slow growth. The objective of this study was to evaluate the effects of different growth media on the growth of *M. zeyheri* seedlings in the nursery.

Materials and Methods

The experiment was conducted at the Botswana University of Agriculture and Natural Resources Content Farm, situated at Notwane, Sebele, (24° 35' S: 25° 58' E) at an altitude of 998 m above sea level. The experimental site has an average maximum and minimum temperature varying between 33.1– 34.7°C and 19.2 – 19.5°C, respectively in summer. However, during the coldest months April and September the average maximum and minimum temperatures ranges between 26 -34°C and 7- 16°C, respectively. The soils are deep sandy loam. The rainfall amount varies between 250 - 600 mm per annum. A pot experiment was conducted in the net shade to determine the effect of different plant growing media on the growth and development of *Mimusops zeyherii* seedlings. The experimental design was completely randomized design with four replications. The treatments were four growing media including T1= sandy loam soil (100%), T2 = sand (100%), T3 = potting soil:vermiculite (1:1) and T4 = growing mix (100%). The various soil media plus 5 g of fertilizer (4:2: 1) was placed in black polythene bags (10 litre) and watered a day before planting to prevent growth media from hardening. One seed per bag was planted. Two months after emergence, the seedlings were transplanted into the same growth medium plus 5 g NPK fertilizer, but in 20 litre polythene bags. All the required cultural practices were carried out regularly throughout the growing season.

Results and Discussion

The results of the study showed that growth media significantly ($P<0.05$) influenced the growth of *M. zeyheri* seedlings. After nine months of growth, seedlings grown in vermiculite/potting soil (1:1) had significantly ($P<0.05$) higher plant height and leaf number than garden soil (sandy loam), sand and growth mix. Seedlings grown in garden soil had significantly ($P<0.05$) higher branch number than seedlings grown in sand, growth mix and vermiculite/potting growth media after nine months of growth. Soil type has been reported to significantly influence the productivity of crops, which may be direct through physical abrasion of soil particles on the root system and/or indirect through the influence of the soil on the availability of water and/or nutrient elements (Hartmann *et al.*, 1988; Mashela *et al.*, 1991). Sandy soils have been reported to reduce productivity of *M. zeyheri* seedlings, whereas loam and clay soils had no significant effect on different parameters (Ndhukula, 2006). Similarly, in a pot experiment conducted to observe the performance of *M. zeyheri* seedlings in three different soil types, it was observed that relative to loam, clay soil increased leaf growth by 19 to 20% and 9 to 58% at 9 and 12 months after transplanting, respectively (Mashela *et al.*, 2013). Relative to loam, sandy soil improved leaf and petiole growth by 10 to 88% and 21 to 49% at 9 to 12 months, after transplanting, respectively (Mashela *et al.*, 2013).

Conclusions

It was concluded that for nursery production of *M. Zeyheri* seedlings either vermiculite/potting soil or sandy loam soils could be used as growth media provided NPK fertilizer was incorporated.

Stomatal regulation of transpiration and photosynthesis in Macadamias

Presenter: NJ Taylor (nicolette.taylor@up.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NJ	Taylor	Department of Plant and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028
TG	Smit	Department of Plant and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028
SJE	Midgley	Department of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa
JG	Annandale	Department of Plant and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028

Introduction

Macadamia is an increasingly important crop in South Africa, with more than 25 000 ha planted, and further expansion taking place each year. Despite the importance of this crop, we still know very little about the ecophysiology and water use of this crop. This is critical to improve current management practices and for securing adequate water rights for this crop in a semi-arid country, which experiences regular droughts. It was as a result of this need that the Water Research Commission of South Africa solicited, funded and managed a project on macadamia water use.

Materials and Methods

Transpiration was determined in a 13 year old 'Beaumont' macadamia orchard 30 km west of Nelspruit using the heat ratio method, together with measurements of leaf gas exchange and stomatal conductance. Weather data was collected using a WS-GP1 Delta-T weather station which was located close to the experimental orchard. Leaf and stem water potential were measured using a Scholander pressure chamber from before sunrise to sunset on selected days. Hydraulic conductance was estimated from transpiration and water potential measurements.

Results and Discussion

Measurements indicate that macadamias exhibit typical isohydric behaviour, with stomata closing in response to high vapour pressure deficit (VPD) to prevent leaf water potential from dropping below critical levels. Despite initial reports, macadamias do not appear to have higher hydraulic conductance than most other fruit tree crops, which could explain stomatal closure in response to high VPD. This regulation does, however, seem to be dependent on phenological stage, with stomatal adjustment occurring particularly during the oil filling stage of nut development, when sink demand is high. Analysis of photosynthesis across different phenological stages, together with transpiration data, demonstrated a shift in water use strategy with changing sink strength.

Conclusions

Stomata regulate transpiration, and as a result photosynthesis, in macadamia, largely as a result of hydraulic limits within the stem to leaf pathway. The degree of control does, however, seem to be determined by crop load.

The role of conservation agriculture on soil hydraulic properties and carbon sequestration is soil and climate dependent

Presenter: EH Tesfamariam (eyob.tesfamariam@up.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
EH	Tesfamaria	University of Pretoria, Department of Plant and Soil Science, Hatfield 0002
PL	Simwaka	University of Pretoria, Department of Plant and Soil Science, Hatfield 0002
PW	Chirwa	University of Pretoria, Department of Plant and Soil Science, Hatfield 0002
AR	Ngwira	Chitedze Agricultural Research Station, Lilongwe, Malawi

Introduction

Conservation agriculture (CA) technologies are increasingly seen as a potentially effective strategy to address low agricultural productivity in SSA (Thierfelder *et al.*, 2015; Ngwira *et al.*, 2012) by restoring degraded lands (Holden *et al.*, 2018; Sithole *et al.*, 2016), enhancing infiltration and soil water retention (TerAvest *et al.*, 2018; Thierfelder *et al.*, 2013) and reducing soil erosion (Thierfelder *et al.*, 2012). A study was conducted to investigate the role of CA compared with Traditional tillage (TT, hand hoe) practice in improving C sequestration and selected soil hydraulic characteristics in two agro-ecologies (Low & Mid altitude) in Malawi.

Materials and Methods

The study was conducted on farmers' fields located in the low altitude (Chinguluwe, Zidyana, Lemu) and mid altitude (Chipeni) agro-ecologies. The areas of Chipeni, Lemu and Chinguluwe receive moderate amounts of annual rainfall (733-853 mm) while Zidyana site receive relatively higher rainfall (1360 mm). Three replicates of two CA treatments (Sole maize under CA (SMCA) and Maize-legume intercrop under CA (MLCA)) and a traditional tillage (TT) laid out in a randomised complete block design (RCBD) has been running across the study sites for the past decade (2005-2015).

Results and Discussion

More carbon was sequestered in dry sub humid areas (Chipeni and Lemu) receiving moderate rainfall than humid areas receiving higher rainfall (Zidyana) and characterized by higher percentage sand. However, under both scenarios CA sequestered significantly higher C than TT practice following 10 consecutive years of study in all agro-ecological zones. A large proportion of the sequestered carbon under both CA and TT was of the decomposable particulate organic matter fraction. However, CA contributed more to the build-up of the stable fraction of the POC, which is physically protected by the soil aggregates (POMP). This suggest that more C may be stored under CA than traditional tillage practices in the long term. Maize-legume intercropping under conservation agriculture also significantly reduced soil surface compaction and bulk density, while significantly improving soil porosity, pore size distribution, and soil plant available water compared to traditional tillage. Conservation agriculture contributed largely to an increase in the proportion of meso and micro pores of the total porosity.

Conclusions

Therefore, changing management practice from TT to CA has the potential to improve the soil quality across agro-ecological zones in Malawi.

Evaluation of terminal drought tolerance in selected cimmyt bread wheat (*Triticum aestivum* L.) genotypes

Presenter: ZG Thungo (thungozama@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
Z	Thungo	Crop Science Discipline, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
H	Shimelis	African Centre for Crop Improvement (ACCI), University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
A	Odindo	Crop Science Discipline, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
J	Mashilo	Crop Science Discipline, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Introduction

Terminal drought is primarily a constraint in the global productivity of bread wheat (*Triticum aestivum* L.). The aim of this study was to evaluate drought tolerance among a selected lines of bread wheat using agronomic yield traits, yield-based drought tolerance indices and physiological crop yield traits.

Materials and Methods

The drought tolerance of 28 CIMMYT lines of bread wheat were evaluated in greenhouse and shade-house environments under terminal drought (TDT) and well-watered (WWT) conditions. The experiment was conducted at the University of KwaZulu-Natal's Controlled Environment Facility (CEF) from late December to May 2016/17 cropping. Agronomic and physiological crop adaptability to drought was investigated using plant number of spike (NS), spike weight (SW), grain yield (GY), thousand kernel weight (TKW), leaf canopy temperature (LCT), chlorophyll content index (CCI) and stomatal conductance (SC) yield traits. Drought tolerance indices were computed using grain yield under optimal (Yp) and stressed (Ys) and their associations with GY observed.

Results and Discussion

GY correlated positively with TKW, CCI, NS and SW under TDT conditions. Also, positive significant associations were discovered for Ys with YSI and STI under shade-house environments and HM, MP, and GMP under greenhouse. Following principal component (PC) analysis, two important PCs explained the variations observed in the responses of studied traits under TDT with 73.54% cumulative variance explained. Three influential PCs were discovered under the WWT, with a cumulative variance of 85.61%. Two influential PCs which accounted for 97.19% cumulative variance explained the variation observed in the responses of studied drought indices under greenhouse environments. Two influential PCs were discovered under shade-house environments and accounted for a cumulative variance of 95.22%.

Conclusions

The study established significant levels of yield adaptabilities to drought among the evaluated genetic materials. Genotypes LM40, LM70, LM72, LM88, LM61, LM95, LM44, LM02, LM32, LM72, LM95, LM22, LM100, LM13 and LM55 shared high stressed yields.

Evaluating dormancy management practises and different planting methods for containerised apple (*Malus domestica* Borkh.) nursery trees.

Presenter: WvH Truter (16705211@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
WvH	Truter	Department of Horticulture, University of Stellenbosch, C/O Neethling and Victoria Street, Stellenbosch, 7600
KI	Theron	Department of Horticulture, University of Stellenbosch, C/O Neethling and Victoria Street, Stellenbosch, 7600
WJ	Steyn	Hortgro Science, Welgevallen Experimental Farm, Stellenbosch, P.O. Box 12789, Die Boord, 7613

Introduction

One of the main challenges in South Africa is growing apples under conditions of insufficient winter chilling, characterised by reduced bud break (Cook, 2010). When nursery trees are planted in the orchard, uniform bud break is essential (Petri and Stuker, 1988). The successful establishment of a new orchard, is often further delayed by a period of slow growth (Struve, 1990). The purpose of this study was to evaluate the effect of dormancy management practises as well as different planting methods on spring bud break and new growth during the first growing season of containerised apple nursery trees.

Materials and Methods

Trials were conducted on one-year-old containerised 'Golden Delicious'/M.9 nursery trees planted in a commercial orchard in the Elgin, Western Cape region. Dormancy management practises included a period of six weeks cold storage at 0 - 4°C compared to a 1.5% hydrogen cyanamide chemical rest breaking treatment or a combination of the cold storage period with the chemical rest breaking treatment. The effect of different planting methods, viz. (1) planting the trees while trying to not disturb the planting medium at all, (2) washing off the planting medium before planting, (3) loosening the planting medium in the root zone before planting and (4) shaking off and removing most of the planting medium with minimal damage to the roots, was evaluated. Both trials were randomized complete block designs with ten single tree replications. The following data were recorded per tree: (1) increase in trunk diameter, (2) apical extension growth, (3) percentage– and rate of total bud break, (4) percentage– and rate of vegetative bud break, (5) percentage reproductive bud break and (6) total new growth of lateral shoots.

Results and Discussion

Dormancy management practises significantly increased the bud break percentage in spring, with a combination of cold storage and the chemical rest breaking treatment the most effective. However, the different dormancy management practises did not significantly increase the total new growth, but improved the tree architecture. Different planting methods did not significantly influence total bud break in spring. However, planting trees with an undisturbed growing medium, or only slightly loosening the growing medium improved new lateral shoot growth and apical extension growth.

Conclusions

Cold storage and chemical rest breaking should be combined to increase the bud break percentage when establishing a new orchard in a region with insufficient chilling. In addition, containerised nursery trees should be carefully handled during transplanting in order to optimise growth during the first growing season.

Non-phytotoxic concentration of Nemarioc-AG and Nemafric-BG phytonematicides on carrot cultivar 'Cape market'

Presenter: TM Tshehla (iniestagertiouz@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TM	Tshehla	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
KG	Shadung	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
PW	Mashela	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa

Introduction

Nemarioc-AG and Nemafric-BG phytonematicides have been researched and developed, with the major challenge being phytotoxicity and with inconsistent results in nematode suppression (Mashela *et al.*, 2015). The Curve-fitting Allelochemical Response Dosage (CARD) computer based model was adopted to compute the Mean Concentration Stimulation Point (MCSP), which is the concentration that would not induce phytotoxicity, while suppressing population densities of nematodes and overall sensitivity (Σk) values which is plant specific (Liu *et al.*, 2003). Therefore, the objective of this study was to determine the MCSP values of Nemafric-BG and Nemarioc-AG phytonematicides and the overall sensitivities (Σk) of carrot cultivar 'Cape market'.

Materials and Methods

Seeds were sown directly into 30-cm plastic pots which was placed at spacing of 0.6 m \times 0.6 m inter and intra- row. Experiment was laid out in a randomized complete block design (RCBD), with 7 treatments (0, 2, 4, 6, 8, 10 and 12 g), replicated 12 times. Treatments were applied once, two weeks after germination. At 56 days after initiation of treatments, plant variables data (plant height, root length, stem diameter, dry root mass and dry shoot mass) was collected, processed and subjected to CARD computer based model.

Results and Discussion

Nemafric-BG phytonematicide exhibited quadratic relations for dry root mass, dry shoot mass, root length, plant height and stem diameter with the model explaining, 74, 94, 53, 66 and 96% coefficients of determination respectively. Similarly, Nemarioc-AG phytonematicide exhibited quadratic relations on dry root mass, plant height, root length and stem diameter with the model being explained by 93, 76, 90 and 79% coefficients of determination suggesting strong density-dependent relationship between test crop and phytonematicides. Nemafric-BG and Nemarioc-AG phytonematicides had MCSP values of 2.5 and 1.5 g respectively, whereas the Σk values were 40 and 47 units, respectively.

Conclusions

Phytonematicides stimulated plant growth at lower concentrations, whilst inhibiting plant growth at higher concentrations. Furthermore, MCSP values of the phytonematicides were 2.5 to 1.5 g, which are within the accepted values that would not be detrimental to other microorganisms and not induces phytotoxicity, however, with a wide range of overall sensitivity of phytonematicides suggesting that the carrot was tolerant to the phytonematicides.

Variance components of fruit quality – a ‘Golden Delicious’ case study

Presenter: A van Lingen (esmelouw@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Van Lingen	Dept of Horticultural Science, Stellenbosch University, Stellenbosch
WJ	Steyn	Hortgro Science, Welgevallen Experimental farm, Stellenbosch
ED	Louw	Dept of Horticultural Science, Stellenbosch University, Stellenbosch

Introduction

Fruit maturity and fruit quality are important horticultural parameters that are of commercial value and demanded by the consumer. The identification and magnitude of the factors contributing to fruit-to-fruit variability in maturity and quality are not always known to the producer and this missing information may complicate decision making and optimisation of pre-and postharvest practises. 'Golden Delicious' is a commercially important apple cultivar in South Africa making up 24% of the total apple production areas.

Materials and Methods

To analyse the variability in fruit maturity and quality, 14 'Golden Delicious' apple orchards were selected in each of two climatic contrasting areas (Elgin (warm winter area) and Koue Bokkeveld (cold winter area)) and five variables (starch conversion, firmness at harvest, firmness after storage, peel colour lightness at harvest and lightness after storage) were measured on all the fruit from two scaffold branches (top and bottom of the tree). The variance in the data was assigned to seven different components (region, orchard, tree, vertical position in the tree, light exposure and bearing wood). Variance that could not be assigned was pooled as "not explained". Effects, interactions and correlations were calculated among the variables and components.

Results and Discussion

Orchard difference was the biggest contributor of variability in all the variables, especially starch conversion, where it was found that the actual starch levels of the fruit at harvest were very different from the mean level calculated to predict harvest release date. Firmness variability was not well described by the components and correlated poorly with starch levels at harvest. Results from both peel lightness (lightness value) and starch conversion at harvest suggested that producers in the Koue Bokkeveld region would benefit from segregating the top and bottom fruit at harvest while Elgin producers can sort starch conversion by segregating sun exposed and shaded fruit. It was also found that lightness at harvest correlates well with lightness after storage but poorly with firmness suggesting that postharvest lightness sorting should result in homogenous lightness batches after storage but the firmness will be variable

Conclusions

Understanding the magnitude of different pre-harvest aspects towards the variability in fruit maturity and quality gives direction to the development of pre- and postharvest horticultural practices that can lead to increased Class 1 pack outs and uniformity in fruit quality post storage.

Amount of monoammonium phosphate needed to increase extractable soil P in alkaline and calcareous sandy soils

Presenter: AE Venter (andrieventer22@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AE	Venter	Douglas, 8730
CC	Du Preez	P.O. Box 339, Bloemfontein 9300, South Africa

Introduction

Soluble P in soil is subject to fixation in either low or high pH soils. A variety of soil properties contributes to this process, for example clay mineralogy, organic matter, sesquioxides and carbonates. Arid and semi-arid areas such as in the Northern Cape and South Western parts of the Free State in South Africa, which are high in carbonates require proper P fertilisation and the correct chemical P extraction method to ensure sustainable crop production. The objective of the study was therefore to establish the amount of monoammonium phosphate needed to increase extractable P in the upper Orange River catchment soils with different Ca and P contents.

Materials and Methods

Soil samples from the orthic A horizon were collected at six sampling sites in the upper Orange River water management area below the Vanderkloof dam in the southwestern parts of the Free State, and eastern parts of the Northern Cape. These samples were dried and sieved before conducting a two-month laboratory incubation study at room temperature, where they were treated with seven levels of monoammonium phosphate. The P in the soil samples was extracted with the Olsen, Bray 1, Mehlich 3 and Ambic 1 methods for colorimetric determination. Simple regression analyses were also done to meet the objective of the study. The six sites can be categorised as low calcareous (<0.7% calcium carbonate) with low to high P contents (8.9 to 24 mg kg⁻¹ Olsen P) and as high calcareous (>3.3% calcium carbonate) with low to high P contents (2.4 to 42 mg kg⁻¹ Olsen P).

Results and Discussion

The phosphorus requirement factors (PRF) estimated from regression equations varied significantly between the four extraction methods. For instance the Bray 1 method showed unrealistic PRFs of 1.8 to 384.6 kg P ha⁻¹. By contrast, the variation of the PRFs for the Mehlich 3 method was very small (0.9 to 2.1 kg P ha⁻¹). The PRFs of the Olsen method (4.6 to 6.1 kg P ha⁻¹) and Ambic 1 method (1.7 to 4.3 kg P ha⁻¹) were more in line with other studies. This study proved that the mineralogical, physical and chemical properties of a soil ultimately prescribed which method is the most suitable to extract P for reliable P recommendations.

Conclusions

Based on these estimated PRFs seems the Olsen method to be the most reliable to determine the amount of monoammonium phosphate needed for increasing extractable P in either non-calcareous or calcareous soils to the required optimal levels.

Effectiveness of conservation tillage to minimize greenhouse gas emissions and its impact on microbial activity, C & P sequestration in comparison with conventional tillage

Presenter: BS Vilakazi (vilakazib1@gmail.com)

Initial	Surname	Authors Company/Organisation and Postal Address
BS	Vilakazi	Cabris Rd, Scotsville, 3209
R	Zengeni	Cabris Rd, Scotsville,3209
P	Mafongoya	Cabris Rd, Scotsville,3209

Introduction

Adopting zero tillage results in changes in soil organic matter content, soil organic C, aggregate stability, decomposition rate and microbial activities when compared to conventional tillage. No-till (NT) is a practice which may increase or maintain SOM and associated nutrients. Conventional tillage (CT) exposes soil organic matter to microbial attack, causing its mineralisation and releasing high quantities of plant available nutrients. Therefore ploughing of the soil has a great effect on the physio-chemical characteristics of the soil and biological processes of the soil. The aim of this study is to assess the effectiveness of zero tillage to minimise GHG emissions and its impact on microbial activity, C & P sequestration compared with conventional tillage.

Materials and Methods

The research was conducted on conventional tillage done yearly (CT 1), conventional tillage after every 5 years (CT 5) and No-till (NT), with fertiliser application rate of 0, 60, 120 and 240 kg N ha⁻¹. Samples were collected at soil depth 0-10, 10 -20 and ≥20 cm. The activities of various soil enzymes were based on the release and quantitative determination of the product in the reaction mixture when soil samples were incubated with their respective substrate and buffer solutions. The invertase enzyme was determined as described by Frankenberger and Johanson (1983). Whereas urease was determined using the method of Frankenberger and Tabatabai (1980). N mineralisation was measured by incubating soil samples as described by Keeney, 1982. Total carbon and nitrogen, organic carbon, particulate organic carbon (POC), potassium permanganate oxidizable carbon (POXC), and microbial biomass carbon (MBC) were also analysed.

Results and Discussion

N mineralisation was higher under NT treatment with depth 0-10 cm having significant higher ($P < 0.05$) mineralisation than other depth on NT. However lower depth of CT had higher mineralisation compared to NT. All the enzymes were higher under NT, 0-10 cm, compared to CT, however the trend did not decrease with depth. NT 10-20 cm had lower enzymes activities compared to 20-30 cm. this is attributed to higher organic matter and organic substrate on the 0-10 cm under NT treatment compared to CT.

Conclusions

Microbial activities, N mineralization and C pools are sensitive to management systems. Depth is also a contributing factor because these carbon pools and microbial activities are mainly influenced by the presence of organic matter. NT is associated with increased stratified organic matter as compared to other tillage systems.

Evaluation of row width and plant population for conservation agriculture maize and soybean in the Eastern Free State

Presenter: MH Visser (visserl@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MH	Visser	1ARC-Small Grain, Private Bag X29, Bethlehem, 9700
JP	Van Zyl	2 VKB, Staatspresident CR Swart St, Reitz, 9810
WH	Kilian	1ARC-Small Grain, Private Bag X29, Bethlehem, 9700
HJ	Smith	3Grain South Africa, Alenti Office Park Block C, 457 Whiterite Road, The Willows,

Introduction

Grain SA, in collaboration with the Riemland Study Group, VKB and ARC-Small Grain, is involved in on-farm trails to promote Conservation Agriculture (CA) in the eastern Free State. Studies in other provinces indicated row width and plant population changes for CA practices. The aim of this study was to evaluate the effect of row width and plant population on maize and soybean yields under dry land CA in the eastern Free State.

Materials and Methods

The study was conducted on the farm VanRooyenwoning, in the Reitz district (eastern Free State) where no-tillage and crop rotation were applied as CA practices under dry land. Three trials were planted annually from 2014 to 2017. These trials were laid out as a randomised complete block design with a factorial combination. Treatments consisted of two main factors: row width viz. 0.5, 0.76 and 1.0 m and plant population viz. 40 000, 60 000 and 80 000 plants ha⁻¹ for maize and 150 000, 250 000, 350 000 and 450 000 plants ha⁻¹ for soybean. Crops were rotated annually between the two blocks.

Results and Discussion

Maize yields indicated that the yield of the 40 000 plant population (5.30 t ha⁻¹) was significantly lower than the yield of 60 000 (6.54 t ha⁻¹) and 80 000 (6.70 t ha⁻¹) plant populations. However, the yield of the last two plant populations did not differ significantly. The 0.5 m row widths produced a significantly higher yield (6.76 t ha⁻¹), than the 0.76 m (5.82 t ha⁻¹) and 1.0 m (5.96 t ha⁻¹) rows for maize. Only two seasons' data were recorded for soybean. Plant population had no significant effect on the yield, which varied between 2.47 t ha⁻¹ and 2.79 t ha⁻¹. The 3.10 t ha⁻¹ yield obtained from 0.5 m rows was significantly higher than the 2.46 t ha⁻¹ and 2.31 t ha⁻¹ recorded on the 0.76 m and 1.0 m row widths, respectively.

Conclusions

Results confirmed that 0.50 m row widths in CA systems produced significantly higher maize and soybean yields than 0.76 and 1.00 m row widths. Although the maize yield was the highest at 80 000 plants ha⁻¹, it did not differ significantly from the 60 000 plants ha⁻¹ population. Therefore, it can be concluded that a combination of 0.50 m row width and 60 000 plants ha⁻¹ will be a viable option for maize CA producers in the eastern Free State.

Development of knowledge engines for use as advisories

Presenter: S Walker (walkers@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Walker	P/Bag X79, Pretoria, 0001
LC	Kaempffer	P/Bag X79, Pretoria, 0001
E	Van der Walt	P/Bag X134, Queenswood, Pretoria, 0121

Introduction

There are many agricultural scientific research results that remain in theses and published articles. Scientists need to also take the next step to formulate these results into a technical transfer message that can be used in farm decision making. An example is the use of weather and climate information to frame crop advisories for summer rainfall regions of South Africa.

Materials and Methods

Stakeholder meetings were used to identify critical gaps in weather-related information needed by farmers for operational decision making. Researchers were engaged to brainstorm available information that can provide answers to the farmers' questions. Decision trees were developed for critical questions including sources of additional information. Algorithms were developed from scientific results to provide solutions using both historical climate data and dynamic weather forecasts. Responses were formulated to deliver messages to farmers via digital technology.

Results and Discussion

Small-scale farmers in several provinces requested further information about the selection of planting dates for summer rain-fed crops, including maize. Available information about the effect of rainfall on planting dates of maize across southern Africa showed that 25 mm rainfall was critical. However, in different agro-ecological zones, the rule of thumb uses a different time period, ranging from 3-15 days. Maps were prepared to show the maize growing areas across South Africa. However, the final solution allows maize to be grown anywhere in South Africa in order to accommodate home gardeners and subsistence growers. The algorithms were written using NOAA rainfall grids and ECMWF 10-day weather forecasts. The message is presented in the form of a calendar with green and red squares, indicating time to plant or not plant. Similarly, scientific information about the effect of weather conditions on the spraying of herbicides and insecticides showed that the maximum temperature and minimum humidity and wind speed are critical factors. These were written into an algorithm using the SAWS 3-day weather forecast at hourly intervals as input data. The critical times when to spray are then shown in green on a chart at 6-hourly intervals for the upcoming 3 days for the specific location. The times to avoid spraying are shown as red blocks.

Conclusions

Many of the available agricultural scientific results can be formulated into algorithms to provide early warning using weather forecasts and then communicated to farmers in a diagrammatic style.

The medium-term effects of tillage reduction on the functions describing the vertical distribution of soil organic carbon in maize production systems on Oxisols

Presenter: LD Wiese (liesl.wiese76@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LD	Wiese	Department of Soil Science, Stellenbosch University, Private Bag X1, Matieland, 7602, Western Cape, South Africa
M	Esmeraldo	Department of Soil Science, Stellenbosch University, Private Bag X1, Matieland, 7602, Western Cape, South Africa
AB	Rozanov	Department of Soil Science, Stellenbosch University, Private Bag X1, Matieland, 7602, Western Cape, South Africa

Introduction

Tillage significantly affects vertical soil stratification. The models of vertical distribution describing soils under natural conditions may not adequately describe the behaviour of soil organic carbon (SOC) in agricultural fields. It was previously shown for various soil types that under grasslands and forests the vertical SOC distribution can be successfully modelled by an exponential function. The changes in vertical SOC distribution pattern under different cultivation systems were not quantified so far.

Materials and Methods

We studied the effects of tillage practices for maize cultivation on vertical SOC distribution functions. The objective was to find the best possible continuous functions describing the vertical distribution of SOC under different intensities of cultivation, so that a single surface sample would be sufficient to estimate the stocks for any depth interval down to one meter. We hypothesise that sufficiently robust vertical distribution models may be developed from a small (<10) number of profile observations with frequent depth sampling increments per established land use system practiced at the specific location for a period longer than ten years (stable in medium-term). Thirty-two sites were sampled and studied; 8 no tillage (NT) sites, 8 reduced tillage (RT) sites, 8 conventional tillage (CT) sites and 8 grasslands (GL) sites. Normalized values of SOC stocks were averaged per sampling depth (5 cm) for all eight profiles representing one land use system and plotted against sampling depth. The depth distributions of average normalized SOC stocks were described by best fitting functions.

Results and Discussion

The no-till system preserved the expected exponential decline pattern of SOC stock distribution observed under indigenous grasslands ($R^2=0.99$ and $R^2=0.96$ respectively). The vertical SOC distributions in the reduced and conventional tillage fields are described by piecewise, though still continuous functions: the systems of equations, where the distribution within the cultivated layer is a linear decline (reduced tillage – $R^2=0.98$) or a constant value (conventional tillage – $R^2=0.13$). The section of the profile below the cultivated layer follows the common exponential decline curve with parameters similar to no-till for both reduced and conventional tillage ($R^2=0.99$ and $R^2=0.96$) respectively.

Conclusions

A small number (<10) of individual soil profile observations per land use (in this case 8) to a depth of one meter is sufficient to develop a robust model of average vertical normalized SOC distribution for stable land use system practiced for more than 10 years.

The effects of rehabilitation methods as a function of topsoil thickness on soil chemical and physical properties under a grass mixture

Presenter: LD Wiese (liesl.wiese1976@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LD	Wiese	Department of Soil Science, Stellenbosch University, P/Bag X1, Matieland
DJ	Beukes	Emmarentia Street, Meyerspark 0184
MV	Kidson	ARC-SCW, P/Bag X79, Pretoria 0001

Introduction

Current high levels of open cast coal mining are putting agriculture and the environment at high risk. Rehabilitated soils are prone to soil acidity, low soil fertility and microbial activity, lack of organic material, compaction and the breakdown of structural stability. The ARC–Soil, Climate and Water (ARC-SCW) was contracted by Agron (Pty) Ltd, in collaboration with Fraser Alexander (Pty) Ltd, to evaluate various rehabilitation methods as a function of topsoil thickness on soil chemical, biological and physical properties, as well as on the composition, growth and yield of a grass mixture over 2 years.

Materials and Methods

A strip plot design field trial was laid out in November 2014 consisting of four topsoil (TSs) thicknesses (0, 70, 150, 300 mm) and seven rehabilitation methods (RMs), including a control, at the Mimosa Coal mine site outside Carolina. The test crop was a grass species mixture. Depending on the soil property, frequency of chemical, physical and microbiological measurements ranged from continuous to once a year to once-off for the 0 and 300 mm TS layers, respectively. Grass biomass production was determined annually. Standard analytical and statistical procedures were used for sample analysis and data processing.

Results and Discussion

Soil pH (KCl) varied as a function of both RM and TS with lower values in the 2nd season. Relatively low soil nutrient status was measured, reflecting the amounts applied with a specific rehabilitation method. Both RM and TS had marked effects on temporal soil water content (SWC), showing drier profiles under the highest RM application and deeper topsoil. Cumulative infiltration was significantly affected by TS with the 0 mm TS at the lowest value. Penetrometer resistance showed shallower onset of severe soil compaction for the 0 mm TS compared to the 300 mm TS. Soil temperatures were higher in a 0 mm TS than in a 300 mm TS. Both RM and TS significantly affected biomass production.

Conclusions

Compared to the control, both RM and TS affected soil chemical properties. Temporal SWC was lower under the highest RM application and deeper TS, reflecting higher grass water uptake. A 0 mm TS had the lowest infiltration and the highest soil compaction. Topsoil thickness affected the soil temperature regime. The highest RM application and a 300 mm TS resulted in the best biomass production. A recommended RM will depend on its cost, grass yield and water use efficiency, while implementing a 300 mm TS layer.

ABSTRACTS
POSTER PRESENTATIONS

HORTICULTURAL SCIENCE

LISTED ALPHABETICALLY

1) On-farm demonstration trials to test different planting techniques and weevil management strategies

Presenter: IN Hlerema (Hleremal@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
IN	Hlerema	ARC-VOP, Private Bag X293, Pretoria
SM	Laurie	ARC-VOP, Private Bag X293, Pretoria
B	Eiasu	University of Fort Hare, Private Bag X1413, Alice

Introduction

Experiments were conducted at the research farm at the Vegetable and Ornamental Plant Institute at Roodeplaat to determine the effect of different planting techniques on sweet potato production and to test a biological control agent against sweet potato weevil. Both these experiment were done under researcher- managed conditions with optimum inputs provided. The objective of this study was to determine if the same results that were obtained at the research station would be obtained on farm under farmer-managed conditions in the Eastern Cape.

Materials and Methods

The experiment to determine planting techniques was done at Zikhovha Village in Chalumna while the experiment to test the biological control was done at Idutywa. For planting techniques, two factors were tested in this experiment, that is cutting orientation and number of nodes underground. The experiment was a 2X3 factorial laid out in randomised complete block design with 3 replicates. The planting techniques tested were horizontal and vertical planting of the cuttings with 2, 3 and 4 subterranean nodes underground. For the weevil control experiment, three treatments were tested namely: 1) sprays with registered chemical Deltametrin at 50 ml 100 litre⁻¹ (recommended dosage) every 2 weeks for four months after planting, 2) spraying the leaves every 2 weeks with *B. bassiana* for four months after planting at a rate of 10 g 100 litre⁻¹ water; and 3) control (sprayed with distilled water). The experimental design was a Randomised complete block design with three blocks with the blocking factor being the treatment. The cuttings were planted on ridges 30 cm high and 1 m apart and 30 cm between cuttings. Each plot consisted of 3 rows of 3 m length planted with 30 cuttings, of which the middle row was be used as data plants.

Results and Discussion

The results reveal that there was significant differences ($P < 0.05$) in total root yield between the six treatments tested with the horizontal planting orientation with four node underground having the highest total root yield and number of roots. In the horizontal technique it was found that as the number of nodes underground increased, so did the root yield and number of roots. For the weevil, management experiment the biological control was not significantly different from the registered chemical control.

Conclusions

There is need to test technologies that would be tested at research center in farmers' fields to exactly determine which technology is best for the farmers condition.

2) Passion fruit breeding

Presenter: J Husselman (johanh@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
JH	Husselman	ARC-Tropical and Subtropical Crops, Addo Research Station, P.O. Box 52, Addo 6105,
S	Lingervelder	ARC-Tropical and Subtropical Crops, Addo Research Station, P.O. Box 52, Addo 6105,
NK	Combrink	ARC-Tropical and Subtropical Crops, Addo Research Station, P.O. Box 52, Addo 6105,
Z	Bijzet	1ARC-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, South Africa
AD	Sippel	1ARC-Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200, South Africa

Introduction

Passion fruit (*Passiflora edulis*) is a climber native to South America. In South Africa production is primarily in Mpumalanga and Limpopo provinces, with minor plantings in KwaZulu-Natal and the Eastern and Western Cape. Nineteen countries export fresh passion fruit to the EU and the main producers for pulp are Brazil and Ecuador. The South African industry relies mainly on one cultivar namely 'Ester' which is a hybrid between the purple (*Passiflora edulis f edulis*) and yellow granadilla (*Passiflora edulis f flavicarpa*). A dynamic environment is created through the development of new cultivars. It shapes the industry and ensures that producers remain competitive. The ARC-TSC started a breeding programme in 1996 to develop improved cultivars to secure a future for the industry in the international market. The programme uses conventional and mutation breeding methods. The breeding programme aims to develop cultivars with improved horticultural traits as well as cultivars with resistance to pests and diseases.

Materials and Methods

The most promising parents were selected over five generations through successive breeding populations in a conventional breeding system. *P. edulis* were mainly used but other *Passiflora* species with tolerance to pests and diseases were also utilized. Selected material with good horticultural characteristics, but without tolerance were crossed with material with resistance. The progeny were evaluated for quality characteristics, which include internal pulp colour external skin colour, fruit size and weight, percentage pulp, Total Soluble Sugars (TSS) and Titratable Acids (TA).

Results and Discussion

Several selections have been identified with improved characteristics compared to the industry standard Ester variety. Selections with improved characteristics include S7 with large fruit size, attractive external colour, and high sugar content with a low acid which makes it pleasant to eat. Selection H10 has fruit similar in size to 'Ester', aromatic pulp and a high yield. K20 and D10 has very large fruit selected for processing. The selections have dark orange pulp with high acid and pulp content.

Conclusions

The ARC-ITSC will release new varieties to the passion fruit industry as soon as Plant Breeders Rights have been awarded.

3) Post treatment disposal effects on the microbial quality of treated wastewater used for irrigation in a semi-arid area

Presenter: PM Kgopa (pholosho.kgopa@ul.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PM	Kgopa	University of Limpopo, Private Bag X 1106 Sovenga 0727
A	Manyevere	University of Fort Hare, Private Bag X 1314, King William's Town Rd, Alice 5700
PW	Mashela	University of Limpopo, Private Bag X 1106 Sovenga 0727

Introduction

The use of treated wastewater has been adopted at University of Limpopo Experimental Farm (ULEF) to challenge water scarcity. However, treated wastewater is associated with health risks due to possibility of presence of pathogens (Al-Lahham *et al*, 2003). The current study investigated the distribution of microbial populations and diversity in treated wastewater used for irrigation, from different stages of post treatment disposal at Mankweng Wastewater Treatment Plant (MWWTP).

Materials and Methods

The study comprised of two factors: four sampling points (pond 16, night dam entry, night dam exit and borehole) and five months (July 2016 to November 2016), arranged as a 4 × 5 factorial experiment. Borehole water was used as a reference point. For bacteria, once a month, water samples were collected for isolation of *Salmonella* spp., *Shigella* spp., *E. coli*, *Vibrio* spp. and *Fecal coliform* using selective media. Sample dilutions at 10⁵ were filtered through 0.45 µm Whatman micro-filter using a water filtering manifold system, incubated and quantified for colony forming units (CFU). For helminths and protozoa, once a month, water samples were collected for detection and quantification of *Entamoeba histolytica*, *Schistosoma mansoni* and *Ascaris lumbricoides* at the Water Microbiology Laboratory, CSIR Pretoria, following methods by Feachem *et al.* (1983). All data were transformed and subjected to factorial analysis of variance.

Results and Discussion

The collection point × time interaction was significant on *Salmonella* spp. and *A. lumbricoides*. However, collection point was highly significant on all microbial variables. *Escherichia coli* was observed to be present in all collection points and were higher than recommended standards by the WHO. However, in borehole water, *E. coli* was observed to be in low amounts. Collection point had highly significant effects on the *Vibrio* species. Relative to borehole, the night-dam exit, night-dam entry and Pond 16 increased *V. cholera*. There was no presence of *V. aginolytica* in the borehole water. *Ascaris lumbricoides* counts were higher in the night-dam entry and Pond 16 in different months of sampling, which indicated that the pathogen decreased with storage post treatment. Also, the counts increased with months, which could be indicating that *A. lumbricoides* multiply better in warmer temperatures. Generally, Pond 16 had high mean counts of the studied organisms.

Conclusions

In conclusion, storage of water in the night dam post treatment at MWWTP was able to improve the microbial quality of the treated wastewater disposed for irrigation at ULEF, as more counts were observed in Pond 16 which is the exit pond at the treatment plant.

4) Recovery response mechanism of hail damaged rose geranium (*Pelargonium graveolens* L.) plant using foliar application of gibberellic acid and cytokinin

Presenter: ZP Khetsha (zkhetsha@cut.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
ZP	Khetsha	Department of Agriculture, Faculty of Health and Environmental Sciences Central University of Technology, Free State (CUT) Private Bag X20539, Bloemfontein, 9300, South Africa
MM	Sedibe	Department of Agriculture, Faculty of Health and Environmental Sciences Central University of Technology, Free State (CUT) Private Bag X20539, Bloemfontein, 9300, South Africa
RJ	Pretorius	Department of Agriculture, Faculty of Health and Environmental Sciences Central University of Technology, Free State (CUT) Private Bag X20539, Bloemfontein, 9300, South Africa

Introduction

Hail has been identified as one of the natural hazards that causes yield loss in crops. Extreme cases on hail climatology of hailstorm events have been reported in South Africa. Furthermore, in South Africa, essential oil plants are not covered under any agricultural crop insurance cover options, and farmers can usually not afford the use of costly alternative mitigating strategies, due to production area size. Yield loss on herbaceous plants damaged by hail is mainly caused by reduced leaf area and plants stand. Furthermore, on potatoes, Bereford (1967) and Irigoyen *et al.* (2011) simulated hail by defoliation. Rose geranium has no definite number of leaves and stems and suitable hail simulation should be through defoliation. The use of phytohormones as an alternative biological mitigating strategy against hail damaged essential oil crops has not received much attention in South Africa. The aim of this study was to recover hail damaged rose geranium plants using synergised combination of cytokinin (CK) and gibberellic acid (GA₃).

Materials and Methods

This study was conducted under a 30% hail net tunnel. The experiment contained a split-plot treatment design laid-out in a randomized complete block design. The main-plot treatments contained three hail-simulations (HS: 0, 50 and 100% defoliation); the sub-plot treatment contained three different synergised combinations of phytohormones (CK0GA0; CK50GA50 and CK100GA100). Herbage yield parameters were analysed to determine the recovery response mechanisms after hail simulation during the 2016/17 season. Tukey's t-test was used to determine significant difference between the means.

Results and Discussion

Results for 2016/17 production season showed that the significant interaction between HS100 and CK100GA100; HS50 and CK100GA100 improved the leaf area index parameter. Plant height was improved by the significant interaction between HS0 and CK100GA100. Moreover, chlorophyll content parameter was better improved where there was a significant interactions between HS0 and CK0GA0; HS100 and CK100GA100.

Conclusions

In conclusion, it is evident where plants experienced 100% hail simulated damage, the foliar application of CK100GA100 rapidly improves the recovery of rose geranium plants.

5) Growth response of *Dendranthema x Grandiflorum* to different growth media

Presenter: KG Koopa (koopakg@unisa.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
KG	Koopa	University of South Africa, Private Bag X6, Florida, 1710
EM	Van Staden	University of South Africa, Private Bag X6, Florida, 1710
RM	Hendrick	University of South Africa, Private Bag X6, Florida, 1710

Introduction

Globally, *D. x grandiflorum* (Chrysanthemum) is one of the most important pot plants and cut flower (Teixeira Da Silva, 2003). Growth media is a soilless mixture used for growing plants in containers (Olle *et al.*, 2012). The aim of this study was to evaluate the growth response of *D. x grandiflorum* to different growth media under greenhouse conditions.

Materials and Methods

A greenhouse experiment was conducted at the University of South Africa's Horticulture centre in Florida, Johannesburg. Eight growth media (100% peat (T1) (control), 100% bagasse (T2), 50:50% v/v peat:bagasse (T3), 75:25% v/v peat:bagasse (T4), 25:75% v/v peat:bagasse (T5), composted bagasse (T6), Coir (T7) and pine bark (T8)) as treatments and one hybrid (Mount® Runca) of *D. x grandiflorum* were arranged in complete randomised block design with four replicates. For data capturing, destructive sampling was done whereby three plants were selected at 89 days after transplanting (DAT) per treatment in each block. The growth parameters measured included plant height, stem diameter, fresh & dry root weights, and fresh & dry shoot weights.

Results and Discussion

At 89 DAT, there were no significant differences in the plant's stem diameter and height in response to the treatments. However, significant ($P < 0.05$) differences were recorded in fresh and dry root weights and fresh and dry shoot weights. The highest fresh and dry root weights (3.03 & 0.78 g) were obtained in plants grown in (T3) compared to the lowest (1.53 & 0.47 g) in (T8). Plants grown in (T1) had fresh and dry shoot weights of (13.57 & 2.03 g) compared to T8 (4.62 & 0.94 g). The results are consistent with findings for similar studies reported by Arenas *et al.* (2002).

Conclusions

In general, *D. x grandiflorum* responded best in peat in terms of the measured growth parameters.

6) Interactive effects of deficit irrigation and soil texture on growth of baby spinach cultivars

Presenter: BP Lekgoathi (boitypatience@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
BP	Lekgoathi	Department of Crop Science, Tshwane University of Technology, Private Bag X680, Pretoria, 0001, South Africa
P	Soundy	Department of Crop Science, Tshwane University of Technology, Private Bag X680, Pretoria, 0001, South Africa
PM	Kgopa	Department of Plant Production, Soil Science and Agricultural Engineering, University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa

Introduction

Water and soil are pre-harvest factors that tend to have an influence on plant growth of various vegetable crops, including baby spinach. However, with the reported challenges of drought in South Africa, deficit irrigation is one of the options adopted as a solution. This study was aimed at determining suitable different deficit irrigation levels that will interact with soil textures to minimise water use without compromising baby spinach growth.

Materials and Methods

The study was conducted at the University of Limpopo, South Africa. Two baby spinach cultivars (Hellios and Dash) were subjected to 3 irrigation treatments (100% of required 25 mm per week per pot, 75% and 50% of required water) x 5 soil textures (clay, clay-loam, sandy-loam, loam and sand) factorial study arranged in a randomized complete block design (RCBD) with five replications. Soil in pots was irrigated to field capacity prior to planting and stomatal conductance, chlorophyll content leaf area and fresh mass were collected at harvest. Genstat was used for data analysis.

Results and Discussion

The irrigation and soil texture interaction showed a significant difference ($P < 0.05$) among treatment means for chlorophyll content, fresh mass and leaf area of the two cultivars. However, Zhang *et al.* (2014) reported no significant difference in chlorophyll content of spinach between appropriate irrigation, over-watering and reduced irrigation. The interaction showed no significant differences on photosynthetic rate and stomatal conductance. Low chlorophyll content was found in all treatment combinations with the cultivar Dash. There was a significant difference among treatment means of photosynthetic rate on soil texture on Dash and Hellios whereby the highest photosynthetic rate was found on sandy-loam soil. Similar results were found by Makus & Lester (2002), whereby 75% irrigation on sandy-loam soil had an effect on photosynthetic rate of mustard spinach.

Conclusions

Hellios had the highest chlorophyll content, while Dash was the tallest cultivar. In conclusion, deficit irrigation of 75% was found to be most suitable with sandy loam soils for both cultivars with regard to the selected growth parameters.

7) Genotypic variation in gaseous exchange and quantum yield of PSII of four Cassava landraces

Presenter: KP Malele (malele92petros@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KP	Malele	PO BOX 2040, Bushbuckridge, 1280
JBO	Ogola	Department of Plant Production, University of Venda, Private Bag X5050, Thohoyandou 0950, South Africa

Introduction

Cassava (*Manihot esculenta* Crantz) is considered a staple food of more than a billion people in 105 countries worldwide (Chetty *et al.*, 2013). However, there is hardly any report in literature on genotypic difference in gaseous exchange and quantum yield of photosystem II (PSII) of cassava landraces in the North-eastern part of South Africa. Therefore we assessed genotypic variation in GE and quantum yield of photosystem II (PSII) of four cassava landraces.

Materials and Methods

The experiment, consisting of four cassava landraces (ACC #1, #2, #3 and #4) laid out in a Randomized Complete Block Design (RCBD) and replicated 3 times, was conducted in 2016/17 cropping season at Thohoyandou under rain-fed conditions. 30 cm long stem cuttings were planted at a spacing of 1 m x 1 m on 36 m² plots. Gaseous exchange and chlorophyll fluorescence were determined at midday in the four cassava landraces using a portable Photosynthetic analyser (Li-Cor Inc., model LI-6400, Lincoln, NE, USA) and fluorometer (PAM- 2000, Walz, Effeltrich, Germany), respectively.

Results and Discussion

Maximum CO₂ uptake values ranged from 10.03 $\mu\text{mol m}^{-2} \text{s}^{-1}$ (#ACC 2) to 11.11 $\mu\text{mol m}^{-2} \text{s}^{-1}$ (#ACC 4) indicating low CO₂ assimilation rates amongst the landraces. However, previous studies have reported relatively higher CO₂ assimilation rates in cassava compared to other C3 plants (El-Sharkawy, 2016). Stomatal conductance and transpiration ranged from 0.15 $\text{mol m}^{-2} \text{s}^{-1}$ (#ACC 2) to 0.2 $\text{mol m}^{-2} \text{s}^{-1}$ (#ACC 4), and from 1.08 (#ACC 2) to 1.98 $\text{mmol m}^{-2} \text{s}^{-1}$ (#ACC 3), respectively. Quantum yield of photosystem II (PSII) was lowest in #ACC 2 (0.34) and highest in #ACC4 (0.47). These results are comparable to the findings of Souza *et al.* (2004) who reported quantum yield of photosystem II (PSII) of cassava of 0.45 at midday.

Conclusions

Our results indicate that there are variations in gaseous exchange and quantum yield of photosystem II (PSII) amongst cassava landraces which may be exploited in cassava improvement programmes in the region.

8) Influence of irradiation with light-emitting diodes at different time cycles on the quality of fresh-cut green sweet pepper (cv. California wonder)

Presenter: GM Maroga (gmmaroga@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
GM	Maroga	Tshwane University of Technology, Private bag X 680, Pretoria
D	Sivakumar	Tshwane University of Technology, Private bag X 680, Pretoria

Introduction

Sweet pepper (*Capsicum annuum* L.) is a popular salad vegetable with numerous health benefits. Currently, new alternative technologies are being researched to maintain the quality and safety of the fresh-cut products, as they have a reduced shelf-life in the processed form. Cutting peppers induces softening, enzymatic browning and reduce shelf life. Irradiation using light-emitting diodes (LEDs) is a novel physical postharvest treatment in the food industry, also providing numerous advantages that include greenhouse crop production. The recent interest in the employment of LED technology during postharvest storage has been reported by several authors. The current study was aimed at optimising LED type and time cycle to maintain the quality of fresh-cut green pepper.

Materials and Methods

Green pepper fruits freshly harvested from a commercial farm were minimally processed and packed in commercial tray-packs and covered with cling film used by the industry. The packets were exposed to red, far-red and blue LED lights, and normal white light was employed randomly, as well as a dark area as control treatments at 7.5°C for time cycles of 8 h, 12 h, and 24 h per day. A completely randomized block design was adopted with 15 replicates of the fresh-cut sweet pepper commercial packages weighing a 100 g for each treatment. The samples were stored for 14 days and random samples were withdrawn at designated intervals (3, 7, 11 and 14 d). Evaluations were made on mass loss (%), changes in color values and browning index.

Results and Discussion

Fresh-cut green peppers exposed to 8 h light cycle retained significantly higher greenness, less browning and the lowest mass loss (%). Moreover, the red LED light treatment significantly minimised luminosity of the product and increased greenness, maintained firmness, inhibited off-odor development, decay and minimised weight loss. Storage time negatively affected all sensory quality parameters. Green color was maintained under lower doses of light that in turn favored green photosynthetic tissue that is more sensitive to high doses of light (Bradoit *et al.*, 2014). The 8 h red LED light treatment maintained the product's overall quality (greenness, lightness, inhibited browning and decay) and minimised mass loss (2.5%) for up to 14 days of storage. Mass loss was less than 5% and within the range of commercially allowable limits on 7 days of storage.

Conclusions

It is evident from this study that overall quality of fresh-cut green sweet pepper is best maintained in 8 h cycles of red LED treatments.

9) Application interval of Nemarioc-AL and Nemafric-BL phytonematicides on rough lemon (*Citrus jambhiri*) rootstock

Presenter: RV Mathabatha (raesibevivyat@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RV	Mathabatha	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa
MN	Mokgalong	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727, Republic of South Africa

Introduction

Worldwide, rough lemon (*Citrus jambhiri*) is the most popularly used rootstock in citriculture due to its adaptability and the quality attributes it confers to scions of different varieties. However, the rootstock is highly susceptible to infection by the citrus nematode, *Tylenchulus semipenetrans*, the causal agent of slow decline of citrus. Consequently, population densities of the citrus nematode should be managed to ameliorate slow decline of citrus. An earlier study suggested that the application concentration of both Nemarioc-AL and Nemafric-BL phytonematicides was 2.97%. The concentration, along with the life cycle of the nematode (42 days) was used to establish the application interval.

Materials and Methods

Rough lemon seedlings, in 20-cm diameter plastic pots, containing loam soil and Hygromix-T at 3: 1 (v/v), were each inoculated with 16 000 eggs and second-stage juveniles (J2) of *T. semipenetrans*. Nemarioc- AL and Nemafric-BL each applied at 2.97% using irrigation at 0, 1, 2, 3 and 4 weeks in context of “weeks-per- month-of-42 days”. At 56 days after initiating the treatments, plant and nematode variables were collected and subjected to lines of the best fit.

Results and Discussion

At 49 days after the treatment, in Nemarioc-AL phytonematicide, dry shoot mass and plant height, respectively, versus increasing application interval exhibited quadratic relations, with the coefficients of determination explaining the models by 96 and 63%, respectively. Nemafric BL measured the model by 91 and 94% total treatment variation on dry shoot mass and plant height variables measured. Application time effects was optimised using the relation $x = -b_1/2b_2$, the optimum application interval on Nemarioc-AL and Nemafric BL phytonematicides were optimised at 2.36 and 2.21 in context of “weeks-per-month-of-42 days”, which translated to 25 and 23 days, respectively. Relative to untreated control, the final nematode population densities were reduced by 5-18% by Nemarioc-AL phytonematicide and 13-19% by Nemafric-BL phytonematicide

Conclusions

Nemarioc-AL and Nemarioc-BL 2.97% could be applied at every 24 days for interrupting the life cycle of *T. semipenetrans* nematodes, without being phytotoxic to rough lemon seedling rootstocks.

10) Plantable suckers produced by the CIRAD queen pineapple varieties at fruit harvest, 4 months and 8 months after fruit harvest

Presenter: BW Mbatha (mbatab@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
BW	Mbatha	ARC-TSC, P.O.Box 194, Hluhluwe, 3960
EC	Rabie	ARC-TSC, P.O. Box 194, Hluhluwe, 3960

Introduction

The Natal Queen pineapple in Hluhluwe is propagated vegetatively using the suckers as planting material. Normally suckers are left to grow on the mother plant for 6 to 8 months after fruit harvest to reach plantable size. Six new CIRAD Queen pineapple varieties namely BR338, BR316C, SI087, TA039, GU044 and GU076, are currently under evaluation for adaptability in the KwaZulu-Natal, Hluhluwe growing conditions. Previous studies show that the CIRAD queen pineapple varieties grow vigorously and have a weak apical dominance, therefore suckers can reach plantable sizes at fruit harvest. The study was conducted to determine the growth period needed for suckers to reach the required plantable size, as well as sucker yield.

Materials and Methods

The trial was conducted in 2016 at Hluhluwe, KZN. The evaluation of plantable material was done at fruit harvest, and at 4 months and 8 months after fruit harvest. BR316C, BR338, GU044, GU076, SI087 and TA039 queen pineapple varieties were also evaluated for planting material yield. The results were presented in percentages plantable suckers. Sucker mass (grams) and length (centimetres) was used to select the number and sizes of plantable suckers produced per CIRAD queen variety. Suckers weighing between 50 g and 400 g and those measuring between 65 cm and 30 cm were regarded as plantable.

Results and Discussion

Each variety was affected differently in terms of the time required to produce plantable sucker sizes. The general trend in both mass and length selection methods was that most varieties produced more plantable material at fruit harvest, and the number of plantable suckers decreased with an increase in months after harvest. Suckers selected by mass had an average of 81% plantable suckers at fruit harvest, 71% at 4 months and 45% at 8 months, while suckers selected by length had an average of 96% plantable suckers at fruit harvest, 85% at 4 months and 37% at 8 months. There were 4 sucker sizes produced, namely sizes 2 (big), 3, 4 and 5 (small). At fruit harvest all the 4 plant sizes required in pineapple production were produced, while as the months after fruit harvest increased there was low production of sucker size 5.

Conclusions

The optimum time to obtain plantable suckers is at fruit harvest. The period of plant growth in months has an influence on sucker yield and size produced. GU076 produced the highest percentage of plantable suckers in the length selection method. TA039 produced the highest percentage of plantable suckers in the mass selection method.

11) Cutting propagation of *Plectranthus madagascariensis*

Presenter: T Moabelo (tmoabelo461@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Moabelo	Tshwane University of Technology, Private Bag X680, Pretoria, 0001
B	Matsiliza-Mlathi	Tshwane University of Technology, Private Bag X680, Pretoria, 0001
R	Kleynhans	Tshwane University of Technology, Private Bag X680, Pretoria, 0001

Introduction

Plectranthus madagascariensis belongs to the Lamiaceae family and is found in southern Africa specifically in the Eastern Cape, KwaZulu-Natal and Mpumalanga. *Plectranthus madagascariensis* is used for ornamental purposes and medicinally to treat skin and respiratory problems. The species possesses aromatic properties because of the production of essential oils. The species' essential oils contain biological activities such as antibacterial, anti fungal, antioxidant, anti-inflammation and anti-tumor activities. A sustainable supply of plant material is needed; however the agronomy of the species is not well researched, except for micro-propagation studies done by Tsegaw and Feyissa (2014). Micro-propagation is expensive and the aim of this study was to develop a conventional vegetative propagation protocol for *P. madagascariensis* in order to provide a sustainable supply of plant material.

Materials and Methods

The study was carried out under greenhouse conditions at TUT. The effect of 4 media namely: vermiculite and compost (1:2), sand and compost (1:1), bark and sand; 3 growth regulators: Dynaroot TM 1, Dip 'n Grow TM and control and 2 cutting positions: apical and middle on survival and rooting of cuttings were investigated. A complete randomized block design was used with 6 cuttings as experimental unit replicated 4 times. Cuttings were dipped in growth regulators and immediately planted in different media. Survival and rooting of cuttings were monitored for 5 weeks. At harvest, length and weight of the roots were determined. Data was analysed using mean average and standard deviation to compare the differences between the treatments.

Results and Discussion

The mixture of vermiculite and compost (1:2) (96% survival and 67% rooting) and the use of apical cuttings (84% survival and 82% rooting) gave the best results for both survival and rooting compared with other treatments, but there were no significant differences. Although Dynaroot TM 1 resulted in better survival and rooting, it did not result in longer or heavier roots compared with the control. This confirms statements by Harrower (2014) that no growth hormone is required for cuttings of *P. madagascariensis*. Although Harrower (2014) indicated that any rooting medium can be used for *P. madagascariensis* cuttings, sand did not perform well in the current study.

Conclusions

Plectranthus madagascariensis can be propagated from apical stem cutting using mixture of vermiculite and compost (1:2) with the addition of Dynaroot TM 1 as growth regulator for better survival and rooting. Further research investigating the effect of season is in process.

12) Effects of NPK rates on early growth of Warty Gourd (*Lagenaria siceraria*)

Presenter: MS Mokolobate (Motlogeloa.Mokolobate@nwu.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MS	Mokolobate	Department of Crop Science, North-West University, Mafikeng
FR	Kutu	University of Mpumalanga, Mbombela

Introduction

Warty gourd (*Lagenaria siceraria*) is an important indigenous vegetable known in Southern Africa by most people. The aim of the research was to study the effect of different NPK fertilizer levels on the growth of Warty gourd to improve the agronomic practices.

Materials and Methods

Four levels of nitrogen (0, 60, 120, and 180 kg ha⁻¹), and four levels of phosphorus and potassium (0, 40, 80, and 120 kg ha⁻¹) were applied in various treatment combinations. These were all applied at planting in pots in the greenhouse. Seedlings grew for nine weeks before termination of the trial. The growth parameters studied included number of leaves, plant height, chlorophyll content, stem diameter, number of lateral branches, and oven dried mass. An ANOVA was conducted using Statistix 10.0 and significance indicated at 5% probability.

Results and Discussion

There was no significant difference on the response of different rates of N and K applied separately with regards to the number of leaves, plant height, chlorophyll content and number of branches. The response to different applications of N and K combinations was also not significant. However, the crop responded positively to increased applications of P resulting in a significant increase in the number of leaves, plant height, chlorophyll content, stem diameter, number of branches and oven dried mass of the plant. There was also a positive response to P and K and also to P and N treatment combinations. The interaction among N, P, and K showed a much higher response than the interaction between N and P, N and K, and P and K. This clearly showed the importance of these primary nutrient elements in the growth of warty gourd.

Conclusions

Generally the amount of NPK required for the best growth of Warty gourd was in the ratio 1:2:3 i.e. 40:80:120 kg ha⁻¹.

13) Minimal processing of litchi fruit cv. Mauritius: effect of packaging and storage temperature on quality

Presenter: RR Mphahlele (mphahleler@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
RR	Mphahlele	ARC-ITSC, Private Bag X11208, Mbombela, 1200
MEK	Ngcobo	ARC-ITSC, Private Bag X11208, Mbombela, 1200
OC	Wokadala	ARC-ITSC, Private Bag X11208, Mbombela, 1200
OJ	Caleb	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch, 7599

Introduction

Litchi fruit rapidly lose colour and unless treated immediately after harvest, the peel will turn an unattractive brown colour. However, the edible arils inside the rind still remain in excellent condition. Thus, the main objective of the research was to investigate the response to packaging and storage duration of minimally processed litchi fruit cv. Mauritius.>

Materials and Methods

Fully matured litchi cv. Mauritius, were harvested from Friedenheim farm located in Nelspruit. Fruit were treated with 200 ppm NaOCl solution for 1 min. After draining, the fruit were peeled without removing the pip. Arils were then dipped into 50 ppm NaOCl solution for 30 s. Clear polyethylene terephthalate clamshell trays (350 ml) with perforation size of 1.1 mm (6 perforations), 5.4 mm (3 perforations) and non-perforated trays were used. Fresh-cut fruit (160 to 180 g) was packed in each tray and immediately stored at $1 \pm 0.5^{\circ}\text{C}$, $90 \pm 5\%$ RH for 15 days. Fruit were sampled on days 0, 3, 6, 9, 12 and 15. Drip loss ($\text{g } 100 \text{ ml}^{-1}$), decay incidences (%), color, total soluble solids ($^{\circ}\text{Brix}$), titratable acidity (% citric acid) and vitamin C ($\mu\text{g ml}^{-1}$) were measured.

Results and Discussion

Storage duration and packaging as well as their interactions had a significant effect on drip loss, decay incidences and TSS ($P < 0.001$). Fruit packaged in perforated clamshells had lower drip loss than those under non-perforated clamshells at day 15. Decay incidences only showed at day 9 in fruit packed under 5.4 mm clamshell averaging 12.5%, while no incidences were observed in other packages. A significant increase in TSS for non-perforated (19.56) and 5.4 mm (19.38) clamshell fruit was observed at day 15. Whiteness index was not affected by storage duration and packaging ($P < 0.1273$). Titratable acidity (TA) was significantly influenced by storage duration ($P < 0.0001$). A significant drop in TA was observed throughout the storage duration irrespective of the package type. The interaction effect of storage duration and packaging type significantly affected vitamin C ($P < 0.0001$). A decline in vitamin C was observed on day 6 with fruit packed under 5.4 mm having higher amounts than other packages. However, an increase was observed after day 9 with higher amounts in fruit packed under non-perforated clamshell.

Conclusions

The study suggests that minimally processed litchi fruit could be stored for up to 9 days at $1 \pm 0.5^{\circ}\text{C}$, $90 \pm 5\%$ RH under non-perforated and 1.1 mm clamshell without any signs of decay or changes in white color.

14) Effect of partial root zone drying and low storage temperature on postharvest quality of 'Hass' avocado fruit

Presenter: KJ Mukovhanama (mukovhanamajessica@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KJ	Mukovhanama	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
NJR	Roets	ARC Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200
TP	Mafeo	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
N	Mathaba	Perishable Products Export Control Board, Montague Gardens, 7441

Introduction

The South African avocado industry is rapidly growing with expansion also occurring in marginal areas (Donkin, 2012). As with the rest of the agricultural sector, this industry is under the obligation to save water and improve water use efficiency. Water use efficiency can be improved using irrigation techniques such as partial root zone drying (PRD). Low temperature storage is used to maintain storage-life of fruit during export. Thus, the current study aimed to investigate the effect of PRD and low storage temperature on 'Hass' avocado post-harvest fruit quality.

Materials and Methods

Fruit were harvested at commercial maturity from fully irrigated and PRD irrigated trees. For the PRD treatment, wet and dry sides were alternated at three-weekly intervals. For each of the two irrigation regimes, fruit were stored at 2 and 5.5°C for 28 days. The experimental design for this study was 2x2 factorial with six replicates per treatment. After 28 days cold storage, fruit were ripened at 21°C. The following parameters were evaluated: external chilling injury, electrolyte leakage (EL), mass loss, respiration rate, firmness, skin colour and vascular browning.

Results and Discussion

Fruit from the PRD treatment had 33.6 and 23.3% more chilling injury than the fully irrigated treatment at the 2 and 5.5°C storage regimes, respectively. Chilling injury was further increased by the lower (2°C) storage temperature. Partial root zone drying also increased electrolyte leakage with 1.0 and 2.8% respectively for fruit stored at 2 and 5.5°C. Irrigation regime had no effect on firmness loss and ripening of fruit, but fruit stored at 5.5°C ripened significantly faster and loss firmness significantly faster than fruit stored at 2°C. Both treatments had no significant effect on fruit skin colour and respiration rate. Vascular browning was not affected by irrigation regime, but was significantly higher in fruit stored at 2°C when compared with fruit stored at 5.5°C.

Conclusions

Partial root zone drying showed negative effects on the incidences of postharvest chilling injury and electrolyte leakage. As this will negatively affect postharvest fruit quality, the treatment shown to be unsuitable for avocado.

15) Effect of time-based hot air drying method on phenolic compounds of *Jatropha zeyheri* tea

Presenter: N Mutshekwa (mutshekwan@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
N	Mutshekwa	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
MS	Mphosi	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
KG	Shadung	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727
PW	Mashela	Limpopo Agro-Food Technology Station, University of Limpopo, Private Bag X 1106, Sovenga 0727

Introduction

Jatropha zeyheri Sond, is a succulent perennial, densely hairy herb producing stems up to 30 cm long, with harvested leaves being sun-dried and brewed for use as health tea (Van Wyk and Gericke, 2000). Limited information on its phytochemicals is available. Also, during sun-drying, most phytochemicals could be lost, but these could be conserved through the time-based hot air drying (TBHAD) method. The objective of this study was to investigate the phenolic content of *J. zeyheri* leaf tissues post-preservation using the TBHAD method.

Materials and Methods

The *J. zeyheri* leaves were collected from Khureng Village, Limpopo Province, transported to the laboratory in cooler boxes and preserved using the TBHAD method for 24, 48 and 72 hours, and sun-drying being a standard. Leaves were ground in a Wiley mill, with 1 g leaf tissue digested in 25 ml 100% methanol and then incubated at room temperature (25°C) for 60 minutes. Total phenolic content (TPC), total antioxidant capacity (TAC) and tannin content were determined using Folin-Ciocalteu, phosphate-molybdate and Vanillin-HCl method, respectively (Waterman and Mole, 1994). Data were subjected to ANOVA, with significant treatment means separated using Fisher's LSD test.

Results and Discussion

Treatment effects significantly increased TPC, TAC and tannins content by 63, 82 and 152%, respectively. Relative to the standard, the TBHAD treatment was not consistent in affecting the phenolic compounds. For instance, TBHAD decreased TPC at 24 and 48 h, but increased at 72 h, whereas tannin was increased at 24 and 48 h, but decreased at 72 h exposure periods. However, relative to the standard, TBHAD increased TAC at all exposure periods. Relative to bush and black tea, *J. zeyheri* had the highest tannin content of 11.6 mg CE 100 mg⁻¹ DM compared to 2.81 mg CE 100 mg⁻¹ DM (Negukhula, 2010) and 0.03 mg CE 100 mg⁻¹ DM (Mudau and Ngezimana, 2014), respectively. The increased TAC in *J. zeyheri* leaf tissues due to drying process makes it a potential tea infusion like bush, green and black tea. Antioxidants in human diets is important for the suppression of free radicals that result in the prevention of cancer, aging and cardiovascular diseases that are common in rural communities of South Africa (Aruoma, 1994).

Conclusions

The TBHAD method increased TAC at all exposure periods, TPC at 72 h, tannins at 24 and 48 h exposure periods. *Jatropha zeyheri* infusion has high tannins compared to black tea, and this undoubtedly, can be the reason why it is used as a tea alternative.

16) Detection of unripe banana flour adulteration with cereal flour using a portable near infrared spectroscopy and chemometrics

Presenter: PF Ndlovu (wokadalao@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PF	Ndlovu	Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit 1200, South Africa
OC	Wokadala	Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit 1200, South Africa
ZS	Tesfay	Discipline of Crop and Horticultural Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3201, South Africa
RR	Mphahlele	Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit 1200, South Africa
LS	Magwaza	Discipline of Crop and Horticultural Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3201, South Africa
MS	Daneel	Agricultural Research Council, Institute of Tropical and Subtropical Crops, Nelspruit 1200, South Africa

Introduction

Unripe banana flour (UBF) is a premium product from bananas due to its anti-diabetes and colon health promotion properties. However a large proportion of commercial UBF is adulterated using cheaper cereal flours, with up to 80% w/w adulteration reported (Sarda *et al.*, 2016). Methods to detect commercial UBF adulteration are still lacking. The main objective the present study was to develop a rapid non-destructive method for identifying and predicting levels of adulterating wheat flour (0-80% w/w) in UBF, using visible-near infrared spectroscopy (Vis-NIRS).

Materials and Methods

Banana flour from twenty-four (24) banana varieties was utilized. Simulated adulteration was conducted from 0-80% w/w banana flour replacement with wheat flour. Vis-NIR absorbance spectra of the adulterated unripe banana flours were obtained using a portable Vis-NIR spectrometer. The collected spectral data was subjected to chemometrics analysis using Unscrambler® software with a 50-50% dataset split (calibration and testing/validation sets). Principal component analysis (PCA) and partial least squares regression (PLSR) were employed.

Results and Discussion

The first two principle components explained 95% of the variation in the data. Five clear clusters that depended on the degree of UBF adulteration (0% 2-20%; 22-40%; 42-60% and 62-80%) were identified. Six (6) PLS data pre-processing methods were assessed. The most optimal pre-processing method was 2nd derivative Savitzky-Golay smoothing (19-point smoothing, 2nd order polynomial). The resultant model quality values were; $R_c^2=0.991$; $R_v^2=0.993$; $RPD=12.021$; $RMSEC=2.226$; $RMSEP=1.993$.

Conclusions

The minimum detection level (RMSEP) of 20 g 1000 g⁻¹ indicated that the developed Vis-NIRS PLSR method can facilitate rapid non-destructive detection of unripe banana adulteration for derived products processing industries at materials reception. It can also be utilized as a rapid method for inspections intended to enforce unripe banana flour standards.

17) Natural innovative approaches applied in the management of postharvest diseases of avocado fruits in South Africa

Presenter: CP Obianom (ObianomCP@tut.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
CP	Obianom	Tshwane University of Technology, Department of Crop Science, Staatsartillerie Road, Pretoria West
D	Sivakumar	Tshwane University of Technology, Department of Crop Science, Staatsartillerie Road, Pretoria West

Introduction

Increases in postharvest losses of fruit and vegetables have created an alarming upsurge of food waste in recent time. These losses have been associated with factors including inappropriate handling procedures, unsuitable storage facilities and microbial infections. One of the main challenges farmers and retailers face are losses caused by fungi which undergoes a quiescent stage of infection before harvest and the host manifests visible symptoms once ripening resumes. Different measures such as chemical, biological and other conventional control have been employed to prolong the shelf life and improve the fruit quality until it reaches the retailers' shelf. This study was aimed at investigating the impact of identified natural agents on mycelia growth, disease development, defence related and antioxidant enzymes activities in the 'Hass' cultivar of avocado fruit.

Materials and Methods

The fungal isolates (*C. gloeosporioides* and *L. theobromae*) were screened against the identified natural biological agents. The biochemical analysis of enzyme activities in the fruit was performed as described by Glowacz *et al.*, 2017. The experiments were repeated twice and statically analysed.

Results and Discussion

Apparently, chitosan-based products, thyme oil and citral significantly reduced the incidence of anthracnose and stem-end rot, and inhibited their causative agents after incubation. These natural agents enhanced the mechanisms involved in the activities of defense related and antioxidant enzymes, resulting in the improvement of fruit quality after cold storage.

Conclusions

Application of natural agents underpinned the significance of inducible factors on the activation of important defensive mechanisms involved in the biosynthetic pathways, thereby retaining fruit quality after cold storage.

18) Elucidating the effects on dynamic controlled atmosphere and initial low oxygen storage techniques on superficial scald implicated volatiles α -farnesene and mho in 'Granny Smith' apples

Presenter: TM Ramokonyane (sekepe1981@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TM	Ramokonyane	Limpopo Department of Agriculture and Rural Development, 69 Biccard Street, Polokwane 0699
UL	Opara	Postharvest Technology Research laboratory, South African Research Chair in Postharvest Technology, Faculty of Agri-Sciences, Stellenbosch University, Private Bag x1, Stellenbosch, 7602
EM	Crouch	Department of Horticultural Sciences, Faculty of Agri-Sciences, Stellenbosch University, Private Bag x1, Stellenbosch 7602
FA	Vries	ARC Infruitec Nietvoorbij, Private Bag x5026, Stellenbosch 7599
JA	Van der Merwe	ARC Infruitec Nietvoorbij, Private Bag x5026, Stellenbosch 7599

Introduction

South African grown apples are mostly exported, typically after a period of cold storage. 'Granny Smith' apples are susceptible to visible blemishing due to superficial scalding which may develop during or after cold storage. This study investigates how volatiles: sesquiterpene 3-7-11-trimethyldodecatetraene (α -farnesene) and its oxidation product 6-methyl-5-hepten-2-one (MHO), evolve during cold storage and how they relate to superficial scald incidence and severity in 'Granny Smith' apples.

Materials and Methods

Pre-optimally and optimally harvested 'Granny Smith' apples were stored for up to 7 months at 0°C in five treatments: (1) Dynamic controlled atmosphere (DCA), (2) Initial low oxygen stress followed by controlled atmosphere (ILOS+CA), (3) Initial low oxygen stress followed by regular atmosphere (ILOS+RA), (4) Controlled atmosphere (CA) and (5) Regular atmosphere (RA) as a control treatment. Peel tissue samples for volatile analysis were taken after different storage periods: (1) Harvest, (2) 2 months, (3) 3 months, (4) 5 months and (5) 7 months. For each storage period sampling was done after 0, 7 and 14 d at 20°C to assess levels of MHO and α -farnesene using gas chromatography-mass spectroscopy (GC-MS).

Results and Discussion

The volatiles α -farnesene and its oxidation product MHO are implicated in the incidence of superficial scald. MHO levels were significantly lower in scald suppressing treatments: DCA, CA and ILOS+CA and higher in scald affected treatments (RA and ILOS+RA). The results suggest that DCA and ILOS inhibit incidence of superficial scald by keeping levels of MHO lower in 'Granny Smith' apples (Mir *et al.*, 1999). The α -farnesene levels were higher in scald controlling treatments (DCA, CA and ILOS+CA) and lower in scalded fruit of ILOS+RA and RA treatments.

Conclusions

DCA technology suppresses superficial scald in 'Granny Smith' apples for up to 7 months in cold storage. The α -farnesene and MHO displayed a precursor product relationship in this study. The levels of α -farnesene in the fruit peel of 'Granny Smith' apples is negatively correlated to scald severity ($R^2 = -0.90$), whereas the levels of MHO in the fruit peel of 'Granny Smith' apples are positively correlated with scald severity ($R^2 = 0.93$).

19) Is there any commercial potential for using white, low-density shade nets for citrus Mandarin orchards?

Presenter: NJR Roets (nico@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NJR	Roets	ARC Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200
IF	Ngwamba	ARC Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200
SZ	Tesfay	University of Kwazulu-Natal, Private Bag X01, Scottville, 3209
MEK	Ngcobo	ARC Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200

Introduction

South African citrus mandarin growers are increasingly covering orchards with white, low-density shade nets. This is mainly to protect their crop against hail and sunburn damage. However, shade nets change the light environment and microclimate of the orchards, subsequently affecting tree performance, yield and fruit quality. The aims of this study were; 1) to determine how the shade net affects growth, yield, return bloom and fruit quality; and 2) to make recommendations for commercial production.

Materials and Methods

The current study was carried out on a commercial citrus mandarin farm in the Nelspruit area of Mpumalanga. Bearing trees (cv. 'Nadorcott'), grafted on 'Carizzo Citrange' rootstocks and planted in two adjacent orchards, were used. One orchard was covered with a low-density (~20%) white shade net, while the adjacent orchard was uncovered. The experimental design was a randomized pseudo-block design with six replicates per treatment. Data on vegetative vigour, yield, return bloom, fruit size, colour, TSS and TA were collected over a three year period from 2015 to 2017.

Results and Discussion

The low-density white shade net had a significant effect on all measured parameters, except return bloom, fruit colour and TSS. Vegetative vigour, measured as the length of vegetative shoots and leaf area, were increased by 25 and 14% respectively, under the shade net. Over the long term, yield was not affected, but there was a strong indication that the shade net reduced alternate bearing, especially during high yielding seasons. In terms of fruit quality, the shade net caused a 24% decrease in TA content, resulting in significantly higher TSS:TA. The shade net therefore affected growth, yield and fruit quality of mandarins.

Conclusions

More vigorous vegetative growth under the shade net is undesirable and will increase costs in terms of controlling excessive growth. Increased fruit size caused by the shade net may not necessarily be an advantage from a marketing point of view. The underlying reasons for the recorded effects by the shade net is currently unknown. The shade nets are recommended for the environmental protection they offer. However, the focus in future studies will be to determine how orchard management (nutrition and irrigation) should be adapted to avoid the above mentioned negative effects.

20) Influence of container-type and positioning on growth of tomato plants and suppression of *Meloidogyne javanica* exposed to Afrikelp

Presenter: ML Sebati (lolodima61@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
ML	Sebati	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727, South Africa
ZP	Dube	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727, South Africa
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727, South Africa

Introduction

The southern root-knot (*Meloidogyne incognita*) nematodes are the most injurious pests of tomato (*Solanum lycopersicum* L.) crops, with the potential to cause total crop failure in certain regions (Mashela *et al.*, 2013). The withdrawal of methyl-bromide from the agrochemical market internationally in 2005 and other synthetic nematicides, led to an increase in research and development of environment-friendly alternatives such as Phytonematicides, Biomuti and Afrikelp. Afrikelp, a natural bio-stimulant product extracted from freshly harvested South African giant brown seaweed (*Ecklonia maxima*), contains high quantities of plant growth regulators such as auxins (Butler and Hunter, 2017).

Materials and Methods

Treatments, comprising 30 cm diameter brown-pot-below, brown-pot-above, black-pot-below, black-pot-above, plastic-bag-below and plastic-bag-above the soil surface, were arranged in a randomised complete block design, with 10 replications. Each container was filled with steam-pasteurised sandy-loam soil and Hygromix at 3:1 (v/v) ratio and four-week old hardened-off seedlings transplanted per container. Cultural practices were as in commercial tomato production systems. Each plant was inoculated with 2000 eggs and second-stage juveniles (J2) of *Meloidogyne javanica*, whereas Afrikelp was applied at 3 L ha⁻¹ as a weekly irrigation supplement.

Results and Discussion

At 56 days after inoculation, treatments significantly affected plant height, dry shoot mass, dry shoot mass, fruit mass and gall rating, contributing 91, 88, 66, 43 and 60% in total treatment variation (TTV) of the respective variables. Similar trends were observed by Khurram *et al.* (2017) where container-type had a significant effect on shoot weight and dry shoot mass of Arizona walnut seedling in the nursery phase. Al-Zalzaleh and Dcruz (2015) grew *E. viminalis* in conventional pots and spring ring container and observed a significant difference in plant height, which confirms the current observations were different container-types had an effect on the variables. Relative to brown-pot-below soil surface, brown-pot-above and plastic-bag-above reduced plant height, dry shoot mass and fruit mass, except for dry root mass and gall rating, which were increased.

Conclusions

Treatment effect had no significant effects on nematode variables. In conclusion, container-type and positioning could affect the efficacy of agricultural inputs when tested under microplot conditions, with below soil surface being the better positioning.

21) Effect of harvesting time on antioxidant activity, total phenols and flavonoids of indigenous tea (*Jatropha zeyheri*)

Presenter: AM Sehlapelo (boreadimankutu@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
AM	Sehlapelo	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
KG	Shadung	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa
MS	Mphosi	University of Limpopo, Private Bag X 1106, Sovenga, 0727, South Africa

Introduction

Jatropha zeyheri indigenous tea is essentially known for its nutritional and health benefits (Van Wyk and Gericke, 2007). However, the chemical composition important for tea is greatly influenced by harvesting time. The influence of harvesting time on the antioxidant activity and total flavonoids on quality of *J. zeyheri* indigenous tea has not been documented. Therefore, the objective of this study was to evaluate whether harvesting time would have effects on antioxidant activity, total phenols and flavonoids in *J. zeyheri* leaf tissues.

Materials and Methods

The study was conducted at Khureng village, Lepelle-Nkumpi Municipality, in Limpopo Province South Africa. Five treatments constituting harvesting dates (February, March, April, May and June) were arranged in a randomised complete block design, with 10 replications. Leaves were harvested on a monthly basis and oven-dried for 24 hrs at a temperature of 60°C. The dried leaves were ground through a 1 mm sieve using a grinder prior to analysis. After laboratory preparations, antioxidant activity, total phenols and flavonoids were analysed using the UV-visible spectrophotometer. Data were subjected to ANOVA using the Statistix 10.0. Mean separation was achieved using Fischer's Least Significant Difference Test. The variables with significant treatment means were further subjected to lines of best fit.

Results and Discussion

Harvesting time had highly significant effects on the antioxidant activity and flavonoids contributing 52 and 88%, respectively, in total treatment variation of the variables. However, total phenols were found to be non-significant. The quadratic curves explained 55% and 97% of the observed variation in antioxidant activity and flavonoids, respectively. Relative to the control, antioxidant activity increased by 37% over increasing harvesting time. Similarly, flavonoids increased by 36 to 137%. Using the optimisation relationship ($x = -b/2a$) from the quadratic equation, harvesting of *Jatropha zeyheri* was optimised at 1.76 months.

Conclusions

In conclusion, the study showed that harvesting of *Jatropha zeyheri* leaves was optimised at 1.76 months which translated to harvesting in April, which will therefore improve the quality of *J. zeyheri* indigenous tea.

22) *In vitro* shoot induction and multiplication protocol for *Actinidia* species

Presenter: MK Sekhukhune (msekukhune6@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MK	Sekhukhune	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727
MY	Maila	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727
RV	Nikolova	University of Limpopo, School of Molecular and Life Sciences, Department of Biodiversity

Introduction

Kiwifruit, *Actinidia* species (Actinidiaceae) is widespread within the temperate and subtropical regions of Asia, with a climbing habit. The vine could grow up to 15 m, with vigorous branches producing spherical berries. In addition to its nutritional value, the kiwifruit could also be used for medicinal and ornamental purposes (Ferguson, 1999). However, the species is difficult to propagate sexually and therefore the *in vitro* shoot induction and multiplication protocols were developed using explants of different sizes.

Materials and Methods

An *in vitro* shoot multiplication protocol was developed through nodal explants excised from *in vivo* raised stem cuttings of *A. arguta* and *A. chinensis*. The effect of 6-benzylaminopurine (BAP) (2.2, 4.4, 6.6, 8.8 μM) on multiple shoot induction from large (2–3 nodes) and small (1–2 nodes) nodal explants of both plant species was studied. The number of shoots per explant and survival percentages of explants were recorded. All treatments were arranged in a completely randomised design, with 5 replications.

Results and Discussion

Up to 50% of the large explants from *A. arguta* produced at least one shoot per explant on MS with and without BAP. Only 10–20% of the small explants produced axillary shoots in the control and BAP treatments (2.2 and 6.6 μM BAP). The highest survival percentage of 70%, on both large and small explants, was attained at 6.6 μM BAP. Small explants cultured at 2.2 μM BAP and the control produced short axillary shoots. Axillary shoots induced on large explants cultured at 6.6 and 8.8 μM BAP were 3–4 nodes in length. In *A. chinensis*, the survival of the explants ranged between 30 to 70% for large explants and 0 to 30% for small explants. 6-Benzylaminopurine affected leaf size since the explants from the control and those treated with 2.2 and 4.4 μM BAP produced bigger leaves, whereas, those treated with 6.6 and 8.8 μM BAP had smaller and fewer leaves.

Conclusions

Size of explant had an effect on the survival and shoot formation of both *A. arguta* and *A. chinensis* explants. Large explants had the highest survival percentage and produced more axillary shoots compared with smaller explants. The best shoot induction was attained on large explants with culture medium supplemented with 6.6 and 8.8 μM for *A. arguta* and 2.2 and 4.4 μM BAP for *A. chinensis*. Further studies are required to optimise the conditions of *in vitro* culture for shoot multiplication and plant regeneration from nodal explants.

23) Yield response of cabbage intercropped with onion in three municipalities of Mpumalanga province

Presenter: M Shange (shangemakhosi6@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
M	Shange	Department Agriculture, Rural Development, Land and Environmental Affairs, Nooitgedacht Agricultural Development Centre, Private Bag X9019 Ermelo 2351

Introduction

Vegetable crop species grown together in an intercrop system interact and influence each other, these relationships can be beneficial or harmful. Therefore, it is important to select compatible crop combinations to promote diversity and yield stability. The objective of this study was to determine the effects of intercropping on the yield of cabbage and onion.

Materials and Methods

Field experiments were carried out to investigate the effect of intercropping on the yield of cabbage (cv. Drumhead) intercropped with onion (cv. Texas Grano), the experiments were laid out in three trial sites (Greylingstad (S1), Driefontein (S2) and Thulamahashe S3) in Mpumalanga province, in a randomized complete block design with four replications. The intercropping combinations were 1:1 (1 row cabbage to 1 row onion), 2:1(2 rows cabbage to 1 row onion) and both crops planted in pure stand. Plant height was measured and the yield components for each crop were determined at harvest.

Results and Discussion

According to the experiments results, intercropping had no negative effect on the yield and head size of the cabbage in both trial sites (S1 and S2), but there was a significant difference in yield and head size of cabbage in intercropping combinations compared to monocrop in S3. The cabbage yield and size under intercropping in S3 significantly decreased; however, there was no significant difference in onion yield between intercropping combinations and monocrop. Cabbage slightly yielded more in 1:1 intercrop combination than the 2:1 intercrop combination in both trial sites (S1 and S2). Onion yield was not significantly affected by intercropping in all sites, but there was a slight decrease in yield of intercrops compared to monocrop. The Land Equivalent Ratio (LER) which is the most common index for measuring the advantages of using intercropping systems on the combined yield of both crops was calculated. The average LER for 1:1 intercrop combination was 1.84 compared to 1.83 for 2:1 intercrop combination. The LER results indicated that intercropping was more productive than sole cropping.

Conclusions

This study showed yield advantage of intercropping which was indicated by LER values higher than 1, indicating that intercrops were more productive than sole crops.

24) The relationship between fruit weight and skin colour of ripe avocado fruit

Presenter: K Shikwambana (shikwambanakingsly@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
K	Shikwambana	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
TP	Mafeo	School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag X1106, Sovenga, 0727
N	Mathaba	Perishable Produce Export Control Board, 45 Silwerboom, Platteklouf, Cape Town, 7550

Introduction

Avocado (*Persea americana* cv. Hass) is known to change skin colour from green to purple, then nearly black during ripening (Cox *et al.*, 2004). In the last decade countries importing South African 'Hass' avocado fruit have been complaining about poor skin colour changes during ripening. The factors responsible for this is not clear and the aim of the study was to investigate the relationship between fruit weight and skin colour in 'Hass' fruit.

Materials and Methods

'Hass' avocado fruit were harvested and sorted into two weight categories (<200g and >200g) and ripened at 25°C. During ripening, data were collected every 2 days for fruit firmness, objective colour parameter measurements (lightness-L*, chroma-C* and hue angle-h*), subjective colour (eye colour rating) and total skin pigments (chlorophyll, carotenoids, anthocyanins) were analysed spectrophotometrically.

Results and Discussion

Fruit firmness and skin colour indices (L*, C*, h* and eye colour) decreased with days to ripening, regardless of fruit mass. However, fruit with a weight below 200g were softer and had the lowest values of colour measurements (L*, C* and h*) when compared with fruit above 200 g weight. Furthermore, the results indicate that skin colour changes during ripening was emphasized in fruit weighing below 200 g when compared with fruit above 200 g. Therefore, lighter fruit (<200 g) had the highest values for eye colour [rating scale 4-5 (purple)] after day 4 of the ripening period, while heavier fruit (>200 g) reached an eye rating scale of 3-olive green at day 4. There was no significant difference between lighter and heavier fruit on skin pigment (total chlorophyll and total carotenoid) of ripe 'Hass' avocado. However, lighter recorded significantly higher total anthocyanin concentration when compared to fruit with a weight of above 200 g.

Conclusions

The results of this study showed that fruit weight can affect skin colour changes leading to differences in skin colour of the same fruit lot during ripening.

ABSTRACTS
POSTER PRESENTATIONS

CROP SCIENCE

LISTED ALPHABETICALLY

25) An investigation into the effect of plant stress induced by northern corn leaf blight on root development in maize

Presenter: AM Abrahams (AbrahamsAM@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
AM	Abrahams	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520, South Africa

Introduction

Stress can weaken the plant's natural defences, which predisposes the plant to increased infections. Root and crown rot are caused by a disease complex. The objective of the current study was to relate the degree of stress induced by Northern corn leaf blight (NCLB) disease development at various growth stages to root and crown rot observed.

Materials and Methods

Three cultivars with varying resistance to NCLB were planted (IMP50-10B - susceptible, BG3292 – moderately susceptible, DKC 61-94BR - resistant) during 2016/17 (Potchefstroom). Eight treatments were included i.e. TMT1- 3 fungicide applications; TMT2 - 2 fungicide applications; TMT3 - not inoculated or sprayed. The remaining treatments were inoculated with a cocktail of five NCLB races (Race 3, 3N, 23, 23N and 13N): TMT4 (5 weeks after planting -WAP); TMT5 (5+6 WAP); TMT6 (5+6+7 WAP); TMT7 (6+7 WAP); TMT8 (7 WAP). The trial was laid out as a split-plot, with three replicates. Six randomly selected plants were sampled at flowering, milk, soft dough and dent growth stages and screened for NCLB as well as root and crown rot according to Elliot and Jenkins (1946) and Soonthornpocot *et al.* (2000) respectively. qPCR analysis was performed to quantify *Exserohilum pedicellatum*, *Macrophomina phaseolina*, *Fusarium oxysporum*, *Phoma spp.*, *Curvularia eragostidis*, *F. graminearum*, *F.verticillioides*, *Pythium spp.*, *Rhizoctonia solani* and *Trichoderma spp.* Regression analysis was conducted to establish the relationship between NCLB, root and crown rot for the three cultivars included in the study.

Results and Discussion

Limited significance was obtained with the current study. A significant interaction between treatments x plant part x sampling date was observed for *F. equiseti* and *F. oxysporum*. *Fusarium equiseti* and *F. oxysporum* biomass increased over time as the levels of NCLB increased for cultivar IMP50-10B in the crowns. *Fusarium oxysporum* was also influenced by the highest order interactions (sampling date x plant part x cultivar x treatment).

Conclusions

Root rot was not significantly affected by the degree of NCLB infection in any of the three cultivars included. Several fungal pathogens showed trends of increase and decrease over time in both the roots and crowns. The study is being repeated.

26) Improving Pearl millet productivity through adaptive management of water and nitrogen

Presenter: PA Ausiku (pausiku@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
PA	Ausiku	University of Pretoria
JG	Annandale	University of Pretoria
JM	Steyn	University of Pretoria
AJ	Sanewe	University of Pretoria

Introduction

Management of nitrogen and soil water along with other essential nutrients plays a significant role in increasing crop productivity. The large amount of N losses from applying fertilizers is due to leaching. This high N loss, increase cost of crop production due to the high cost of N fertilizer. Precise estimates of the amount of N required by millet is challenging because optimum N depends on conditions that are localized and dynamic. For this reason, adaptive management of water and nitrogen is required to optimize production and minimize N losses. Wetting front detector and a chameleon sensor as management tools were used to adapt water and nitrogen with the goal of increasing yields and thus increase water use efficiency of millet.

Materials and Methods

The experiment was a randomized complete block design with a factorial combination of four nitrogen levels and three water regimes with four replications. The four nitrogen rates used were 0, 45, adapted-N and 90 kg N ha⁻¹. Water regimes were adapted-water, 15 and 30 mm week⁻¹. Soil nitrate-nitrogen (NO₃-N) was measured with Nitrate test strips to determine soil fertility levels of adaptive nitrogen. The strips were dipped into an extracted water from WFDs and permitted to develop colours. The soil solution nitrate concentrations of 25 and 50 mg L⁻¹ were selected as a benchmark for N application. For adaptive water plot was irrigated to field capacity, whenever one of the sensors turned red. The study was conducted under a rain-shelter at the University of Pretoria. Data were analysed with a General Linear Model (SAS 9.4), SAS Institute Inc. Cary. NC.

Results and Discussion

The results showed that grain yield (8488 kg ha⁻¹) and biomass yield (20228 kg ha⁻¹) were optimum at 56 kg N ha⁻¹ of adapted-N fertilization. Dry matter yield (22910 kg ha⁻¹) and grain yield (8533 kg ha⁻¹) were highest at 90 kg N ha⁻¹. Integrated adaptive management of nitrogen and water did not significantly influence biomass yield of pearl millet. The highest-yielding treatment had the highest water use (33 kg ha⁻¹ mm⁻¹) compared with a low yielding at 13 kg ha⁻¹ mm⁻¹. There was 100% variation in WUEs for a given amount of crop water use. The maximum grain yield was obtained with 90 kg N ha⁻¹ in fixed irrigation and the optimum N rate for pearl millet was 56 kg N ha⁻¹ in all integrated, adapted water and nitrogen.

Conclusions

Integrated nitrogen and water management had led to increasing yields and thus increase water use efficiency.

27) Investigating the effect of reducing phytic acid content on seed germination and vigour of maize (*Zea mays* L.)

Presenter: MAE Bakhite (melgorashi@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
MAE	Bakhite	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa
AO	Odindo	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa
LS	Magwaza	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa
SZ	Tesfay	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa

Introduction

Breeders have recently focused on reducing the phytic acid (PA) content of seed to improve grain nutritional quality. Moreover, monogastric animals, including humans, lack phytase in their digestive tract and incapable of metabolizing phytate. PA is also a major storage form of phosphorus (P) in seeds. PA undergoes a digestion process and releases P and cations essential for seedling growth, therefore a reduction in PA may affect seed vigour as a result of reduced P content. The main objective of this study was to assess the consequences of the reduction of PA on seed germination and vigour.

Materials and Methods

Two experiments were conducted at the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal. Four maize genotypes were selected and 25 seeds each were used to determine seed length, width, thickness as well as seed mass (gm). PA was determined for each genotype according to Aina *et al.* (2012) to ensure that they vary in phytic acid content. Standard germination test was conducted according to ISTA (2012) in a completely randomized design experiment which consisted of four replicates of 25 seeds each for each genotype. Samples were placed in germination chamber at a temperature of $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$. After the final count, plumule length (mm) and radical length (mm) were measured. An Accelerated Ageing (AA) test was also conducted. Collected seeds were exposed to a temperature of 41°C and 100% relative humidity for 0, 1, 3, 5, 6 and 7 days before germination. For seedling emergence evaluation, the four maize genotypes were planted in a controlled growth chamber. The experiment consisted of four replicates of 25 seeds from each genotype.

Results and Discussion

There were significant differences ($P < 0.05$) between the selected genotypes. The study revealed that genotypes with low PA content affected seed germination and vigour as a result of reducing phosphorus. The high PA genotypes registered high means especially for seed Germination % and seedling emergence % and that agreed with Redekar *et al.* (2017). This indicates that PA within the seed is hydrolysed and releases phosphorus. P reserves in the seeds helps seeds to germinate and allow seedlings to establish faster with an extensive root system, and eventually produce plants with higher yields.

Conclusions

Seeds with low PA are associated with low germination and seedling emergence. More research work is needed to address the effect of external P application on seed germination and vigour of low and high PA seeds.

28) Alleviating food insecurities through biotechnology integration in Southern Africa

Presenter: L Blom (blomlangaliphumile@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Blom	Department of Rural Development and Agrarian Reform, Döhne Agricultural Development Institute, Stutterheim, 4930
C	Mutengwa	Department of Agronomy, Faculty of Science & Agriculture, University of Fort Hare, Private Bag X1314, Alice, 5700

Introduction

Southern African farmers are facing challenges keeping up with the ever-increasing food demand. Simply increasing crop production output using conventional methods is not enough, as 86% of the land area across the country is already under cultivating or grazing use. Continued agricultural industrialization and increasing intensification have been closely associated with food safety risks, environmental degradation and unemployment. Food producers thus need to adapt to the changing scientific and technological advancements in our time. This paper aims to express the key advantages related to the adoption of Biotechnology, its practical crop propagation-based applications, as well as to recognize the related disadvantages associated with the integration of this technology, together with all the possible solutions to overcoming these challenges.

Materials and Methods

The method used was a literature review looking at papers that; clearly outlined the various practical applications of Biotechnology; the threat posed on South African food security; and depicted the impact of Biotechnology on food and nutrition in developing countries.

Results and Discussion

The integration of Biotechnology into food production helps global feeding scheme initiatives aimed at lowering food security risks by producing greater crop yields with fewer inputs, maximizing capital input which can be redirected towards increasing annual yield output, compared to conventional production methods; decrease the amounts of agricultural chemicals necessary to crops - lowering surface run-off incidences of these chemicals into the environment, such as into open water sources; etc. Only 22 percent of South Africa's limited cultivatable land is regarded high potential arable land. This figure stresses the importance of introducing innovative measures to overcoming such obstacles, and being able to produce plentiful amounts of food crop, high in quality standards, both locally, and on an international scale. Numerous obstacles and challenges persistently stand in the way of new technologies being implemented in the agricultural sectors of many developing countries, some of which include poor communication linkages between national and international research institutions. This lack of (efficient) interaction between the two facilities limits the chances of such advances in agriculture taking place.

Conclusions

The obstacles that stand in the way of this advancement are generally possible to overcome, and the goals set forth beyond them attainable. Part of the shift that needs to take place is with the farmers and their comfortability with current methods and practices. The realization of these new technologies offered by biotechnology would see them unlock vast areas of improvement in yield return, as well as income profit.

29) Mode of action prospecting of the plant growth promoting Rhizobacteria *Lysinibacillus sphearicus* and *Paenibacillus alvei* using next generation sequencing techniques

Presenter: G Breedt (gerhardbreedt@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
G	Breedt	Crop Research Division, Limpopo Department of Agriculture and Rural Development, Towoomba Agricultural Development Centre, Private Bag X1615, Bela Bela, 0480, South Africa
NL	Labuschagne	Department of Plant Pathology and Microbiology, University of Pretoria, 0002, South Africa

Introduction

The increase in environmental hazards and decrease in ecosystem health can largely be contributed to the excessive use in synthetic fertilizers and chemicals. To create a more sustainable agriculture growing research focusses on plant growth promoting rhizobacteria (PGPR) as an eco-friendly alternative. The longstanding *in vivo* mode of action tests are still used when prospecting for new PGPR isolates but these tests are costly, complicated and timely processes. The identification of the PGPR genes using Next generation sequencing (NGS) technologies can increase the effectiveness of preliminary screening procedures and thus the aim to verify biofertilizers mode of action through the systematic analysis of whole genome data as a new PGPR prospecting technique.

Materials and Methods

The isolates *Lysinibacillus sphearicus* and *Paenibacillus alvei* were selected based on the *in vivo* and field performance to promote maize growth. The isolates were sent to the Forestry and biotechnology institute at the University of Pretoria, South Africa for whole genome sequencing using the Ion Torrent Personal Genome Machine. The contigs yielded from sequencing were assembled using the assembly program SeqMan NGen® and annotated using the Rapid annotation subsystem technology 4.0 (RAST) server and NCBI prokaryotic genomes automatic annotation pipeline (PGAAP). The annotated genomes were viewed and identified using the Seedview framework®.

Results and Discussion

A spectrum of plant growth promoting (PGP) genes were identified and translation of these genes were verified in the *in vivo* study conducted by Breedt *et al.* (2017). The most important genes identified for agricultural purposes were involved in nutrient cycling and phytohormone production. The *Lysinibacillus* sp. coded for a total of twenty nine phosphate specific transfer system (PsTS), ten ammonium assimilation, five auxin and thirty four siderophore genes. *Paenibacillus* sp. coded for only nine PsTS, nine ammonium assimilation, four auxin and Thirteen siderophore genes respectively.

Conclusions

Current Plant growth promoting substances identification is still via the very popular *in vivo* methods. *In vivo* screening methods although highly accurate are limited that these methods are costly, time consuming and highly targeted. With the advancement of NGS methods, PGP genes and the expression of these genes are quickly and more easily identified that could have been overlooked using the traditional *in vivo* methods.

30) Influence of different nematode resistance mechanisms on *Meloidogyne* species in potato-based cropping systems: Preliminary findings.

Presenter: NE Chiuta (nyashachiuta@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NE	Chiuta	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727
KM	Pofu	Agricultural Research Council-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727

Introduction

Root-knot nematodes (*Meloidogyne* species) can reduce crop yield in potato (*Solanum tuberosum*) by 50%, with incidents of complete crop failure in some cases (Pofu *et al.*, 2012). The sustainable production of crops that have no root-knot nematodes resistant genotypes such as potato, depends much on the availability of nematode resistance in crops that could be included in crop rotational systems. Therefore, the objective of this study was to investigate the response of nematodes to crops exhibiting different nematode resistance mechanisms under field conditions.

Materials and Methods

Two rotational studies were conducted simultaneously at two separate locations (A and B), at the University of Limpopo, South Africa. The experiment was laid out in a randomised complete block design (RCBD), replicated six times. In the first sequence, four treatments namely sweet stem sorghum (SSS) [*Sorghum bicolor* (L.) Moensch], *Cucumis africanus*, potato ('Mondial G3') and potato-velum were each randomly assigned to 2 m × 2 m subplots in the first year of the rotation. Each crop was assigned to a plot and this was the first year of the experiment. In the second year, Sequence 2 was established whereby potato were grown in all plots following the removal of the randomly assigned treatments. Cultural practices were plant specific and similar to those used in commercial production of each crop. The experiment was terminated 56 days after emergence of the potato crop and nematodes were extracted from the plant roots and soil. Data were subjected to Student-T test using STATISTIX 10.0 software.

Results and Discussion

The cultivation of potato as a successor crop in location A resulted in highly significant increases in reproductive potential (RP) by 918, 1560, 1766 and 1958% relative to potato, SSS, *C. africanus*, potato-velum respectively. A similar trend was observed in location B, except that the potato-potato sequence did not have significant effects on RP. Relative to SSS, *C. africanus*, potato-velum, the cultivation of potato as a successor crop resulted in a highly significant increase in RP by 551,196, 1092% respectively. Results showed that the potato crop in Sequence 2 did not have significant effects on second stage juveniles (J2) in the soil at both locations.

Conclusions

The results obtained suggest that none of the mechanisms tested was effective in managing nematodes under short-term rotational systems.

31) Manipulation of planting density affects partitioning of water use in chickpea (*C. arietinum* L.)

Presenter: RH Choma (chomahr23@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RH	Choma	University of Venda
JBO	Ogola	University of Venda
TM	Leboho	University of Venda

Introduction

Increasing crop water use efficiency (WUE) requires an understanding of how crop production is related to determining factors such as transpiration (T), direct evaporation of water from the soil beneath the crop canopy (Es), water capture and water retention. A preliminary study in North East part of South Africa reported an increase in water use and WUE of chickpea (*C. arietinum*) with an increase in planting density (PD) (Ogola and Thangwana, 2013). However, the study did not look at the effect of PD on T and Es. Therefore this study assessed the effects of PD on the partitioning of water use of four chickpea genotypes. The hypothesis tested was that higher PD will result in greater WUE through an increase in T and a concurrent decrease in the wasteful Es due to greater canopy cover.

Materials and Methods

A factorial combination of four chickpea accessions (ACC#1, ACC#3, ACC#4 and ACC#7) and three planting densities (20, 25 and 33 plants m⁻²; low, medium and high PD, respectively) were arranged in a Randomized Complete Block Design and replicated three times in a field experiment during winter season. Changes in the soil water content was measured by monitoring soil moisture content at 7-day interval using a neutron probe, Es was measured indirectly using soil moisture sensors. Intercepted Radiation was measured using the Ceptometer. EvapoTranspiration was calculated by making use of the water balance equation

Results and Discussion

Genotypes and PD did not affect cumulative Es (16.6 mm), T (92.2 mm), ET (108.7 mm) and Es/ET (15.2%). However, the interaction between genotype and PD affected Es and the proportion of IR during certain periods of crop growth. For example, at 41 Days After Emergence ACC#1 intercepted greater radiation at low and medium PD compared with the other genotypes but the magnitude of the difference was greater at medium planting density. This may suggest that medium PD may be effective for radiation in genotypes having erect canopies at complete ground cover.

Conclusions

The non-significant effect of PD on cumulative Es may partly be attributed to the oversimplification of the inaccuracies of the Intercepted Radiation Technique in estimating Es over an entire crop period. However, although non-significant, cumulative Es was lower at high PD compared with medium PD and low suggesting that manipulation of PD may improve partition of water use of four chickpea genotypes having contrasting canopy structures. Therefore further studies is proposed, incorporating higher PD.

32) Development of a rapid *Macrophomina phaseolina* screening method and the comparison thereof with resistance levels in commercially available maize hybrids

Presenter: M Craven (CravenM@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
B	Janse van Rensburg	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520
M	Craven	Agricultural Research Council – Grain Crops, Private Bag X1251, Potchefstroom, 2520

Introduction

Macrophomina phaseolina (Tassi) Goid is the causal organism of charcoal rot in more than 500 plant species. This fungus flourish under dry, hot conditions and is increasing in incidence and severity. The planting of resistant varieties remains the most effective management practice as crop rotation will be ineffective due to a wide host range. The aims of this study are therefore to 1) evaluate inoculation methods at seedling and adult plant stage for levels of resistance and 2) to establish if seedling screening results correlate to that of field trial screenings, to establish a fast and efficient screening method

Materials and Methods

Twelve cultivars were evaluated in seedling glasshouse trials (induced drought), planted in 72-way seedling trays in a randomised complete block design. Treatments included 1) 0.5 and 2) 1% ground inoculum, 3) horizontal placement of infected kernels and 4) infected toothpicks in cones. Measurements included days to wilting, root- and plant-length 28 days after planting and the quantification of *M. phaseolina* target DNA in the roots with qPCR. A field trial was planted at Potchefstroom during 2017/18, using 30 cultivars in a randomized order, replicated three times. Plants were inoculated at flowering stage with infected toothpicks and rated for charcoal rot infections at soft dough stage.

Results and Discussion

The toothpick inoculation method yielded significantly higher *M. phaseolina* target DNA in the seedling trials ($P < 0.001$). Significant cultivar differences were observed ($P < 0.001$) in the field trial. LS8541BR, PAN5R-591R and PAN4A-156 had the lowest disease ratings (healthy or slightly discoloured at the site of inoculation) and cultivars SC506 and US9616 the highest (100% of the first internode discoloured, with less than 50% discolouration of the adjacent internode). Seedling and adult plant severities correlated for five common cultivars (0.85), indicating that the toothpick seedling screening method is effective and it will be investigated further.

Conclusions

Macrophomina phaseolina resistance information generated with the current study, can now for the first time provide assistance to the industry with regard to cultivar choices and the subsequent management of charcoal rot in maize productions. A potential seedling screening protocol has been identified for the fast and effective screening of maize varieties, and will be refined with future research.

33) Sink-source relationship response of popcorn (*Zea mays* Everta.) to different plant density and fertilizer rates

Presenter: OA Dada (oadada247@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
OA	Dada	Food Security and Safety Niche Area Research Group, North-West University, Mafikeng Campus
FR	Kutu	School of Agricultural Sciences, University of Mpumalanga
S	Mavengahama	Food Security and Safety Niche Area Research Group, North-West University, Mafikeng Campus

Introduction

Appropriate plant spacing results in minimum intra-competition and maximization of soil resources towards higher crop yield per unit area. However, little is known about the soil fertility status under which high plant density grain yield of maize is improved. Therefore, effects of plant density and compost and NPK fertilizer as soil amendment on physiological process of popcorn was investigated in semi-arid conditions at Mahikeng, North West Province, South Africa.

Materials and Methods

The experiment was laid out in split-split fashion with soil amendments (compost and NPK 20-7-3) being the main plot effect; amendment rates (4 and 8 t ha⁻¹ compost, 90 and 180 kg N ha⁻¹ mineral fertilizer, and unfertilized control) the sub-plots and plant density (47 222.22; 56 944.44; 70 833.33 and 95 833.33 plants) as the sub-sub plot. These treatment factors were randomized in a complete block design and replicated three times. Leaf area index (LAI), total dry matter (TDM), relative growth rate (RGR), net assimilation rate (NAR), specific leaf area (SLA), harvest index (HI) and grain yield were determined following standard methods. Data were analyzed using ANOVA and correlation ($p \leq 0.05$).

Results and Discussion

The LAI was significantly highest (403.96) in plots with 56 944.44 plants fertilized with 4 t ha⁻¹ compost. The total biomass was highest (19.08 t ha⁻¹) in plots supplied 90 kg N/ha⁻¹ with 47,222.22 plants which was not significantly different from plots amended with 4 t ha⁻¹ under similar plant density. The highest RGR (0.030 g g⁻¹ d⁻¹) was recorded in plots with 56 944.44 plants and fertilized with 8 t ha⁻¹. Also, the NAR was highest (1.082 g m⁻² d⁻¹) under high plant density (95 833.33 plants) with low compost rate (4 t ha⁻¹) relative to other treatments. The highest SLA (786.50 m² g⁻¹) was observed in plot supplied 90 kg N ha⁻¹ and 56 944.44 plant density which was significantly different from other treatments. However varying plant density and soil amendment rates had not significant ($P \geq 0.05$) on the HI of popcorn. The ear weight was highest (6.5 t ha⁻¹) in plots fertilized with 180 kg N ha⁻¹ and 47 222.22 plant density. The RGR significantly correlated with NAR ($r=0.313$), SLA ($r=0.250$) but is positive and strongly correlated with TBM ($r=0.729$) and ear weight ($r=0.710$). The TBM is strongly correlated with ear weight ($r=0.853$). Wide spacing improves biomass accumulation. Application of high rate of fertilizer in plots with high plant density improved grain yield of popcorn in semi-Arid region of South Africa.

Conclusions

High sink-source relationship is directly related to high plant density with high fertilizer rates.

34) Weed management system and compost manure in plantain production: a source of income to educational institution in Niger delta

Presenter: TUU Ekpo (ekpoekpo1980@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TUU	Ekpo	Agricultural Education Dept.College of Education Afaha Nsit, Akwa Ibom State

Introduction

Despite high potentials of plantain to combat hunger, plantain production Nigeria has been hampered by a number of constraints, which have been identified to include soil fertility decline, diseases and weed competition (Akinyemi and Tijani- Eniola, 2001).

Materials and Methods

The experiment was conducted at College of Education, Afaha Nsit, Akwa Ibom State, Nigeria. Ten treatments were replicated three times and laid out in randomized complete block design. The treatments were sweet potato (10 000 plants ha⁻¹), hand-slashing, primextra (1.5 kg ai ha⁻¹) plus egusi-melon (10 000 plants ha⁻¹) and sweet potato plus three levels of compost manure (30, 35 and 40 t ha⁻¹) each. Analysis of variance was carried out on data obtained on weed studies and plantain characteristics. The means were separated using DMRT.

Results and Discussion

Egusi-melon and sweet potato smothered weeds and deprived the weed seeds of sunlight and moisture necessary for germination as reported by Ekpo *et al* (2010). The high quantity of compost manure (40 t ha⁻¹) might influence the agronomic characters of plantain due to release of available exchangeable cations.

Conclusions

The treatment: primextra (1.5 kg ai ha⁻¹) + sweet potato + egusi-melon + compost manure 40 t ha⁻¹ gave the best weed control and enhanced plantain bunch yield; hence recommended.

35) Yield and postharvest quality improvement of sweet pepper using plant growth regulators

Presenter: H Fotouo (fotouoh@yahoo.fr, fotouomakouateh @tut.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
H	Fotouo	Department of Crop Sciences, Tshwane University of Technology,
NP	Mbandlwa	Department of Crop Sciences, Tshwane University of Technology,
MM	Maboko	Vegetable and Ornamental Plants, Agricultural Research Council-Roodeplaat, Pretoria, South Africa
D	Sivakumar	Department of Crop Sciences, Tshwane University of Technology, Pretoria

Introduction

Sweet pepper is an important fresh commodity, but its production is constrained by high temperature, which increases the incidence of blossom-end rot and sunscalds, causing substantial yield loss. Post-harvest losses become a major constraint during marketing. The use of plant growth regulators (PGRs) introduced promising alternatives to fertilisers to improve plant productivity and shelf life. The study examined the effects of naphthalene acetic acid (NAA), Kelpak and their combination on yield and postharvest quality parameters of hydroponically grown yellow sweet pepper (*Capsicum annuum* L.).

Materials and Methods

Seedling root plugs were soaked in Kelpak at 10 ml L⁻¹, 3 h before transplanting. Thereafter, solutions of NAA (20 mg L⁻¹) and Kelpak (5 ml L⁻¹) were applied to foliage at 15, 30 and 45 days after transplanting. Sweet peppers were harvested at maturity and stored at 7.5°C, evaluating random samples on days 0, 7, 14, and 21.

Results and Discussion

The application of plant growth regulators did not improve the total and marketable yield significantly. Kelpak and NAA application minimised weight loss and colour degradation during storage. All treatments significantly improved the firmness and pH compared to the control. The combination of NAA+Kelpak favoured accumulation and retention of total soluble solids up to 14 d of storage. Fruit from Kelpak and NAA+Kelpak yielded higher ascorbic acid content than all other treatments. The application of NAA+Kelpak significantly retained higher carotenoid contents, whereas NAA, Kelpak their combination enhanced accumulation of total phenols over time with minimal impact on antioxidant capacity.

Conclusions

The application of plant growth regulators can improve the quality of yellow sweet peppers during postharvest storage.

36) Agronomic development of rain-fed maize in response to plant population and row spacing under no-tillage

Presenter: SJ Haarhoff (17807328@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
SJ	Haarhoff	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland 7602
TN	Kotzé	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland 7602
PA	Swanepoel	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland 7602

Introduction

Maize plays a significant role in meeting global and local food demands. Globally, recent yield increases is attributed to genetic advances and improved agronomic practices such as plant population and row spacing. Tillage practices further influence the relationship between population density and maize yield. This highlighting the importance to adjust plant population and row spacing accordingly to attain optimal yields. The aim of the study was to explore the agronomic development of rainfed maize in response to varying levels of interplant competition under no-tillage practices.

Materials and Methods

A trial was established during the 2017/2018 growing season near Ottosdal, North West. Main plots were row spacing (0.52 and 0.76 m), while plant population formed sub-plots ranging from 20 000 to 60 000 plants ha⁻¹. The John Deere 2117 and Jumil 2670-EX-POP no-tillage planters was used for the 0.76 and 0.52 m row spacing plots, respectively. A single Pioneer (P2864WBR) cultivar was used. Previous crop was maize, and the site has been under no-tillage for seven years. Plant architecture and development were evaluated in 30 day intervals until harvest by randomly selecting five plants per plot. Measurements included biomass production, leaf area index, grain yield and yield components.

Results and Discussion

At 0.76 m row spacing, a difference in biomass production was found between 20 000 and 50 000 plants ha⁻¹ ($P < 0.05$), while a difference in grain yield was found between 50 000 and the lower plant populations ($P < 0.05$). These parameters remained constant ($P < 0.05$) at 0.52 m row spacing, except that biomass production and grain yield decreased ($P < 0.05$) when plant population were more than 38 000 plants ha⁻¹. Maximum biomass production in 0.76 m row spacing was at 50 000 plants ha⁻¹. Tiller production was highly affected ($P < 0.05$) by plant population at both row spacings. Higher ($P < 0.05$) leaf are indices were obtained at high plant populations due to the increased number of plants per unit area. Grain yield per plant decreased ($P < 0.05$) as plant population increased at both row spacings, demonstrating the effects of varying levels of interplant competition for soil resources.

Conclusions

Overall, agronomic development was more affected by plant population at 0.76 m compared to 0.52 m row spacing. Increasing plant population to 50 000 plants ha⁻¹ at 0.76 m led to higher yields, while no yield benefits were achieved with high plant populations at 0.52 m row spacing. It is suggested that the trial be repeated as different seasonal growing conditions will provide alternative agronomic responses.

37) The influence of maize plant population and row spacing on soil microbial carbon cycling potential under no-tillage

Presenter: SJ Haarhoff (17807328@sun.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
SJ	Haarhoff	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland, 7602
TN	Kotzé	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland, 7602
J	Habig	MicroLife Research Centre, Agri Technovation, Louw Street, Wellington, 7655
PA	Swanepoel	Department of Agronomy, Stellenbosch University, Private Bag X1, Matieland, 7602

Introduction

β -Glucosidase activity is a sensitive indicator of soil quality. It fulfills an important role in catalysing the hydrolysis and biodegradation of various β -glucosides present in crop residues. The quantity and quality of organic matter inputs directly influence soil microbial diversity, biomass and activity. Both plant population and row spacing influences rooting volume. Therefore, different combinations of these agronomic practices can stimulate soil microbial activity differently. The aim of this study was to investigate the effects of maize plant population and row spacing on β -glucosidase activity and active C levels under no-tillage.

Materials and Methods

A field trial was carried out near Ottosdal, North West Province, during the 2017/2018 growing season. The trial was laid out in a split-plot design. Main plots were row spacing (0.52 and 0.76 m), and plant population formed sub-plots ranging from 20 000 to 60 000 plants ha⁻¹, respectively. Representative soil samples were taken to 100 mm depth at 60, 90 and 120 days after emergence (DAE) and at harvest. Samples were analysed for β - glucosidase activity. Active C assays were conducted on soil samples collected at harvest.

Results and Discussion

Although no significant changes were observed at 0.52 m row spacing, a significant increase ($P < 0.05$) in β - glucosidase activity were observed at 40 000 and 50 000 plants ha⁻¹ from 120 DAE to harvest at 0.76 m row spacing. Maximum β -glucosidase activity was found at 60 000 and 40 000 plants ha⁻¹ for the 0.52 and 0.76 m row spacings, respectively. This is likely linked to the higher rooting volume present in the inter-row area of high plant populations, as crops have the ability to attract specialised bacterial populations to their rhizosphere by released exudates. No treatment effects ($P < 0.05$) for active C was observed.

Conclusions

The current study indicates that plant population and row spacing influences β -glucosidase activity throughout the growing season. At plant populations of more than 30 000 plants ha⁻¹, β -glucosidase activity increased from 60 DAE to harvest. Across all treatments, a plant population of 60 000 plants ha⁻¹ at 0.52 m row spacing exhibited the highest β -glucosidase activity.

38) Agromorphological diversity of Bambara groundnut

Presenter: NC Hlanga (thulatlou@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NC	Hlanga	thulatlou@gmail.com
AT	Modi	ModiAT@ukzn.ac.za
T	Mabhaudhi	Mabhaudhi@ukzn.ac.za

Introduction

Many countries in Sub-Saharan Africa are affected by multidimensional food insecurity of access, nutrition and economics (Kruger *et al.*, 2012). Climate change related drought reduces food production of common crop species (Lee *et al.*, 2012). There is a need to diversify food crops. The first step is to identify naturally adapted orphan crops and improve their value for food security. Bambara groundnut (*Vigna subterranean*) is a food legume whose agronomic and genetic characteristics are not well studied. Agro-morphological characterization leads to phenotype and genetic information (Zenabou *et al.*, 2014). Further, this provides opportunities for identifying proxy traits that can be used to indirectly improve desirable traits such as yield and ability to resist abiotic and biotic stress (Zenabou *et al.*, 2014). The aim of the study was to evaluate physiological and agro-morphological traits of twenty Bambara groundnut lines that could be used to develop selection strategies for variety development.

Materials and Methods

Twenty Bambara groundnut lines were evaluated between December 2017 and May 2018 under field conditions in Pietermaritzburg (29°37'12"S; 30°23'49"E), South Africa. Soil analysis results allowed application of recommended fertiliser under rainfed conditions. A completely randomised experiment design, with three replications, was used to determine growth related morphological and physiological traits from crop establishment to harvest maturity. Changes in leaf number, plant height, leaf size, canopy diameter, chlorophyll content index, stomatal conductance, flowering and yield components were determined.

Results and Discussion

Bambara groundnut lines showed significant differences ($P < 0.05$) for the fourteen traits. Differences in rate and total emergence among lines suggested potential linkage with seed quality traits, including seed coat thickness and germination metabolism. Plant size differed with respect leaf number, height and canopy size. These differences were linked to growth physiology of stomatal conductance and chlorophyll content. Preliminary genetic analysis using electrophoresis showed a weak correlation with morphological traits.

Conclusions

The diversity exhibited by the landraces for the measured characteristics is important as crop improvement depends on the extent of variation within a population under investigation. Future research will investigate genotype x environment interaction with respect to agronomic traits.

39) Crop sequence effect on the yield of barley and wheat

Presenter: WR Langenhoven (johannst@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
WR	Langenhoven	Department of Agriculture, Western Cape, Elsenburg
JA	Strauss	Department of Agriculture, Western Cape, Elsenburg

Introduction

Rain-fed agricultural production systems in the southern Cape area of Western Cape has been based on long rotation systems consisting of lucerne followed by cereal cash crops, especially wheat and barley. Production was based on conventional practices. The introduction of conservation agriculture principles has shown great benefit in the sustainable production of both these crops. The aim of this paper is to evaluate the effect of crop sequence within short rotation systems on yield of both these cereal crops.

Materials and Methods

The Tygerhoek long term trial was implemented in 2002. It is currently in its 17th year of production. The main systems tested are pasture/pasture/crop; pasture/pasture/crop/crop and pasture/crop/pasture/crop and the pure cash crop systems have a four and six year combination. Each of the pasture/crop systems have several combinations of annual legume pasture (medic-clover) and different cash crops with distinct crop sequences. All possible 3 year sequences ending with either barley or wheat was extracted from the different systems to determine if crop sequence had an effect on the yield of the two main cereal crops. This resulted in 5 distinct cropping sequences ending with barley and 12 ending with wheat. Yield data from 2005 to 2017 was analysed using the SAS statistical analysis program and significant differences were measured at the 95% confidence level.

Results and Discussion

Cropping sequence had no significant effect on the yield of barley. The sequence of pasture/pasture/barley had the highest average yield over years and sequences that included legume pastures tended to achieve a higher average yield than pure cash crop sequences. The effect of cropping sequence on the yield of wheat had a bigger variation than the yield of barley. The two cropping sequences containing a pasture and a canola year preceding the wheat year (canola/pasture/wheat and pasture/canola/wheat) yielded significantly higher than the two sequences that contained two wheat years (pasture/wheat/wheat and wheat/canola/wheat). All sequences that included legume pastures or a legume cash crop tended to have higher average yields than the sequences containing cash crops only. The only exception is the sequence pasture/wheat/wheat. The latter might be due to weed control problems with wheat following wheat.

Conclusions

Crop sequence did not have a pronounced effect on the yield of barley and wheat. All sequences that included a single or two legume pastures or a legume cash crop tended to have higher average yields than the sequences without a legume.

40) Characterisation of the antioxidant properties and phenolic composition of twelve Sweet potatoes clones developed over the past 20 years in South Africa

Presenter: KE Lodama (lodamakm@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
KE	Lodama	Agricultural Research Council, Vegetable and Ornamental Plants (VOP) Private Bag x293, Pretoria 0001, South Africa
S	Laurie	Agricultural Research Council, Vegetable and Ornamental Plants (VOP) Private Bag x293, Pretoria 0001, South Africa
B	Ncube	Agricultural Research Council, Vegetable and Ornamental Plants (VOP) Private Bag x293, Pretoria 0001, South Africa
AR	Ndhlala	Agricultural Research Council, Vegetable and Ornamental Plants (VOP) Private Bag x293, Pretoria 0001, South Africa.

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is a perennial crop grown as annual. It is a root crop that provides food to a large segment of the world population, especially in the tropics where the bulk of the crop are cultivated and consumed. Right now, sweet potato are useful in Africa to combat a widespread vitamin A deficiency that result in blindness and even death for 250,000 – 500,000 African children annually. The aim of the study was to characterize 12 sweet potato clones developed over the past 20 years in terms of antioxidant properties, and phenolic and nutritional composition.

Materials and Methods

Matures tubers of the twelve sweet potato breeding line cultivars (2008-8-5, 2005-5-5, 1987-2-1, 1990-10-2, 2008-3-1, 199062.1 X Ndou, 1987-19-5, 2000-12-16, 1999-5-1 X Monate, Bophelo, 1988-7-7 and 2012-8-4) grown at the Agricultural Research Council (ARC) experimental farm, Roodeplaat, Pretoria were harvested and prepared for analysis 2 days after harvesting. Fresh plant materials were ground into powder and extracted non-sequentially (1:20 w/v) with 50% aqueous methanol in an ultrasonic bath for 1 h. Fresh extracts of 50% aqueous ethanol were used in the phytochemical analysis and antioxidant assays, the data was subjected to statistical analysis of variance (ANOVA) using Genstat version 18.

Results and Discussion

In this study, clones 1988-7-7 and 2012-8-4 showed the highest level of total phenolic content at 0.9,5 and 0.8,0 g GAE 100g⁻¹ DW, respectively. While the same clones showed also the highest levels of flavonoid content, 2012-8-4 at 0.29.0, 1988-7-7 at 0.28.0 mg CTE g⁻¹ DW. Using 1,1-diphenyl-2-picryl hydrazyl (DPPH) to determine the radical scavenging activity indicated 2012-8-4 and 2000-12-16 to have the highest activity with the lowest IC₅₀ of 0.0070 ± 0.000 and 0.0076 ± 0.000 mg ml⁻¹ respectively.

Conclusions

The twelve clones of sweet potato showed large variation in reducing power. Thus, storage roots of selected clones of sweet potato can be used as potential source of natural antioxidants. Characterization of the nutritional components enabled identification of potential breeding parents.

41) Canola seed oil content in the rain-fed environment of the Western Cape

Presenter: PJA Lombard (pietl@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
PJA	Lombard	Private Bag x1, Elsenburg, 7607
JA	Strauss	Private Bag x1, Elsenburg, 7607
L	Smorenburg	Private Bag x1, Elsenburg, 7607

Introduction

Canola is a crop that is produced for its high quality oil. The area under production in the Western Cape has doubled in the past seven years to 84 000ha in 2017. The oil content varied from 35% to 43% in the cultivar trials from 2014 to 2017. Oil is deposited in the seed during seed development, the period from flowering for 60 days onwards. Triazine-tolerant (TT) varieties has, in general, a lower oil content than other genotypes. Oil content is a genetic characteristic but is also influenced by climate and nitrogen availability.

Materials and Methods

Canola cultivar trials were planted during the 2014 to 2017 seasons in both the Swartland and southern Cape (seven trials in each area). Ten cultivars was used in all four seasons and all trials were replicated three times. The cultivars is divided into three genotypic groups namely, conventional-, TT- and Clearfield types (CI). The trials were direct harvested and were allowed to fully develop before harvest. The seed oil was measured with a near-infrared spectroscopy using uncrushed seed.

Results and Discussion

In the southern cape there was no significant difference between the cultivars for 2014, 2015 and 2016, however in 2015 the oil content of the CI-type was significantly higher. The mean oil content over the four seasons did not varied between genotypes (40.1%). There was no significant difference in oil content over the four growing seasons in the Swartland (40 to 40.2%). The mean oil content of the TT-type was between 0.1-0.2% lower than the other genotypes in the Swartland. The cultivar with the highest oil content from each genotypic group was Belinda (42% and 40.2%), Hyola 577CI (41.8% and 41.2%) and Hyola 559TT (41.6% and 41.3%), in the southern Cape and Swartland respectively.

Conclusions

There was no significant difference in oil content between different genotypes. However, oil content was strongly related to specific cultivars.

42) Influence of environment on oil content of Canola

Presenter: PJA Lombard (pietl@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
PJA	Lombard	Western Cape Department of Agriculture. Private Bag x1, Elsenburg,
JA	Strauss	Western Cape Department of Agriculture. Private Bag x1, Elsenburg,
L	Smorenburg	Western Cape Department of Agriculture. Private Bag x1, Elsenburg,

Introduction

Canola is an oilseed crop produced under rain-fed conditions in the Western Cape. Climatic conditions varies from a temperate climate in the eastern part of the southern Cape to a Mediterranean climate in the Swartland. Both areas have cool winters with higher temperatures in the spring during the seed fill period. Oil is formed in the seed during the 60 day period from flowering until the plant is physiologically mature. Oil content is a genetic characteristic is influenced by available soil water and temperature during the seed fill period. Oil accumulation in the seed follows an s-curve that starts to increase rapidly from 20 days after seed fill starts. There is a positive correlation between seed yield and oil content (Edwards, 2011). The aim of this paper is to compare the two production areas in terms of the environmental effect on oil content.

Materials and Methods

Canola cultivar trials were planted in the 2014 to 2017 seasons in both the Swartland and southern Cape (seven trials in each area). The data used for this study included that of all four production seasons as well as all trial sites, with three replicates each. Ten cultivars were used in the trial and their data were pooled for this study. The trials were direct harvested and were allowed to fully develop before harvest. The seed yield was determined (kg ha^{-1}) and seed oil content was measured using near-infrared spectroscopy. Data was analysed using the SAS statistical analysis program.

Results and Discussion

Cultivars were grouped per growing season for the southern Cape and Swartland, respectively. The seed yield in the southern Cape varied between 1970 and 2787 kg ha^{-1} . The oil content showed an inverse response to seed yield which is in contrast with previous findings. The seed yield in the Swartland varied between 1381 and 1721 kg ha^{-1} . Seed yield and oil content correlated significantly in the Swartland production area.

Conclusions

Location has a significant effect on oil content in this study. The inverse response in the southern Cape can be attributed to high temperatures during seed fill or high nitrogen levels in the soil due to mineralisation.

43) The effects of phosphorus fertiliser and *Bradyrhizobium* inoculation on dry matter and nutrients accumulation in chickpea (*Cicer aritenum* L.) genotypes

Presenter: V Madzivhandila (mvhulenda@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
V	Madzivhandila	University of Venda, P.O. Box 821, Phangami 0904, South Africa
JBO	Ogola	University of Venda, Private Bag X5050, Thohoyandou 0950, South
ST	Maseko	Tshwane university of technology

Introduction

Crop productivity in the semi-arid regions of Limpopo Province is limited largely by the physical constraints of inadequate water, high temperatures and poor soils. The use of drought tolerant legume crops such as chickpea may be an important food security crop for smallholder resource-poor farmers in the dry environments of Limpopo Province, South Africa (Thangwana and Ogola 2012; Matthews *et al.* 2011). Chickpea has the ability to fix atmospheric nitrogen (N) for its growth. However, chickpea productivity not only depends on N fixation or dry matter accumulation, but also the need of effective nutrient partitioning to seed, a key component to overall yield. Therefore this study assessed the effect of phosphorus (P) fertilizer application and rhizobial inoculation on dry matter and nutrients accumulation in chickpea.

Materials and Methods

A field experiment was undertaken at University of Venda Thohoyandou and University of Limpopo's experiment farm Syferkuil in winter 2017 using a factorial combination of two P rates (0 and 90 kg P ha⁻¹), two desi chickpea genotypes (ACC#1 and ACC#5) and two rhizobial inoculation levels (with and without Rhizobium) were laid out in a randomized complete block design with three replications. Aboveground biomass, number of pods per plant (NPP), number of seeds per pod, hundred seed weight (100-SW), grain yield and harvest index (HI) were determined at harvest maturity.

Results and Discussion

Grain yield was greater in Syferkuil (3312 kg ha⁻¹) compared with Thohoyandou (2409 kg ha⁻¹) respectively. Grain yield was greater in ACC#5 (2322.0 kg ha⁻¹) compared with ACC#1 (2598.0 kg ha⁻¹) at univen. At Syferkuil ACC#5 (3312 kg ha⁻¹) had greater compare to ACC#1(2896 kg ha⁻¹). Furthermore application of 90 kg P ha⁻¹(3259 kg ha⁻¹) increased the grain yield compared to 0 kg ha⁻¹ (2921 kg ha⁻¹). Moreover, inoculation affected the grain yield. The greater grain yield at 90 kg P ha⁻¹ compared to the control in the current study was probably due to an increase in crop biomass (at harvest maturity) in both cases. It is likely that fertilizer P application increased canopy growth and hence grain-filling duration and remobilization of assimilates to the developing grains

Conclusions

Our findings show that inoculation and P application may improve chickpea productivity by increasing yield and Syferkuil may be the best environment for chickpea production and that ACC#5 is probably the most adapted genotype in this region.

44) Host-status and host-sensitivity of sweet potato cultivar 'Blesbok' to *Meloidogyne javanica*

Presenter: NV Makhado (ndemedzo@hotmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NV	Makhado	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727
KM	Pofu	Agricultural Research Council-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727

Introduction

Root-knot (*Meloidogyne* species) nematodes could cause serious challenges in successful production of sweet potato (*Ipomea batatas* L.). Current research efforts are focusing on the use of nematode-resistant cultivars as an alternative strategy for managing *Meloidogyne* species population densities. During the screening study, cv. 'Blesbok' was shown to be non-host to *M. javanica*, but was a host to *M. incognita* races 2 and 4 (Pofu *et al.*, 2017). The objective of this study was to determine the host-status and host-sensitivity of sweet potato cv. 'Blesbok' to *M. javanica* under greenhouse conditions.

Materials and Methods

Twenty-cm-diameter plastic pots were filled with steam-pasteurised loam soil and placed on greenhouse benches at 0.3 m × 0.3 m spacing. Rooted sweet potato cuttings, obtained from the Agricultural Research Council-Vegetable and Ornamental Plants were transplanted at one cutting per pot. At three leaf-stage, plants were inoculated at 0, 5, 25, 125, 625, 3 125 and 15 625 eggs + second-stage juveniles (J2) from *M. javanica* using isolates previously cultured on tomato cv. 'Floradade'. The treatments were laid out in a randomised complete block design, with six replicates. Plants were fertilised once at five leaf-stage using 2 g NPK 2:3:2 (26) and NPK 2:1:2 (43). Insect pests were scouted and monitored on daily basis, whereas a disease management programme was not developed.

Results and Discussion

At 56 days after inoculation, inoculation less than 125 eggs and J2 and greater than 625 eggs and J2, the RF values were greater and less than one respectively. None of the plant variables were affected by nematode infection. In nematology, there are two forms of nematode resistance, namely, pre-infectious and post-infectious nematode resistance (Pofu *et al.*, 2017). The post-infectious nematode resistance is the only one that can be used in nematode plant breeding programs (Pofu *et al.*, 2017). The nematode resistance is described using two concepts: (a) host-status and (b) host-sensitivity (Seinhorst, 1965).

Conclusions

In conclusion, cv. 'Blesbok' was a tolerant host to *M. javanica* and should not be used in crop rotations intended to manage nematodes population densities since it could result in build-up of nematode numbers for the successor crops.

45) Comparison of direct to indirect methods for estimating lucerne (*Medicago sativa* L.) biomass

Presenter: J Makuni (josiahmakuni@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
J	Makuni	Department of Agronomy, Stellenbosch University, Private Bag X1 Matieland 7602
J	Labuschagne	Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607
PA	Swanepoel	Department of Agronomy, Stellenbosch University, Private Bag X1 Matieland 7602

Introduction

Lucerne is an important fodder crop used for grazing and haymaking. Currently in South Africa there is no uniform data collection method for lucerne. The standard method for determining lucerne yield is the cut-and-dry method. It is labour intensive, costly and time consuming. There is a need to identify if use of non-destructive methods can be used to accurately estimate yield in a time-efficient manner. The aim of this study was to calibrate a ceptometer, metre ruler, rising plate meter (RPM), and unmanned aerial vehicle (UAV) to estimate lucerne herbage yield.

Materials and Methods

The trial conducted at Elsenburg Research Farm was laid out as a randomised block design. Fifteen lucerne cultivars, representing all dormancy groups, were used as treatments, replicated three times. A ceptometer was used to determine light interception by taking ten readings above and below the canopy. Ten plant height readings per plot were taken using a meter stick. Twenty RPM readings per plot were taken as indicator of plant height and density. UAV was flown before and after plot harvest to determine percentage cover of lucerne. Three rings of the same area (0.0975 m^2) were cut to 50 mm above ground level and dried. A sickle bar mower was subsequently used to cut each plot. Fresh weight was recorded using a platform scale and the herbage yield (kg DM ha^{-1}) was determined from the dry matter content from the rings. Pearson correlations were used to calculate linear regressions between the non-destructive methods and herbage yield.

Results and Discussion

The herbage yield ranged from 554.79 to 4084.54 kg ha^{-1} with the mean yield at 1714.81 kg ha^{-1} DM. Variation was caused by seasonal effect. Regressions between actual yield and indirect methods to estimate yield is shown in Table 1. Table 1: Method, regression equation and coefficient of variation (r-value) for estimating lucerne yield. Method Regression r^2 Ceptometer Yield = $1.04(\text{ceptometer}) + 630.85$ 0.55 Metre ruler Yield = $34.09(\text{Plant height}) + 170.19$ 0.50 RPM Yield = $2.17(\text{RPM}) + 457.32$ 0.69 UAV Yield = $1422.2(\text{UAV}) + 158.64$ 0.45

Conclusions

The RPM provided the most accurate results with the r^2 value at 0.69 accuracy compared to the other three yield estimations. Water restrictions cut the data collection short, however more cuts should be done to get more comprehensive results.

46) Land suitability assessment for groundnut (*Arachis hypogaea* L.) production in Polokwane municipality of Limpopo province, Republic of South Africa (RSA)

Presenter: L Mamanyuha (mamanyuhal@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Mamanyuha	Private Bag X9487, 67/69 Biccard Street
MW	Sefara	Private Bag X9487, 67/69 Biccard Street

Introduction

Limpopo Department of Agriculture and Rural Development (LDARD) is tasked with implementation of agricultural policies and programmes meant to improve the livelihood of all Limpopo citizens. A number of programmes are being implemented, including the current Fetsa Tlala Food Production Initiative, which is introduced to support subsistence and smallholder farmers to put one million hectares of land countrywide under cereal crops (maize and beans) by 2018/2019 to alleviate poverty, reduce unemployment and inequality by 2030. Land capability or suitability assessment is identified as one of the pillars crucial for the success of the programme. An internal study conducted by LDADR in 2007, using a Boolean logic (binary logic), reported that Polokwane municipality is unsuitable for groundnuts. This method is not recommended for multicriteria evaluation (MCE) problems and a weighted linear combination (WLC) method is sanctioned for these types of problems.

Materials and Methods

Land suitability evaluation for optimum groundnut production was conducted through the integration of geographic information system (GIS) and weighted linear combination (WLC) analysis. The first step of two-stage evaluation approach was used to evaluate the physical land characteristics of the study area. Seven thematic data layers were collected from Limpopo Department of Agriculture and Rural Development (LDARD) in vector and raster GIS formats, and used within the GIS-based WLC analysis to select land areas for optimum production of groundnut crops. The layers are topography, slope, soils (soil depth and soil texture), summer maximum temperatures, annual average rainfall (MAP) and land-use. Weighted overlay was used for integrating classified datasets into composite suitability map.

Results and Discussion

It is found that Polokwane municipality, as the study area, has land areas of marginal quality for the production of groundnuts. The findings shall be validated first before being utilized, especially when the quality of input datasets is unknown.

Conclusions

Land suitability assessment is crucial for allocating different land use types according to the quality of the land concerned in order to promote sustainable development. A number of methods are available for suitability analysis. Boolean logic is suitable for analysing discrete dataset while WLC is recommended for continuous variable. The results of WLC used in this study show that Polokwane municipality has land areas of marginal quality. However, the results would need to be verified before implementation as the quality of the data is not known. Nonetheless, the same datasets were used in the first study where Boolean logic was used.

47) Seed coat structural and imbibitional characteristics of dark and light coloured Bambara groundnut (*Vigna subterranea* L.) landraces

Presenter: T Mandizvo (takudzwamandizvo@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Mandizvo	Rabie Saunders, Room 344, Scottsville, Pietermaritzburg
AO	Odindo	Rabie Saunders, Room 305, Scottsville, Pietermaritzburg

Introduction

Bambara groundnut is cultivated using landraces of different seed coat colours. However, very few studies have associated the seed coat colour (morphological feature) with other physiological and biochemical processes as underlying the observed differences in seed quality among landraces. This research sought to investigate seed quality characteristics (viability and vigour) of landraces on the basis of seed coat colour with the hypothesis that; seed coat colour could be linked to other properties (physical, physiological, biochemical and ultra- structure) that may account for seed quality with respect to germination, vigour and storage potential.

Materials and Methods

Four landraces were analyzed for differences in seed coat colour and seed coat thickness using a scanning electron microscope (SEM). Seed imbibition, electrolyte conductivity, tetrazolium test, and standard germination tests were combined to evaluate the viability of seeds after deterioration through accelerated ageing (AA) at 42°C and 100% relative humidity (RH) over 5 durations, namely 24, 48, 72, 96 and 120 hours.

Results and Discussion

There were significant differences ($P < 0.001$) among landraces with respect to seed coat colour, seed coat thickness, electrical conductivity (EC), hydration rate, germination rate and length of the measured seedling axis. The light coloured landrace, Kazai, had the highest germination (66.9%) whereas the dark coloured landrace, G340A, had the lowest final germination (53.6%) after 120 hours of seed ageing. Likewise, G340A and Kazai had the highest ($110.33 \mu\text{S cm}^{-1} \text{g}^{-1}$) and lowest EC ($92 \mu\text{S cm}^{-1} \text{g}^{-1}$), respectively. Electron microscope revealed that dark and light seeds had the thickest ($127 \mu\text{m}$) and the thinnest ($104.6 \mu\text{m}$) seed coats, respectively.

Conclusions

This study highlighted that (1) seed coat thickness and colour alone do not account for hydration pattern of Bambara groundnut landraces and (2) Bambara groundnut seeds viability may not necessarily imply good seed vigour.

48) Semi-commercial scale evaluation of advanced Cassava starch cultivars at Mpumalanga Province

Presenter: NR Mashamba (Mashambar@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NR	Mashamba	Agricultural Research Council , Private Bag x 82075, Rustenburg, 0300
ND	Ngobeni	Agricultural Research Council, P/Bag x 82075, Rustenburg, 0300

Introduction

Cassava (*Manihot esculenta* Crantz.) is a shrub, which belongs to the Euphorbiaceae family. Cassava was introduced into South Africa as alternative crop and is grown in Limpopo, Mpumalanga and KZN Provinces of SA. Cassava is the basis of a multitude of products, including food, flour, animal feed, alcohol, starches for sizing paper and textiles, sweeteners, prepared foods and biodegradable products. The products are derived from a number of forms of cassava, ranging from fresh leaves and roots to modified cassava starch. The degree of processing and the technical requirements tend to increase from the fresh form to the modified starch form. The objective of the study was to evaluate adaptability and performance of advanced starch cultivars at Mpumalanga Province.

Materials and Methods

The trials for evaluation of advanced starch cultivars were planted during May/June 2017 in Mpumalanga. The trial design was laid out as a randomised complete block design (RCBD) with thirteen cultivars viz. 98/0002, Msaf2, 98/0505, P1/19, P4/10, UKF2, UKF3, UKF4, UKF5, UKF6, UKF7, UKF8 and UKF9, replicated four times. Plants were harvested 12 months after planting (MAP). Data collected includes plant growth (height and number of branches), fresh tuber yield, number of roots and harvest index (%). Data collected was analyzed using Statistix 10 to develop analysis of variance (ANOVA) tables while means were separated using least significant difference (LSD) of Tukey at $P \leq 0.05$.

Results and Discussion

There was a significant difference between cassava cultivars in plant height , number of branches, number of roots, fresh root, biomass yield yield and harvest index (%) at $P \leq 0.05$. UKF5 and UKF8 produced the highest plants at 180 cm. This accounted for 18.6% above the cultivars average. The shortest plants were observed with UKF3 at 106 cm which was 30.2% below the cultivar's average. Cultivar 98/0505 produced the highest number of branches at 101 branches while UKF3 had the lowest with 19 branches. Highest numbers of roots were produced by UKF4 and UKF6 at 52 roots each. The highest fresh root yield was produced by UKF4 and P1/19 at 78,7 t ha⁻¹ and 74 7 t ha⁻¹ respectively. Cultivars P1/19, UKF2, UKF4 and UKF5 produced highest biomass yield while UKF3, UKF4 and P4/10 had the highest harvest index.

Conclusions

According to the results, all advanced starch cultivars are adapting very well in Mpumalanga Province, with UKF4 and P1/19 producing the highest fresh tuber yield per hectare.

49) Present and future variability of Heat Units for South Africa

Presenter: T C Masithela (tmasithela00@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
T C	Masithela	South African Weather Service
M G	Mengistu	South African Weather Service

Introduction

Heat units, often known as Growing Degree-Days (GDD) are used frequently to assess the timing of biological processes (McMaster and Wilhelm, 1997). The concept of heat units has been used effectively in agricultural sciences (Neild and Seeley, 1977). The GDD is an indicator used to measure amount of heat accumulated above a specific base temperature, and plays an important role to predict plant and insect developmental stages (Castillo *et al.*, 2016). The aim of this study was to investigate the future variations in GDD under Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 emission scenarios in relation to the reference period (i.e. 1976-2005) for South Africa.

Materials and Methods

Present GDD for warm season crops were calculated using daily air temperature data values obtained from (SAWS-obs) and output from RCA4 regional climate model (RCMs) driven by nine CMIP5 GCMs models. The ensemble mean (ENSMEAN) was calculated using all nine models for the period of 1975 – 2005. Out of the nine models only best performing models were selected and then future GDD for warm season crops were calculated using these models for periods of 2036-2065 and 2066-2095 under RCP 4.5 and RCP 8.5 emission scenarios. Accumulated GDD were also calculated for both present and future periods. The model simulations were validated using the gridded air temperature data created using observed data (SAWS-obs). The formula in Eq. 1 was used to calculate the number of GDDs. An average base temperature of 10°C was used for the warm season crops to calculate GDD. $GDD = ((T_{max} + T_{min} / 2)) - T_{base}$ Eq.(1) The daily GDD values were calculated for the growing season over a period of October to April each year for 30 years and then accumulated into seasonal averages.

Results and Discussion

The future projections were obtained under RCP 4.5 and RCP 8.5 and analyzed covering the growing seasons from 2036-2095. The results were derived using historical data for present seasonal accumulated GDD and from the best performing models for future seasonal accumulated GDD. The seasonal accumulated GDDs increased under both RCPs. The increase in the GDDs was higher for RCP 8.5 compared to RCP 4.5. The GDDs are directly dependent on temperature, therefore the change in temperature resulted in the change in GDDs.

Conclusions

The results indicated that there would be an increase in GDDs under both RCPs. These increase in accumulated GDDs will likely have an impact on growth and development of crops.

50) Elevated carbon dioxide and water deficit interaction effects on sugarcane water use and yield – Preliminary findings

Presenter: S Masukume (samuel.segimasukume@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Masukume	Unit of Environmental Science and Management, North West University, Potchefstroom 2550, South Africa
JM	Berner	Unit of Environmental Science and Management, North West University, Potchefstroom 2550, South Africa
PDR	Van Heerden	South African Sugarcane Research Institute, Mount Edgecombe, 4300

Introduction

Effects of climate change, through its associated symptoms on sugarcane growth and development seems inevitable. Studies on sugarcane grown under elevated CO₂ and well-watered conditions show a reduction in stomatal conductance (gs) and associated increase in water use efficiency (WUE). Hence, reduced gs coupled with increased WUE under elevated CO₂ and soil water deficit conditions may delay the effects of drought stress, which could stimulate biomass production due to partial stress avoidance. A pilot experiment was conducted to investigate the mediated benefits of elevated CO₂ and water deficit interaction on a drought sensitive sugarcane variety. The findings of this pilot experiment are reported in this paper and possible refinements to trial methodology, to be implemented in the subsequent main experiment, will be discussed.

Materials and Methods

A pot experiment was conducted at North-West University in Potchefstroom during the 2017-2018 growing season using an Open Top Chamber (OTC) facility which allowed controlled CO₂ fumigation. The interactive effect of elevated CO₂ [ambient (± 400 ppm); double-ambient (750-800 ppm)] and drought stress [well-watered (2 L day⁻¹ pot⁻¹); drought stress (1 L day⁻¹ pot⁻¹)] on physiology and above-ground biomass components were determined in variety NCo376. Two way analysis of variance was done using GenStat 18th and means were separated with least significant difference ($P < 0.05$).

Results and Discussion

Leaf level stomatal conductance (gs) was reduced by 45% and 26% respectively under drought and elevated CO₂ conditions resulting in a 39% (drought stress) and 18% (elevated CO₂) reduction in E. WUE increased by 52.4% under elevated CO₂ and drought stress conditions over elevated CO₂ and well-watered conditions owing to lower transpiration rate. Dry biomass components were only significantly influenced by drought stress while sugar yield was not significant. Limitations to plant growth, owing to overcrowding of the crop in chambers during the initial vegetative stage were identified. This possibly limited crop growth and development of significant CO₂ and water treatment interactions.

Conclusions

On the pilot experiment, the main effects of elevated CO₂ and drought stress had a profound effect on plant physiology and limited influence on plant biomass partitioning and sugar yield. Crop grown under elevated CO₂ and drought resulted in the highest WUE indicating the direct benefit of reduced gs. Possible refinements to the main experiment include pre-calibration of the soil moisture sensors relative to field capacity of the soil media. Irrigation in the well-watered and drought treatment will be increased to 4 L day⁻¹ pot⁻¹ and 2 L day⁻¹ pot⁻¹ respectively coupled with distribution of this water volume over eight irrigation cycles per day.

51) Promoting on-farm conservation and multiplication of plant genetic resources in selected provinces of South Africa

Presenter: LA Matelele (matelelela@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
RP	Sema	Department of Agriculture, Forestry and Fisheries, National Plant Genetic Resources Centre, P/Bag X 973, Roodeplaat Pretoria 0001
NL	Maluleke	Department of Agriculture, Forestry and Fisheries, National Plant Genetic Resources Centre, P/Bag X 973, Roodeplaat Pretoria 0001
LA	Matelele	Department of Agriculture, Forestry and Fisheries, National Plant Genetic Resources Centre, P/Bag X 973, Roodeplaat Pretoria 0001, RSA; 2Chinese Academy of Agricultural Sciences – Institute of Agricultural Resources and Regional Planning, 12 Zhongguancun Southern Street, Haidian District, Beijing 100081, People’s Republic of China

Introduction

The South African smallholder’s seed and food production systems are threatened in the face of growing food demand, climate change, global warming, declining land and resources and environmental degradation. Furthermore, farmers are increasingly purchasing more seed and losing locally adapted varieties with associated traditional knowledge and skills in selection and seed storage. Consequently, the urgent need to conserve and sustainably utilize plant genetic resources (PGR) is critical. The aim was to promote the conservation and utilization of PGR for food and agriculture in selected provinces of South Africa.

Materials and Methods

An exercise was conducted in the Free State and the Northern Cape Provinces whereby a total of 14 and 9 farmers, respectively, were participating. These farmers had initially deposited their PGR in the National Plant Genetic Resources Centre (NPGRC) in 2005 for conservation purposes. A structured questionnaire was used to gather information linking to the conservation and sustainable use of PGR and these was done in 2017/2018 planting season in both provinces.

Results and Discussion

The results revealed that the majority of participating farmers from the Northern Cape Province were woman, recording 88.9%. This was not the case in the Free State Province, wherein both male and female participating farmers were equal (50%). From the PGR that the participating farmers are planting in the Northern Cape Province, it was observed that the highest planted PGR was watermelon, recording 27.6%, whereas pumpkin, melon, sweet sorghum and calabash were the least planted PGR (6.9%). On the other hand, pumpkin was planted by the majority (26.0%) of farmers in the Free State Province, and Bambara was the least planted PGR (2.0%). In both provinces, farmers indicated a need for crop rotation.

Conclusions

The results indicated that the need for the conservation of plant genetic resources for food and agriculture cannot be over emphasized. These conservation of PGR at the farmers’ fields was emphasized and it supplements the ex-situ conservation at the NPGRC. The continuous conservation and multiplication of these PGR at the farmers’ level will ensure that households are food secured thereby dealing with food insecurity issues of the country. There is need of collaborative effort from different stakeholders in promoting the use and nutritional benefits of these PGR for food and agriculture

52) Effect of nitrogen fertilizer levels on grain yield and yield components of dry bean (*Phaseolus vulgaris* L.) varieties in Limpopo province

Presenter: R Mathobo (rudzanimathobo@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
R	Mathobo	Limpopo Department of Agriculture and rural development, Research Services, Private Bag X 9487, Polokwane 0700
MR	Ngwepe	Limpopo Department of Agriculture and rural development, Towoomba Research Station, Private bag X1615, Bela-Bela 0480

Introduction

Dry bean is one of the most important field crops in South Africa due to its high protein content and dietary benefits. The yield of dry bean is very low in both developed and developing countries (Fageria, 2009) due to biotic and abiotic stresses (Fageria *et al.*, 2015). Dry bean is known as poor nitrogen fixer probably due to its short growing season (Liebenberg *et al.*, 2002), therefore dry bean depend more on the nitrogen fertilizer application than the other legumes like cowpea. The objective of the study was to determine the effect of nitrogen fertilizer levels on dry bean grain yield and yield components in Limpopo province.

Materials and Methods

The trial was planted at Towoomba Research Station in Bela-bela Municipality, Limpopo Province during 2013 and 2014 growing season. It is a 3x3 factorial experiment in a split plot design. Three varieties of dry beans are all red speckled which are Jenny, Kranskop, and OPS-RS2 and three levels of nitrogen 0, 30 and 60 kg ha⁻¹. The plot consisted of 4 rows which are 5 m long. Within row spacing of 7.5 cm and between row spacing of 90 cm. Nitrogen levels were the main plot and dry beans varieties was the sub plot. The fertilizer was applied as a topdressing fertilizer in the form of Lime ammonium nitrate (LAN) 28% N. The trial was replicated three times. The following data was collected: chlorophyll content, plant height, number of seeds per plant, number of pods per plant, hundred seed mass, grain moisture content and grain yield.

Results and Discussion

The results of the combined analysis for 2013 and 2014 revealed that grain yield, number of seeds per plant, number of pods per plant and hundred seed mass were significantly influenced by the interaction relationship between year, dry bean variety and nitrogen level ($P \leq 0.01$). The results indicated that the highest grain yield was produced by OPS-RS2 with 30 kg N ha⁻¹ during 2013 (2.4 t ha⁻¹). The maximum hundred seed mass was produced by Kranskop with 30 kg N ha⁻¹ during 2014 (59 g). The highest number of seeds per plant and number of pods per plant was produced by OPS-RS2 with 30 kg N ha⁻¹ during 2013 (86.8) (24.67) respectively.

Conclusions

The fertilizer application rate of 30 kg N ha⁻¹ was found to be the best for higher grain yield production, maximum number of seeds per plant and number of pods per plant for dry bean production.

53) Evaluation of genotype and environment effects on yields for medium – long season maize hybrids under dry land in South Africa.

Presenter: Z Mavunganidze (ziramavunganidze@yahoo.co.uk)

Initials	Surname	Authors Company/Organisation and Postal Address
Z	Mavunganidze	Agricultural Research Council, P Bag X1251, Potchefstroom, South Africa

Introduction

Cultivar evaluation is an essential exercise in the maize industry that enables the farmers to select the best- adapted cultivar for any particular region. It is quite pertinent that the evaluation be done each year because new cultivars are introduced in the market every year. Genotype X environment (GE) interactions are a challenge to plant breeders because they cause difficulties in selecting genotypes evaluated in diverse environments. The present study was performed to analyze the genotype-by-environment (G×E) interaction for grain yield of commercial hybrids grown in different environments.

Materials and Methods

The adaptability of medium-long season hybrids to a wide range of yield potentials was evaluated during the 2015/16, 2016/17 and 2017/18 production seasons in the eastern and western areas of South Africa under rainfed conditions. Forty maize hybrids were planted for yield adaptability and stability evaluation in thirty locations situated in the Western and Eastern agro-ecological regions. All trials were laid out in a complete randomised design replicated three times. Maize grain yield data was subjected to ANOVA using Genstat statistical package. Yield data was also analysed using the statistical probability method to indicate a cultivars probability to achieve a higher yield than the average of all cultivars. Yield data was also analysed using the additive main effects and multiplicative interaction (AMMI) model.

Results and Discussion

The (AMMI) analysis of variance (additive main effects) showed significant effects for genotypes, environment and the genotype by environment interaction. The Western region had the lowest average yield of 5,85 t ha⁻¹ while in the eastern region had the highest with an average of 9,85 t ha⁻¹. In the West, DKC72-76BR was stable with a 48% yield potential across the yield potentials of 4 to 12 t ha⁻¹. The following cultivars, DKC74-26R, P2137B and DKC75-65BR were some of the most stable cultivars over environments, although not necessarily the best performers in the East. The cultivars, which were high potential in the east, were PAN5A-154, PAN4A-172, DKC72-76BR and P2553WY. Genotypes adapted to low potential environments were KKS8326B, VP8301 and PAN6R-710BR. DKC78-45BRGEN had a 100% potential to obtain 12 t ha⁻¹ grain yield in the Eastern region.

Conclusions

Maize producers should take locations and genotypes into account when selecting cultivars for optimum yields. The superior genotypes identified through the stability analysis, could be used as references for genotype evaluation.

54) Response of cowpea grain yield and soil reaction to applied inorganic, lime and kraal manure in acidic soils of Mhlontlo local municipality, Eastern Cape, South Africa

Presenter: S Mhlontlo (Simphiwe.Mhlontlo@drdar.gov.za)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mhlontlo	Dohne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930
MM	Mbangcolo	Dohne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930
S	Tuta	Mthatha Dam Satellite Station, Private Bag X5262, Mthatha, 5099
L	Blom	Dohne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930

Introduction

Acidic soils in the Eastern Cape Province, coupled with changing climatic conditions necessitate a need to look for alternative approach to crop production. This may include changes in cropping systems and introduction of unaccustomed crops to the region such as Cowpea (*Vigna unguiculata*). Cowpea is grown in a wide range of soils and is known to be tolerant to acidic soils (DAFF 2014). Cowpea seeds and processed food from cowpea could provide rural communities the opportunity to generate income. Cowpea could also be an alternative crop, either in rotation or intercropped with maize. A study was conducted to evaluate the response of cowpea grain yield and soil reaction to the application of inorganic fertiliser, kraal manure and lime.

Materials and Methods

A study was conducted at Mbinja Village in Tsolo. The experiment was arranged in a Randomised Complete Block Design with seven treatments, namely: recommended rate of fertilizer with lime (RFL+), recommended rate of fertilizer without lime (RFL-), 5 and 10 t ha⁻¹ of sheep kraal manure with lime (5KML+ and 10KML+), 5 and 10 t ha⁻¹ of kraal manure without lime (5- and 10KML-) and the unfertilized plot, replicated three times. Soil samples were collected to determine soil physical and chemical properties, soil pH (KCl) and acid saturation (%). At harvesting, grain yield was determined at 12.5 % moisture content and all data were subjected to Statistica version 13.2 for analysis and LSD was used to separate the means.

Results and Discussion

No significant effects of the treatments were observed on selected soil properties at the vegetative phase of cowpea. However, the application of RFL+ and 5KML+ significantly ($p \leq 0.05$) improved acid saturation, but the effect was not significant for pH at harvesting phase. The highest acid saturation (%) at harvesting was observed in the control treatments while the lowest was found in 5KML+ but this did not differ with RFL+. At harvesting, RFL+ and 5KML+ significantly improved grain yield compared to other treatments, while application of 5KML- showed the lowest cowpea yield response.

Conclusions

No effect of treatment was observed at the vegetative phase of cowpea on soil pH and acid saturation. Applications of RFL+ and 5KML+ significantly improved the acid saturation but not pH at harvesting. Both RFL+ and 5KM+ significantly improved cowpea grain yield compared to other treatments. Preliminary results from this study indicate that RFL+ and 5KML+ were essential in improving cowpea grain yield and acid saturation.

55) Screening of cowpea cultivars for canning ability

Presenter: MA Mofokeng (MofokengA@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MA	Mofokeng	Agricultural Research Council-Grain Crops, Private Bag X 1251, Potchefstroom, 2520

Introduction

Cowpea (*Vigna unguiculata*) is a pulse crop containing high protein, vitamins and minerals. It is consumed as a high-quality plant protein source in many parts of the world. Hence, referred to as "poor man's meat" due to the high levels of protein found in the seeds and leaves. However, there are limited efforts for prolonging its shelf life in a form of seed canning in South Africa. The objective of the study was to screen cowpea for canning ability using canning quality traits.

Materials and Methods

The ARC-GC in-house method was used for canning. Hundred grams of seed samples were soaked at 30°C water bath for 30 min and then blanched at 88°C for 30 min. Bean weight after soaking was recorded as Ingo mass. Soaked beans were canned in a tomato puree canning medium and heat sterilized at 121.1°C for 30 min. Cans were left to stabilize for 14 days before opening. Bean splitting and visual appearance were evaluated subjectively on a scale from 1 = poor overall appearance, with splits, cracked seeds or loose skin = split, to 10 = good acceptable appearance without cracks or loose skins and even colour. Mass of washed beans was recorded as drained mass. Completely broken splits beans and loose skins were considered as splits and expressed as a percentage of drained mass. The texture of the canned beans was determined by using the Stable Micro Systems Texture Analyser, which calculates the amount of force required to compress the beans and the force was recorded.

Results and Discussion

Water uptake ranged from 58 to 139.9%, splits ranged between zero and 3.75%, and the force ranged between 1257.6 and 1275.9 N. Out of 90 cowpea genotypes, only 11 genotypes were spoiled and had bad odor. Among the 79 remainders, 7 genotypes had less water uptake compared to the others. RV446, OLOYIN, Glenda, Pan311, RV555 and RV411 had the highest water uptake. RV416, RV411, OLERU, TVU5138, 97K-44935, and RV465, had an excellent appearance with even color, and no cracks or loose skins.

Conclusions

RV 411, Oloyin, RV446, TVU5138, 97K-44935, RV441, RV10 and RV512 had high water uptake, good visual appearance and were without splits. These genotypes are recommended for canning.

56) Monitoring the Occurrence of the Fall Army Worm in the Free State Province

Presenter: S Mogoloagae (seitsiro@fs.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mogoloagae	Free State: DARD, Private Bag x01, Glen, 9360

Introduction

Fall Army Worm (FAW) (*Spodoptera frugiperda*) is a migratory Lepidoteran pest. It has a wide range of host plants; i.e. maize. FAW originates in South America and in 2016, it was reported that FAW was responsible for 30 to 60% of yield loss in West and Central Africa, including Zambia and Zimbabwe. Adult moths of FAW are strong fliers, they spread through strong winds. In February 2017, male moths from Limpopo Province were positively identified as FAW by the Agricultural Research Council-Plant Protection Research Institute. These results confirmed the existence of FAW in South Africa. For the five past seasons (2013/14-2017/18) Free State Province has contributed 59% of maize production in South Africa. Since it has been stated that yield loss caused by FAW can amount up to 60%, this could lead to food insecurity and economic losses. It is against this background that FAW occurrence was monitored in the Free State.

Materials and Methods

Pheromone traps were placed in all 5 Municipal Districts of the Province for monitoring the occurrence of FAW. The traps were placed in 13 towns, along the border of the neighboring Provinces and Kingdom of Lesotho. Moth specimens from the traps were collected on monthly basis during the growing season and were sent to the Department of Agriculture, Forestry and Fisheries laboratory for identification.

Results and Discussion

FAW was positively identified in six of thirteen towns where traps were placed. The six towns were Bothaville, Qwaqwa, Rouxville, Deneysville, Ladybrand and Bainsvlei. FAW was frequently found in Bothaville and Deneysville as compared to other towns. It can be assumed that North West and Gauteng Provinces pose a threat to the Free State Province with regard to the spread of FAW. This is evident by frequent occurrence of FAW during 2017/18 monitoring in Bothaville (North West border) and Deneysville (Gauteng border).

Conclusions

Fall Army Worm is present in the Free State Province. It was found frequently on the border of two (2) neighbouring Provinces; Gauteng and North West.

57) The evaluation of flue-cured and air-cured tobacco breeding lines for resistance to Black Shank (*Phytophthora nicotianae* var. *nicotianae*)

Presenter: P Mphuthi (MphutiL@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
P	Mphuthi	ARC - Industrial Crops, Private Bag X82075, Rustenburg, 0300, South Africa
T	de Beer	ARC - Industrial Crops, Private Bag X82075, Rustenburg, 0300, South Africa

Introduction

Black shank caused by *Phytophthora nicotianae* var. *nicotianae* is one of the most devastating diseases in tobacco production and is widespread in South Africa. The use of resistant cultivars is by far the most important control method against black shank. Nevertheless, resistant cultivars, crop rotation and chemical/biological control should be used in combination to lessen the pathogen inoculum in the soil. The objective of this study was to evaluate the advanced tobacco breeding material (F5) for resistance to black shank.

Materials and Methods

A total of 22 advanced tobacco breeding lines (11 flue-cured tobacco 11 air-cured tobacco) were evaluated for resistance in a *P. nicotianae* var. *nicotianae* infested field. Two cultivars with high susceptibility to this pathogen were also planted as controls. An initial stand count of healthy plants was done one week after transplant when plants were established. Thereafter, healthy plants were counted every three weeks up to week 15 after transplanting. To confirm the presence of the pathogen, samples of healthy plants and those showing symptoms were analysed in the laboratory. The weighted average was calculated from the percentage survival data during the experimental period on a three-weekly basis, starting from the third week after transplanting. The resistance group allocated was calculated according to a published and accepted resistance index.

Results and Discussion

All 11 flue-cured tobacco advanced breeding material, which were evaluated, proved to have high resistance to black shank. Only eight out of the 11 air-cured tobacco advanced breeding material had high resistance to black shank.

Conclusions

Results of this study provide valuable information on cultivar resistance and selection of *P. nicotianae* isolates for future breeding programs in South Africa.

58) Effects of maize, cowpea and soybean rotation on crop yield and soil mineral nutrition under varying NPK fertilizer regimes

Presenter: EA Nemadodzi (Nemadodzie@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
EA	Nemadodzi	ARC-Grain Crops, Private Bag x1251, Potchefstroom, 2520
Z	Mavunganidze	ARC-Grain Crops, Private Bag x1251, Potchefstroom, 2520

Introduction

Cereal-legume rotations have been reported to be the most productive form of crop rotation since the cereals benefit from the nitrogen fixed in the root nodules of legumes. However, nutrient requirements in maize (*Zea mays* L.), cowpeas (*Vigna unguiculata* L.), and soybeans (*Glycine max* L.) crop rotation is lacking. The aim of the study was to determine the effects of cowpea and soybean on crop yield and soil mineral nutrition in a maize cropping system under varying NPK fertilizer regimes.

Materials and Methods

An on-farm study was carried out at Lichtenburg and Ventersdorp in the North West province, South Africa during the 2016/17 and 2017/18 seasons. The study comprised of maize cowpea and soybean in different rotation sequences under two NPK fertilizer levels categorized as high-H (recommended) and low input-L (50 percent of recommended). The experiment consisted of 10 treatment combinations namely; maize-cowpea(H), maize-cowpea(L), cowpea-maize(H), cowpea-maize(L), maize-soybean(H), maize-soybean(L), soybean-maize(H), soybean-maize(L), maize-maize(H) and maize-maize(L) arranged in a randomized complete block design with four replications. Soil samples obtained from a depth of (0 – 15 cm) for each treatment were analysed for pH, organic carbon, total nitrogen and exchangeable cations at the end of the season. Grain yield, stover yield, plant height, stem girth and soil fertility parameters were subjected to analysis of variance using Genstat statistical program.

Results and Discussion

The results presented are for the second season of the study. Maize-cowpea(H) and maize-soybean(H) rotation significantly ($P < 0.05$) resulted in higher stover weight, plant height and grain yield when compared to all other treatments. Maize-maize (L) resulted in the lowest yield when compared to other cropping systems in both sites. The growth parameters and grain yield for maize-maize (H) sequence did not significantly differ ($P = 0.05$) from that of a cowpea-maize(L) combination. Cowpea-maize(H) resulted in 36% higher grain yield than maize-maize(H) sequence, subsequently the cowpea-maize(L) resulted in 53% higher grain yield than maize-maize(L) in Ventersdorp. The grain yield for, cowpea-maize (H) in Lichtenburg was 27% higher than maize-maize (H) while the cowpea-maize(L) resulted in 36% higher grain yield than maize-maize(L). Residual mineral N was significantly higher on cowpea plots than in soybean and maize plots irrespective of the amount of N applied.

Conclusions

The high residual N after cowpeas increases stover and grain yield and reduces the N requirement for the subsequent maize crop. Consequently, a crop following soybean would require more N because of low residual nitrogen observed. The effect of rotations beyond the alteration of soil mineral nutrition deserve further investigation.

59) Response of Kenaf (*Hibiscus cannabinus* L) cultivars to row spacing and planting density on growth and fiber quantity

Presenter: ND Ngobeni (ntsakon@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
ND	Ngobeni	Private Bag x 82075, RUSTENBURG, 0300
NR	Mashamba	Private Bag x 82075, RUSTENBURG, 0300

Introduction

Kenaf (*Hibiscus cannabinus* L.) is a fiber plant native to east central Africa where it has been grown for centuries. Plant density and row spacing have a more pronounced effect on growth and yield than on fiber percentage. Usually with more space available, the plants grow taller and develop thicker stems. Increased plant populations result in higher yields, while increased row spacing result in lowering yields. Higher plant populations will not necessarily result in higher yields. The cost of planting extremely high plant populations is not always economically viable. Therefore, the objective of this study was to determine the optimum row spacing and planting density for optimum yield and growth of kenaf cultivars under dry land conditions.

Materials and Methods

The study was conducted under dry land conditions at Rustenburg (NW) during 2015/2016 growing season. The trial design was a split plot with main plot treatments as row spacing (30, 35 and 40 cm) and sub plots comprised of planting densities (400 000 plant ha⁻¹, 500 000 plants ha⁻¹ and 600 000 plants ha⁻¹) with two cultivars, Elal 1 and Raz 2 as treatments, replicated four times. Plants were harvested manually at flowering stage (Duke and Ducellier, 1993). A sample of ten fresh stems were randomly selected to determine dry stem yield, fibre yield and basal stem diameter. Fresh stalks were oven dried for 5 days at 60°C. Fiber yield (%) was computed by using the weight of fibre in the above ground dried stalk after water retting divided by dry stalk mass multiplied by hundred.

Results and Discussion

There were significant differences ($P \leq 0.05$) observed in fresh biomass, green stems, dry stem yield and fiber yield of cultivars as influenced by row spacing, planting density, and row spacing x cultivars x planting density interactions. Kenaf yield increased at lower row spacing of 30 and 35 cm with combination of high planting densities for both cultivars. Elal1 dry stem yield was the highest at 30 cm and 627 778 plants ha⁻¹, with 13 552 kg ha⁻¹. This was 68% higher than the dry stem yield at 40 cm and 616 667 plants ha⁻¹. Plant height and diameter did not differ significantly between cultivar, row spacing and plant densities. Fiber quantities were better at the lowest row spacing and high planting densities.

Conclusions

Minimum row spacing and plant densities for optimum yields were 30 to 35 cm and 500 000 to 600 000 plants ha⁻¹ for both cultivars.

60) Non-host status in ARC-developed Sweet potato lines and cultivars to tropical *Meloidogyne* species and races

Presenter: TS Nkuna (Nkunathabo@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TS	Nkuna	ARC – Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001/University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727
KM	Pofu	Agricultural Research Council – Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001
SM	Laurie	Agricultural Research Council – Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727

Introduction

The Agricultural Research Council is in the forefront of developing biofortified sweet potato (*Ipomoea batatas*) in South Africa. The withdrawal of fumigant nematicides from the agrochemical markets and limited information on genotypes with nematode resistance, the biofortification programme could be threatened by root-knot nematodes (*Meloidogyne* species). The existence of non-host sweet potato lines/cultivars could enhance the use of such genotypes in introgression for nematode resistance. The objective of this study was to determine the host-status of 22 sweet potato lines/cultivars to *M. javanica*, *M. incognita* race 2 and *M. incognita* race 4. Aim of the study is the assessment of the potential existence of non-host status in selected sweet potato lines/cultivars, developed at the ARC, to South African *Meloidogyne* species and races.

Materials and Methods

Cuttings obtained from the ARC genebank collection were grown in seedling trays containing Hygromix and hardened-off prior transplanting into 25-cm-diameter plastic pots filled with steam-pasteurised loam soil. Pots were placed on greenhouse benches at 0.2 m × 0.2 m spacing, irrigated using 250 ml water per pot. Lines/cultivars were screened against *M. javanica* (Trial 1), *M. incognita* race 2 (Trial 2) and *M. incognita* race 4 (Trial 3) included 22 lines of sweet potato with 'Beauregard' serving as a nematode-susceptible standard. The lines/cultivars were arranged in a RCBD, with six replicates. Each plant was inoculated with 3 000 eggs and second-stage juveniles (J2). At 56 days after inoculation, eggs and J2 were extracted from root sample using the blending and maceration method, which was followed by the sugar- flotation centrifugation method to separate the nematodes from the debris. Nematodes were counted under the stereomicroscope and expressed as reproductive potential (RP = eggs + J2/g root sample).

Results and Discussion

Line 1990-10-2 had a RP value of zero for all *Meloidogyne* species and races, whereas all other lines/cultivars, including the standard, had RP values that were significantly greater than one. The finding showed that line 1990-10-2, was a non-host to the test *Meloidogyne* species and races. However, due to the existence of the Seinhorst equilibrium point (E point, where $P_f = P_i$), beyond which RP is zero, it would be important to subject line 1990-10-2 to different levels of nematode to establish the degree of nematode resistance.

Conclusions

Sweet potato line 1990-10-2 was the only non-host to the test *Meloidogyne* species and races. It would be imperative to establish the mechanism of nematode resistance since only post-infectious nematode resistance could be used in introgression.

61) Influence of *Meloidogyne javanica* on growth and yield of *Solanum retroflexum* under microplot condition

Presenter: FH Nndwambi (nndwambif@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
FH	Nndwambi	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga 0727, South Africa
PW	Mashela	University of Limpopo, Green Biotechnologies Research Centre of Excellence, Private Bag X1106, Sovenga, 0727, South Africa

Introduction

Predictive models on climate change suggested that conditions in Limpopo Province would not be suitable for most exotic crops due to high temperatures, extended droughts and other factors such as nematodes infestation. Inland South Africa, in Limpopo Province, most areas have semi-arid climate, with indigenous leafy plants adapted to the conditions, being widely used for food security and also as cash crop especially amongst small holder farmers. However, the information on host status in this crop is too scanty. The objective of this study was to determine the relative host status of nightshade (*Solanum retroflexum*) during two consecutive growing seasons.

Materials and Methods

Seedlings were raised in seedling trays containing steam-pasteurised loam soil and Hygromix at 3:1 (v/v) ratio and at a two-leaf stage were hardened-off outside the greenhouse for one week. Seedlings were then set in 20- cm-diameter plastic pots filled with the growing medium used for raising seedlings, irrigated with 250 ml water every other day, fertilised once with 5 g of NPK 2:3:2 (26) + 5% Zn + 5% S + 5% Ca per 2 litres of water. Each seedling was sown per pot placed at 0.2m X 0.2m spacing in a micro plot experiment and inoculated at 0, 25, 50, 125, 250, 625, 1250 and 3125 eggs + second-stage juveniles (J2) from *M. javanica* that was cultured on tomato cv. 'Floradade', arranged in a randomised complete block design, with ten replicates. Fifty-six days after inoculation, experimental trial conducted was terminated and data collected were subjected to analysis of variance, with means separated using the LSD for all pair-wise comparison.

Results and Discussion

During season 1 and 2, *M. javanica* population density did not contribute to total treatment variation for growth and yield variable. Increased galling incident due to increase in *M. javanica* population density did not affect growth and yield. However, during season 1 treatment effects were highly significant on eggs, J2s in roots, J2s in soil, total nematodes and reproductive factor, contributing 91, 94, 80, 96 and 78% in total treatment variation (TTV) of the respective variables. In contrast, in season 2, treatment effects on eggs, J2s in roots, J2s in soil, total nematodes and reproductive factor contributed 92, 93, 75, 95 and 70% respectively.

Conclusions

Solanum retroflexum exhibited degree of tolerance to different population of *M. javanica* infestation on growth and yield variables. Different population of *M. javanica* that reproduce within the host did not correlate with growth and yield variables.

62) Possible use of SPAD – 502 meter for evaluation of leaf chlorophyll, carotenoids and nitrogen index in cassava (*Manihot esculenta* crantz) grown in crude oil amended soil in Nigeria

Presenter: SR Osu (samuelrobert2007@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
SR	Osu	Department of Biology, College of Education Afaha Nsit, P.M.B. 1019 Etinan, Akwa Ibom State, Nigeria. (In collaboration with the Department of Botany and Ecological Studies, University of Uyo, Nigeria.)

Introduction

Cassava is one of the economic crops cultivated in south-south Nigeria where crude oil pollution is rampant. The research is aimed at improving crude oil contaminated soil with application of different levels of palm bunch ash (PBA) and dry poultry manure (PBM) as organic amendments on cassava (*Manihot esculenta* Crantz) growth and also evaluate the leaf chlorophyll, carotenoids and nitrogen index of three cultivars, namely: TMS 30572, NR 8082 and Local Variety (LV) Using Konica Manolta SPAD-502 Meter.

Materials and Methods

Field experiment was conducted in a randomized complete block design (RCBD) in a 3x4 factorial arrangement with three cassava cultivars and four levels of amendments replicated thrice. Data were collected on cassava growth as: plant height (cm), number of nodes per plant, stem girth (cm), leaf area (cm²) using meter rule according to Okon *et al.* (2012). Data obtained were subjected to analysis of variance (ANOVA) and significant [$P \leq 0.05$] means were separated using the least significant difference (LSD).

Results and Discussion

Results showed that; TMS-30572 and NR-8082 had higher growth rate than local variety (LV) at 36 WAP. The combination of DPL and OPBA gave higher cassava growth than their single applications. The combination of DPM and OPBA gave higher rates of metabolism [Chlorophyll concentration index, chlorophyll a, b, carotenoids and leaf N index for improved cassava varieties in $\mu\text{g cm}^{-2}$] than their single applications. It has been reported that the most important internal factor governing the chlorophyll content of any plant is the genetic potential of the plant (Tanee and Albert, 2010). In consequence, nitrogen status can be indirectly assessed by measuring leaf chlorophyll content so that useful information can be provided to adjust the rate of nitrogen fertilization (Süß *et al.*, 2015).

Conclusions

Soil amendments were considered important in reclaiming soils contaminated with crude oil. The chlorophyll meter was used in the present study to evaluate the chlorophyll concentration index, chlorophyll a, b, carotenoids and leaf nitrogen index for cassava varieties: TMS 30572, NR 8082 and Local Variety. However, variety TMS 30572 and NR 8082 had higher growth rate than Local Variety (LV) and the combination of DPL + OPBA gave higher growth rate than their single applications.

63) Evaluation of information and communication technology use in small-holder farmers in selected provinces of South Africa

Presenter: MO Phahlane (phahlane@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MO	Phahlane	Agricultural Research Council, 600 Belvedere St, Arcadia, Pretoria, 0083
S	Walker	Agricultural Research Council, 600 Belvedere St, Arcadia, Pretoria, 0083
TC	Mapumulo	Agricultural Research Council, 600 Belvedere St, Arcadia, Pretoria, 0083
P	Maluleke	Agricultural Research Council, 600 Belvedere St, Arcadia, Pretoria, 0083
RMH	Sethaba	Agricultural Research Council, 600 Belvedere St, Arcadia, Pretoria, 0083

Introduction

The Agricultural sector in South Africa is continuously facing new and important problems and challenges. Use of Information and Communication Technologies (ICTs) can be a major intervention for more efficient agricultural production. ICTs have been a significant contributor to growth and socio-economic development in business sectors, countries and regions where they are well adopted and integrated (Waz and Weiser 2013). These new challenges stretch over a large number of issues among which are the nationalization of food markets which intensifies the competition in the agricultural sector, the productivity and competitiveness of small-holder farmer (Salampasis and Theodiridis 2013). A high percentage of South Africans living in the more remote rural areas have pre-paid accounts which gives a good indication of how a USSD (Unstructured Supplementary Service Data) service can add value. USSD is supported by all handsets and networks and requires no internet connection or application to be installed.

Materials and Methods

Farmers meetings were conducted in KZN, Limpopo, North West, Gauteng, Mpumalanga and Eastern Cape Provinces to identify basic needs and gaps in ICT relating to weather issues. A questionnaire was completed to collect qualitative information about the current use and application of ICT platforms in communicating weather related information in decision support services in selected provinces.

Results and Discussion

A total of 1200 questionnaires were completed, during 46 meetings in 22 districts across 6 provinces. Small-holder farmers in six provinces indicated a low percentage of smart phone ownership thus it was necessary to develop a USSD platform. Mobile phone penetration in South Africa now exceeds 75%. The purchase of a low-cost smart phone is now possible and the telecommunications infrastructure is expanding and provides quick access to the Internet using high-speed cell network protocols. A high percentage of farmers are over the age of 40 years. Limpopo and KZN provinces indicated highest percentage of farmers not having access to any internet facility. North West province has the lowest percentage of relevant weather forecast information for agricultural purposes.

Conclusions

For small-holder farmers to benefit from the offers of ICT products within the agricultural sector, the youth of South Africa should compose a high percentage of this group. In this environment mobile phones can become the solution to deliver services through IT applications that are affordable, accessible everywhere and easy to use by farmers. A relevant platform is available in South Africa through AgriCloud Application.

64) Diversity of hymenopteran pollinators in sunflower fields and surrounding grassland

Presenter: NC Schutte (nadineschutte2@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NC	Schutte	North-West University, Potchefstroom 2520, Unit for Environmental
SJ	Siebert	North-West University, Potchefstroom 2520, Unit for Environmental
J	Van den Berg	North-West University, Potchefstroom 2520, Unit for Environmental

Introduction

Hymenopterans are one of the most important insect orders as they provide important ecosystem services such as pollination, which is required for the production of many essential food crops worldwide. Honey bees are considered to be the most important pollinator species but are not very effective on a per-visit basis. It is thus important to increase this pollination efficiency to ensure optimum production within cropping systems. This can be done by ensuring that a healthy diversity of Hymenopteran pollinators exist within cropping systems, as it has been found that the interspecific interactions between different bee species improve the pollination efficacy of honey bees.

Materials and Methods

This study investigated the diversity of bees within sunflower fields and natural grassland. Three study sites were chosen within the sunflower production area of the North-West province, each consisted of three zones: 1: sunflower field, 2: field margin, and 3: adjacent grassland. Sampling took place in a 10 x 50 m transect in each zone and commenced for 20 min at a time. Each site was sampled three times. The sampling was done by means of sweep nets within the margin and grassland zones, and within the sunflower fields the honey bees were counted per flower head. Samples were grouped into morphological species.

Results and Discussion

NMDS analysis revealed unique Hymenopteran pollinator compositions (Stress = 0.09) for each zone. ANOSIM revealed that the species composition of the fields differed significantly from the margins ($R=1$) as well as the grasslands ($R=1$). No significant differences occurred between the margins and grasslands ($R=0.07407$). The difference between the fields and the other zones is due to the lower species diversity of wild bees in the former. The Shannon-Wiener diversity index showed significant differences ($P<0.05$) between the three zones. The margins scored the highest on the Shannon index with 1.32, grasslands scored 1.17, and the sunflower fields scored 0.05. The wild bees seem to prefer the margin and grassland zones as the diversity was highest there. These results are consistent with similar studies done in other countries.

Conclusions

Hymenopteran pollinator diversity differs between fields and surrounding natural areas, with the fields having a much lower diversity. Thus, the assumption can be made that the honey bees within the sunflower fields are not pollinating as effectively as they could be, because of the probable lack of interspecific interactions between the bees. Future studies should investigate the reasons why the wild bees are not entering the sunflower fields.

65) Yield and quality effects of cash crops following cover crops in the Western Cape

Presenter: LT Smorenburg (lilas@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
LT	Smorenburg	Western cape Department of Agriculture
PJA	Lombard	Western cape Department of Agriculture
JA	Strauss	Western cape Department of Agriculture

Introduction

Soil improvement benefits from cover crops are well documented within conservation agriculture; although the concept is relatively new in the Western Cape grain producing region. The aim of this project is twofold, firstly to determine the weed suppression ability of the different cover crop mixtures and secondly to evaluate the performance of cash crops planted in the year following the different cover crop mixtures in terms of yield and quality parameters. This paper focus on the second aim of this project.

Materials and Methods

The 2016 cover crop mixtures were planted with no fertiliser and no further chemical inputs during the season. In 2017 wheat was planted across the 2016 cover crop trial, at the Klipfontein site, while barley was planted at the Tygerhoek site. Yield and quality for both sites were determined at the end of the growing season for each of the six different treatments. The mixtures were terminated by crimping roller. The 2017 wheat and barley were managed according to best practice principles. All treatments were harvest using a Hege plot harvester. Yield obtained from each whole plot was measured and recalculated to kg/ha. Quality parameters included hectolitre mass, protein and falling number to obtain the final grade.

Results and Discussion

The yield for barley planted across the previous cover crop treatments at Tygerhoek was 4.8 t ha⁻¹. The control barley plot did not follow on a cover crop and yielded less than 3 t ha⁻¹. The barley yield was significantly higher following a mixture consisting of rye, vetch, field peas and white mustard (Treatment 5). All mixtures from 2016 resulted in barley that was classified as malting grade. The yield of wheat planted across the 2016 cover crop mixtures at Klipfontein was 2.6 t ha⁻¹ compared to the control mean of 2.3 t ha⁻¹. In the control wheat followed medic pasture. A mixture consisting of rye, vetch and faba bean (Treatment 4) showed the highest yield of 3.07 t ha⁻¹, followed closely by a mixture of rye, vetch, field peas and white mustard (Treatment 5) at 2.9 t ha⁻¹. The wheat grading for all treatments was B1, except for a mixture of rye, vetch and bitter lupines (Treatment 3), which was B2. The control treatment resulted in a B2 grade.

Conclusions

Preliminary results suggest that cover crop mixtures can boost yield and improve quality parameters of both barley and wheat. The economics of the yield and quality increase still needs to be evaluated to determine the financial benefit.

66) Quantifying the influence of three seed-drill openers on soil physical properties in a semi-arid region of South Africa

Presenter: KJ Truter (truterkj@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
KJ	Truter	Directorate Plant Sciences, Western Cape Department of Agriculture, private Bag X1, Elsenburg, 7607; Department of Agronomy, University of Stellenbosch, 7600
JA	Strauss	Directorate Plant Sciences, Western Cape Department of Agriculture, private Bag X1, Elsenburg, 7607
PA	Swanepoel	Department of Agronomy, University of Stellenbosch, 7600

Introduction

Seed-drills are commonly used in Conservation Agriculture systems of the Western Cape to place seed directly in soil. The influence of seed-drills and their furrow openers, on the soil physical properties, is not fully understood. The aim of this research project is to quantify the change in soil physical properties to allow producers to compare seed-drills for optimal seeding practices in semi-arid production regions.

Materials and Methods

A trial was carried out in the southern Cape, 35 km south of Swellendam, on a farm where minimum-tillage were implemented formerly. Seed-drills with either double disc openers, tine openers or a combination of tines and double chute single disc openers were tested. Twenty-seven plots were laid out in a completely randomised design (25 x 100 m), comprising of three treatments and nine replicates. Bulk density and gravimetric soil water content was determined through an excavation method and sand with a known density (1.52 g cm^{-3}) was used to determine the volume of the sample. Samples were taken up to a depth of 100 mm on the seeding row at 7, 30, 60, 90 and 120 days after seeding. Unsaturated hydraulic conductivity was measured with a Mini Disc Infiltrometer on the seeding row, at a suction rate of 0.5 kPa at 7 and 60 days after seeding. Mixed models and the restricted maximum likelihood procedure was used to test for treatment effects at a 5% level of significance.

Results and Discussion

Seed-drill openers had varying influences on soil physical properties. Bulk density was the highest after

seeding took place with the double disc seed-drill, over the rest of the season it gradually decreased. Lower bulk densities were found where seed-drills with tine openers were used. In areas where low rainfall events occur over the season, decreasing the amount of soil disturbance while seeding, might help to conserve water in the seed-furrow. When comparing the unsaturated hydraulic conductivity of the seed-furrows, an increase in soil disturbance while seeding have led to a higher infiltration rate at the commencement of the season. Despite the fact that inconsistent changes occurred over the season, unsaturated hydraulic conductivity values remained low regardless of opener.

Conclusions

Different seed-drill openers influence soil physical properties differently. Various factors, including soil physical characteristics should be considered by producers when selecting a seed-drill. The results obtained may vary over time as conservation agriculture systems advance.

67) The performance of ten desi chickpea germplasm in Mpumalanga Lowveld

Presenter: NM Vilane (vilanem@mpg.gov.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NM	Vilane	Department of Agriculture , Rural Development Land and Environmental Affairs,P/Bag X 11318 Nelspruit 1200
SM	Magongwa	Department of Agriculture, Rural Development Land and Environmental Affairs,P/Bag X 11318 Nelspruit 1200
MD	Lengwati	Department of Agriculture , Rural Development Land and Environmental Affairs, P/Bag X 11318 Nelspruit 1200
SK	Shilenge	University of Venda, Department of plant Production, P/Bag X 5050, Thohoyandou-0950

Introduction

Chickpea (*Cicer arietinum* L) is a herbaceous, annual plant of the pea family (Fabaceae), that grows to 45- 60 cm high. Chickpeas are not grown in South Africa commercially. It has well developed tap root, concentrated in the top 45 cm that can grow to 2 m deep. It is highly self- pollinated with natural out crossing <1%. Based on seed size and colour, cultivated chickpeas are of 2 types, Desi and Kabuli (Ramaiah, K.V 1983). Several sets of elite desi and kabuli genotypes developed at (ICRISAT), Patancheru, India were tested in Mpumalanga in the past. The desi type was found superior in its adaptability to the local environment when compared to kabuli. As a result, superior desi genotypes from these studies were further tested during the 2016 cropping season to identify the most outstanding ones for farmer participatory variety evaluations in the coming season.

Materials and Methods

Ten ICRISAT chickpea varieties were evaluated in a field trial carried out at the University of Mpumalanga farm (25° 25' 55"S, 30° 58' 34"E) at Nelspruit, Mpumalanga in a Randomized Complete Block Design (RCBD) with three replications. The plot size was 4 rows of 4 m long, with inter and intra row spacing of 40 cm and 10 cm respectively. The seed placement was at 7 cm deep and 40 seeds row⁻¹. The data on yield parameters were recorded and analyzed statistically.

Results and Discussion

The study showed greater grain yields in eight genotypes compared to the control (ICCV 97125) that yielded 552 kg ha⁻¹. Greater grain yields were recorded in the varieties ICCV 3203 (935 kg ha⁻¹), ICCV 92944 (893 kg ha⁻¹), ICCV 8101(794 kg ha⁻¹) and ICCV 4110 (729 kg ha⁻¹). Although statistically there was a difference amongst the tested varieties.

Conclusions

The outstanding varieties selected based on their grain yield and other parameters such as shelling %, number of seeds pod⁻¹ and days to maturity would be further pushed to the smallholder farmers across the Lowveld of Mpumalanga.

ABSTRACTS
POSTER PRESENTATIONS

WEED SCIENCES

LISTED ALPHABETICALLY

68) Intra-plant spacing and fertilizer application enhanced weed suppression and popcorn (*Zea mays* L. var. *everta*.) performance under South Africa semi-Arid condition

Presenter: OA Dada (oadada247@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
OA	Dada	Food Security and Safety Niche Area Research Group, North-West University, Mafikeng Campus
FR	Kutu	School of Agricultural Sciences, University of Mpumalanga
OS	Olubode	Department of Crop Production and Environmental Biology, University of Ibadan, Ibadan
S	Mavengahama	Food Security and Safety Niche Area Research Group, North-West University, Mafikeng Campus

Introduction

Weed interference imposes biotic stress on crops, while poor soil fertility limits growth and yields. The manipulation of crop geometry and provision of adequate nutrient management stimulate a suitable crop growth environment for increase yield. This study examined the influence of intra-plant spacing, and compost and NPK fertilizer as soil amendments on weed suppression and performance of popcorn (*Zea mays* L. var. *everta*) under semi-arid conditions in Mahikeng, South Africa.

Materials and Methods

Trial consisted of intra-plant spacing (15, 20, 25 and 30 cm) and soil amendments (4 and 8 t ha⁻¹ of Municipal solid waste-based compost, 90 and 180 kg ha⁻¹ NPK 20-7-3 fertilizer, and unfertilized control) as treatment factors. The trial was laid out in a split plot arrangement fitted into randomized complete block design and replicated three times. Two seeds of mid-altitude popcorn variety were sown per hole. Weed samples from each plot were collected at six and nine weeks after sowing using a 0.5 m² wooden quadrant. The community structure was described using Dominance, Simpson, Shannon Wiener and evenness indices. Grain yield of popcorn was also determined. Data were analysed with descriptive statistics, ANOVA and means separated with LSD at p≤0.05. Growth and yield components were correlated with weed biomass.

Results and Discussion

A total of 1021 widely distributed weed species that belong to eighteen taxa were encountered with *Elusine indica* having the highest RIV of 27.5%. The field had a rich and highly diverse community structure. Weed abundance was reduced by 81.8% at closer intra-row spacing during the second weeding while weed biomass significantly (P<0.05) reduced popcorn biomass and grain yield at wider intra-row spacing. Significantly less weed biomass (255.80 t ha⁻¹) was recorded in plots with 15 cm intra-plant spacing amended with 8 t ha⁻¹ compost. Grain yield was highest (10.16 t ha⁻¹) in 20 cm intra-plant spacing plot amended with 90 kg N ha⁻¹. The better grain yield from 20 cm intra-plant spacing at 8 t ha⁻¹ compost suggests that higher compost rate with closer intra-row spacing suppressed weed interference and improved popcorn grain yield.

Conclusions

Closer intra-plant spacing suppressed weed interference in popcorn field however higher rate of fertilizer is required to improve grain yield.

69) Evaluating the fertilizer value of biogas slurry and cattle manure on soya bean (*Glycine max*)

Presenter: T Mdlambuzi (mdlambuzit@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Mdlambuzi	Agriculture Research Council, 600 Belvedere, Arcadia, Pretoria, 0083
P	Muchaonyerwa	University of KwaZulu Natal, Scottsville, Pietermaitzburg, 3200
M	Tsubo	University of Japan
ME	Moshia	Agriculture Research Council, 600 Belvedere, Arcadia, Pretoria, 0083

Introduction

The decline in soil fertility associated with agricultural intensification and continuous cultivation without replenishing nutrients is a major problem for the agricultural sector (Gurung, 1997). Khan *et al.* (2012) reported that lack of adequate nutrient supply and poor soil quality the main constraints in low input agriculture. To resolve soil fertility and nutrient management problems, organic soil amendment resources that positively influence soil fertility and crop productivity need to be targeted, utilized and recycled to avoid waste or loss to the environment (Smith *et al.*, 2014). The use of slurry from biogas production using cattle manure could make a contribution.

Materials and Methods

The study was conducted at Agricultural Research Council, Vegetable and Ornamental Plant experimental site in Roodeplaat. The field experiment was conducted in the 2016/17 and 2017/18 seasons and was arranged in a randomized complete block design, with four replicates and each plot was 3 × 2 m. The treatments were biogas slurry, cattle manure and a mixed fertilizer 3:2:1 (28) applied at 15, 30, and 60 kg N ha⁻¹.

Results and Discussion

Increasing N application rate caused an increase in dry matter and grain yield of soybean for all the treatments, which were higher than the control. Biogas slurry (BGS) resulted in higher dry matter than cattle manure (CM) at all N rates for both seasons. There were no significant differences between BGS and chemical fertilizer (CF) when applied at 30 and 60 kg N ha⁻¹. In both seasons, BGS resulted in higher grain yield than CM while CF resulted in higher grain yield than both organic wastes at all N rates. More N uptake was observed at higher N application rates while there were no differences among the treatments at 15 kg N ha⁻¹ in both seasons. The results were in agreement with those of Nasir *et al.* (2015), who reported that application of biogas slurry increased plant growth and yield. Islam *et al.* (2008) also indicated that application of dried slurry as a source of N in soils increased biomass yield and plant nutrient uptake of maize.

Conclusions

BGS shows potential to improve crop yield and nutrient uptake than CM at least in the short-term. However, the nutrients in the two organic wastes are less readily available than CF, but accumulate in soil. Where CF is not readily accessible, farmers can take advantage of the high levels of available nutrients in BGS compared to CM to increase crop yield and improve soil fertility.

70) Influence of phenolic compounds in controlling Ryegrass under different temperatures using Glufosinate Ammonium

Presenter: T Mucheri (tendiem3@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Mucheri	Stellenbosch University
PJ	Pieterse	Stellenbosch University
C	Reinhardt	Villa Crop Protection Academy
A	Kleinert	Stellenbosch University

Introduction

There have been numerous reports on the development of ryegrass resistance to paraquat and glyphosate but no occurrences have not been documented in South Africa yet. Glufosinate ammonium shows remarkable control of a variety of weed species thus makes it a possible alternative or rotational herbicide with other post-emergence herbicides. However, it poses a great challenge because it also shows variable results under some field conditions and no conclusive observation can be drawn from the studies conducted. Glufosinate ammonium should be studied in detail in order to provide definite results. The aim of this study is to investigate factors that affect efficacy of glufosinate ammonium on ryegrass grown under different temperatures.

Materials and Methods

The experiment was conducted at Stellenbosch University Welgevallen Experimental farm. Wild ryegrass was sown and trans-planted after 2 weeks in four glasshouses set at 10/15°C, 15/20°C, 20/25°C and 25/30°C night/day temperatures. Application of glufosinate ammonium was done three weeks after trans-planting and the dosage rates included 0, 1.5, 3, 4.5 and 6 L ha⁻¹. Assessment on mortality of ryegrass was done four weeks after glufosinate ammonium application. Intensity of phenolic compounds produced under stress was investigated using a confocal microscopy. A study on photosynthesis, stomatal conductance and rate of transpiration was done 24, 48 and 72 hours after glufosinate ammonium application using an IRGA (Infra-red Gas Analyser- LI 6400).

Results and Discussion

Mortality rate of ryegrass decreased with increasing temperature particularly for dosage rates of 0, 1.5, 3 and 4.5 L ha⁻¹. Further investigations of phenolic compounds of control and treated ryegrass showed that ryegrass grown under warmer temperatures exhibits a higher intensity of phenolic compounds. There was an increasing intensity of phenolic compounds in treated ryegrass with increasing temperatures. Presence of such compounds in ryegrass resulted increases its resilience against herbicide applications. This observation was confirmed by the photosynthetic study which showed photosynthesis of ryegrass under warm temperatures drastically decreased in the first 24 hours and bounce back in the next 24 hours. Increase in photosynthesis of ryegrass under warm temperatures ensured the plants' survival since it strives to make an effort to live normally in spite of difficult conditions.

Conclusions

Survival of ryegrass under warmer temperatures can be attributed to phenolic compounds. Phenolic compounds act as support structure and function in adaptation and defence under stress. These compounds also increase the plant's photosynthetic rate by increasing resistance to photo-inhibition under stress (Ramakrishna and Ravishankar 2011).

71) Paraquat and Glyphosate resistance in two ribwort plantain (*Plantago lanceolata* L.) populations

Presenter: V Ndou (nvhuthu@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
V	Ndou	Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland, 7602
FH	Eksteen	Syngenta South Africa, Private bag X60, Halfway House, 1685
SS	Kaundun	3Syngenta UK, Jealott's Hill International Research Centre, Bracknell, Berkshire RG42 6EY, UK
PJ	Pieterse	Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland, 7602

Introduction

Resistance to glyphosate in ribwort plantain (*Plantago lanceolata* L.), a serious weed in South Africa has already been confirmed in 2003. More recently, ribwort plantain populations that were putatively resistant to paraquat were reported. This study aims to investigate the possible cross- or multiple resistance of ribwort plantain to paraquat and glyphosate.

Materials and Methods

Seed from a putatively susceptible (S) ribwort plantain population in Kuilsriver outside Cape Town and from two putatively resistant populations (R1 and R2) located in the Robertson district in the Breede River Valley was collected. Seedlings were grown in small plastic pots in coarse gravel in a glasshouse and irrigated with a balanced nutrient solution. At the 4 - 8 leaf stage the plants were subjected to Paraquat (200 g a.e. L⁻¹) and glyphosate (450 g a.e. L⁻¹) applications in a dose response trial using a pneumatic pot sprayer with a flat fan nozzle operated at a pressure of 2.0 KPa. Paraquat dosage rates applied in 400 L ha⁻¹ water, were 0, 100, 200, 400, 800, 1600 and 3200 g a.e. ha⁻¹ to which Agral® adjuvant at 0,05% were added. Glyphosate was applied in 100 L ha⁻¹ water at dosage rates of 0, 169, 338, 676, 1352, 2704 and 5408 g a.e. ha⁻¹. The herbicide trials were considered two separate experiments, each a 3x7 factorial arranged CRBD replicated six times. Preliminary evaluation took place 2 weeks after application (WAA) and the percentage mortality was calculated. Two-way ANOVA analyses were carried out to test for significance. The LD50 values were calculated. The final evaluation will be made six WAA.

Results and Discussion

The Paraquat LD50 value for the R1 population was 800 g a.e. ha⁻¹, similar to that of the S population. The LD50 value for the R2 population was however 1600 g a.e. ha⁻¹, resulting in a resistance index of 2. For glyphosate, the LD50 value of the S population was 1352 g a.e. ha⁻¹ and the LD50 values for R1 and R2 was higher than the highest dosage rate tested. Mortality rates of 0% and about 10% respectively for the R1 and R2 populations were achieved at a dosage rate of 5408 g a.e. ha⁻¹.

Conclusions

The R1 ribwort plantain population showed no resistance to paraquat but very strong resistance to glyphosate. The R2 population showed two-fold resistance to paraquat and very strong resistance to glyphosate indicating possible cross- or multiple resistance.

72) Optimizing the use of pre-emergent herbicides in wheat production, under the conservation agriculture practices in the South-Western Cape region

Presenter: BN Ntombela (zithazakes6@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
BN	Ntombela	Stellenbosch University
PJ	Pieterse	Stellenbosch University

Introduction

Permanent organic soil cover in conservation agriculture, creates a barrier that impedes enough amount of pre-emergent herbicides to reach the soil surface for effective weed control. The failure of herbicides to reach the soil surface is caused by the fact that herbicides become intercepted by the residue cover and sometimes react with the residue cover. In the short term this can result into poor weed management. In the medium term, it can lead to more weed seeds reaching the soil seed bank, which results in higher weed pressure in the following planting seasons and in the long-term, these sub-lethal doses can lead to the development of non-target site herbicide resistant. Therefore, the aim of this study was to probe the possible dosage rate/application rate combination that can assist in obtaining the required amount of pre-emergent herbicides to reach the soil surface at different sizes of the permanent organic cover.

Materials and Methods

Pot experiments were conducted in a glasshouse at Welgevallen Experimental farm. Residue cover were manipulated to result in 5 different stubble cover treatments, viz. 100%, 75%, 50%, 25% and 0%. ± 50 seeds of ryegrass and 5 seeds of wheat were planted per pot. Sakura was applied at dosage rate/application rate combination of 125 g ha⁻¹/200 L ha⁻¹, 125 g ha⁻¹/400 L ha⁻¹, 187.5 g ha⁻¹/200 L ha⁻¹, 187.5 g ha⁻¹/400 L ha⁻¹ and control with no herbicides applied. Field experiments were conducted at Langgewens and Tygerhoek in 2016 and 2017 where residue cover was manipulated in 3 different stubble cover treatments, viz. 100%, 50% and 0% with herbicides treatments identical to pot experiments. Weeds and crops count was made at 7 weeks after planting (DAP) and at anthesis. Vegetative growth parameters were determined at anthesis. Yield components were determined just before harvesting. After harvesting; yield, 1000 kernel mass, hectolitre mass and protein content were determined.

Results and Discussion

The overall results showed that there was significant interaction between dosage rate and residue, both at Langgewens and Tygerhoek. The increase of dosage rate to 187.5 g ha⁻¹ showed a decrease in weed infestation even on high residue cover percentage, with few differences among parameters. In contrast, there was minimum significant interaction between residue cover and application rate. The increase of application to 400 L ha⁻¹ showed less impact as the stubble cover increased.

Conclusions

Increase in dosage rate showed an increase of weed control with Sakura, even on high residue cover and on the other hand the increase in application rate showed minimal impact.

73) The effect of Glyphosate and biostimulants on ryegrass seedlings (*Lolium spp.*)

Presenter: T E Tandathu (tandathut@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
TE	Tandathu	University of the Free State, P.O Box 339, Bloemfontein, South Africa, 9300
E	Van Der Watt	University of the Free State, P.O Box 339, Bloemfontein, South Africa, 9300
E	Kotze	University of the Free State, P.O Box 339, Bloemfontein, South Africa, 9300

Introduction

Weeds continue to be a huge problem in plant production and herbicides are largely used in the agricultural sector to regulate crop yield losses due to weeds (Bhau & Singh, 1979; Akobundu, 1987). Glyphosate remains the most used herbicide among those available to combat weeds. Due to the extensive use of glyphosate in the field, several ryegrass species have developed resistance to glyphosate worldwide and crop damage is increasing (Yanniccari *et al.*, 2012). Since biostimulants are known to increase crop resistance and growth, both against biotic and abiotic stresses, the aim of the study was to determine whether they can protect crops combined with glyphosate under laboratory conditions. And whether or not this combination will increase the problem that we have with resistant ryegrass.

Materials and Methods

A laboratory study was conducted where ryegrass seeds were germinated in petri dishes for 10 days before the seedlings were sown in potting soil for 14 days. The seedlings were transplanted in glass bottles where they were treated with different treatments. Shoot length (SL), root length (RL) and plant fresh weight (FW) were measured 14 days after the plants were treated with various treatments. Plant dry weight (DW) was observed after the seedlings were dried in an oven at 75 degrees until constant mass.

Results and Discussion

Biostimulants showed an increase in FW and SL of ryegrass seedling and a decrease in DW and RL. When in combined with glyphosate they showed a decrease in growth of all measured parameters. This confirmed that care should be taken when applying Biostimulants on weeds but when combined with glyphosate at the correct concentration it can still control the weed and protect the crop.

Conclusions

Biostimulants combined with glyphosate can kill ryegrass and protect the crops but care should be taken with the application concentration and when it is applied.

74) The effect of applied plant available manganese levels in soil on Glyphosate efficiency in ryegrass (*Lolium* spp.)

Presenter: E Verster (Enrike@potatoes.co.za)

Initials	Surname	Authors Company/Organisation and Postal Address
E	Verster	Potatoes SA, Private bag X135, Pretoria. 0001
PJ	Pieterse	Department of Agronomy, Stellenbosch University, Private bag X1, Matieland, 7602

Introduction

Manganese (Mn) is a transition metal similar to zinc and iron and is involved in redox reactions in plant cells. Because of its tetravalent structure, it will generally form salt complexes with herbicides and especially an insoluble molecule such as glyphosate. It is widely believed that antagonism exists between glyphosate and certain micro-nutrients, notably Mn, although there is contradictory evidence regarding this. Observations that glyphosate resistance in ryegrass (*Lolium* spp.) occurs more commonly in areas in the Western Cape where high Mn levels are prevalent, leads to the question whether high soil Mn levels could possibly play a role in the efficacy of glyphosate in ryegrass.

Materials and Methods

The dosage response of two susceptible ryegrass biotypes was tested in a sand soil medium fertigated with a balanced nutrient solution containing the prescribed amount of Mn. Different Mn treatments (1.5, 3.0, 4.5, 6.0 and 7.5 mM MnSO₄) were applied twice a week to these pots. Glyphosate was applied to the plants at rates of 0, 0.5, 1.0, 1.5 and 2.0 L ha⁻¹ (0, 180, 360, 540 and 720 g a.i. ha⁻¹). Percentage survival of ryegrass was evaluated six weeks after application.

Results and Discussion

Significant interactions were obtained between glyphosate application rate and Mn level in the two susceptible biotypes tested. The recommended label rate of glyphosate for ryegrass is 540 g a.i. ha⁻¹. The survival of ryegrass plants proved to be significantly higher at Mn levels 4.5 to 7.5 mM Mn than at lower levels only at the lowest sub-lethal glyphosate rate of 180 g a.i. ha⁻¹. The reduced efficacy of glyphosate at low application rates at high Mn levels may be due to Mn/glyphosate antagonism taking place inside the plant or at absorption interfaces. Mn, which is readily available, may form complexes with the smaller amount of glyphosate present due to the lower application rate when the Mn-glyphosate ration within the plant is high.

Conclusions

In plants growing under high Mn conditions that are sprayed under poor spraying conditions, a glyphosate application rate normally lethal to the plants may become a sub-lethal rate due to the combined effect of the above mentioned factors. This might make the plants more predisposed to the development of non-target site resistance to glyphosate than plants growing under conditions of lower plant available Mn. This study also confirmed that, from a management perspective, the use of glyphosate at sub-optimal rates should be avoided.

75) Identification and characterization of *Amaranthus palmeri* in South Africa

Presenter: BJ Vorster (juan.vorster@up.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
BJ	Vorster	SAHRI, Department of Plant and Soil Sciences, University of Pretoria , Pretoria
NA	Similane	SAHRI, Department of Plant and Soil Sciences, University of Pretoria , Pretoria
N	Malindzisa	SAHRI, Department of Plant and Soil Sciences, University of Pretoria , Pretoria
CF	Reinhardt	SAHRI, Department of Plant and Soil Sciences, University of Pretoria , Pretoria

Introduction

Amaranthus palmeri S. Wats. is a dioecious weedy species in the genus *Amaranthus* considered one of the worst weed in agronomic crops in the USA. Currently herbicide resistance to six herbicide target sites has been identified with some populations resistant to at least three herbicide classes. Reports of a possible introduction of this species to South Africa were received and investigated. Seed and plant material were collected from a farm in the Northern Cape for further analysis. Herbarium samples were submitted to SANBI (Pretoria and Kirstenbosch) for morphological identification. DNA was isolated at for rDNA ITS sequence identification and characterization of herbicide resistance target sites. Plants were grown and growth responses tested for against three herbicide MOAs

Materials and Methods

Genomic DNA was extracted from fresh leaf tissue and the ITS region amplified by PCR from primers designed from known NCBI sequences. *Amaranthus hybridus* samples were used as a control. To investigate the presence of the mutations known to confer resistance to ALS inhibitors in *Amaranthus* species, the five domains of the ALS gene were amplified and sequenced. Known PPO mutations conferring resistance were cloned and sequenced. Dose response experiments using Roundup (EPSPS inhibitor), mesotrione (HDDP inhibitor) and chlorimuron (ALS inhibitor) were done in greenhouse pot experiments at the University of Pretoria.

Results and Discussion

Morphological identification was done by SANBI Pretoria and Kirstenbosch and further rDNA ITS sequencing by the University of Pretoria confirmed the identity of the samples as *A. palmeri*. Additional sequence characterization of known mutations conferring resistance to ALS and PPO were done but did not indicate any target site mutations. Further characterization is under way. Herbicide dose response trials showed that at least some plants survived application of the three MOAs to doses as high as four times the recommended field rates. This is however more closely related to field conditions and additional trials are underway.

Conclusions

Palmer amaranth has been positively identified in South Africa. There is an urgent need to establish the spread and prevalence of the weed as well as to characterize the population diversity of the South African population. It is especially important to establish the diversity of herbicide resistance alleles in South Africa. We have shown that the identified population do not have known target site mutation to some of the herbicide MOA but are not controlled by these MOAs. Further studies are being conducted to clarify the resistance mechanisms and determine the spread of the invasion.

ABSTRACTS
POSTER PRESENTATIONS

SOIL SCIENCE

LISTED ALPHABETICALLY

76)Yield responses of dry beans on the Glen-Bonheim ecotope using conventional tillage and in-field rainwater harvesting

Presenter: JJ Anderson (AndersonK@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
JJ	Anderson	ARC - ISCW, Private Bag X01, Glen, 9360
JJ	Botha	ARC - ISCW, Private Bag X01, Glen, 9360

Introduction

Farmers in the semi-arid Thaba Nchu region of the Free State Province suffer because of food insecurity. Appropriate water conservation crop production strategies can contribute towards alleviating this problem. It was hypothesized that by employing the in-field rainwater harvesting (IRWH) crop production technique the effective rainfall would be increased considerably making bean production possible in this area.

Materials and Methods

Field experiments were conducted to evaluate dry bean production using conventional tillage (CON) and IRWH, with various crop rotation systems on the Glen-Bonheim ecotope, which is representative of the ecotopes in the Thaba Nchu area. IRWH treatments used were IRWH with organic mulch in basins and bare runoff area (ObBr) and IRWH with stones in basins and stones on runoff area (SbSr) over four growing seasons. The three different crop rotations were: mono-cropping dry beans (cultivar PAN 148, 133333 plants ha⁻¹) with CON; dry beans - maize (PHB 33V08, 22000 plants/ha) rotation with CON, ObBr and SbSr; dry beans - sunflower (SNK74; 33333 plants ha⁻¹) rotation with CON, ObBr and SbSr. Each treatment was replicated three times. Crops were hand planted and manually harvested. A neutron water meter was used to monitor the soil water content of the rootzone was during the growing season. Biomass and grain yield were recorded at harvesting. Rainwater productivity was calculated (Botha, 2006).

Results and Discussion

IRWH dry beans grown in rotation with maize or sunflower consistently gave significantly higher yields than in the same rotation with CON, viz. overall averages of 895 kg/ha compared to 413 kg/ha. IRWH increased dry bean production by 30 - 50% compared to CON and improved RWP values for dry beans from 0.75 kg/ha/mm for CON to 1.15 kg/ha/mm for IRWH.

Conclusions

The IRWH water conservation crop production technique has the potential to reduce vulnerability to drought and improve the sustainability of crop production by subsistence farmers in the Thaba Nchu area on ecotopes similar to the Glen-Bonheim ecotope by ensuring optimum utilization of the limited rainwater. Mulch (organic or stone) applied on the 2 m wide runoff strip of IRWH reduce soil movement which promotes sustainability and suppress evaporation from the soil surface which makes more water available for plant growth.

77) Soil phosphorus availability and utilization efficiency by soybean under No-till

Presenter: PB Chauke (Chaukep@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
PB	Chauke	1Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
AD	Nciizah	1Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
IIC	Wakindiki	School of Agriculture, University of Venda, P/Bag X5050, Thohoyandou,

Introduction

One of the main constraints limiting the productivity of soybean in South Africa is low native soil phosphorus (P) availability and poor utilization efficiency of added P. Soybean yields could be increased by using improved or high yield potential cultivars, P fertilization and appropriate cropping systems. No-till favours the increase of organic P levels and/or a decrease of inorganic phosphate adsorption through accumulation, decomposition and mineralization of soil organic matter. The objective of this study was to determine the effects of tillage, cultivars and fertilization levels on P uptake and P use efficiency, as well plant growth and yield, and grain protein and oil content, in a soybean-based cropping system.

Materials and Methods

The study was conducted under dryland conditions at Kalkoenvier farm in Sheepmoor, Mpumalanga. A field experiment was established in a randomized complete block design arranged in a 2 x 3 x 3 strip-split-plot treatment structure with two tillage systems [no-till (NT) and conventional tillage (CT)] as vertical treatments, three cultivars (PAN 1614R, PAN 1521R and PAN 1532R) as horizontal treatments, and P fertilizer rate (0, 30 and 60 kg ha⁻¹) as sub-plots in three replications. P use efficiency was calculated using the balance method.

Results and Discussion

Phosphorus application rate, tillage and cultivar had significant effects ($P < 0.05$) on P uptake, P use efficiency, seed yield and yield components of soybean. P uptake was highest at 60 kg ha⁻¹, whilst P use efficiency was highest at 30 kg ha⁻¹. No significant interactions among the three main effects were observed on P uptake and use efficiency. However, there were statistically significant interactions between P application rate, cultivar and tillage on soybean yield. Yield was highest at 30 kg ha⁻¹ P application under NT for PAN 1521R whilst for PAN 1532R and PAN 1614R yield was highest under NT at 60 and 30 kg ha⁻¹ P, respectively. P application at 30 and 60 kg ha⁻¹ significantly reduced oil content by 11.3% and 7.16% but had inverse effects on protein content increasing it by 0.83% and 1.06%, respectively.

Conclusions

Phosphorus uptake by soybean increased as P application increased, but excessive P uptake decreased P use efficiency. No-till with P application significantly improved soybean yield by up to 44.5%; however, the yield varied with different cultivars. Smallholder farmers are encouraged to adopt no-till and apply fertilizers to improve soil fertility conditions and yield.

78) Nitrogen and phosphorus release patterns on selected humic soils

Presenter: N Dlamini (ntethelatha@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
N	Dlamini	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, Private Bag X01, Scottsville 3201
P	Muchaonyerwa	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, Private Bag X01, Scottsville 3201

Introduction

Humic soils are distinguished by humic A horizon, its own distinctive characteristics such as high organic carbon (1.8%) present, and less than 4 cmol(+) of exchangeable bases per kg clay for every one % organic carbon present (Soil Classification Working Group, 1991). The study was conducted to quantify contributions of N and P mineralization to nutrient availability from humic soils through nutrient release patterns over a period and relative amount, and to determine the effect of mineralization on P fractions.

Materials and Methods

Five sites were selected; Eston, Eshowe, Cedara, Karkloof and Underberg. A depth of 20 cm was sampled. A 100g of oven-dried equivalent soil from each sample was incubated for 84 days period at 80% moisture field capacity. The experiment had 420 containers to allow for destructive sampling at 0, 7, 14, 28, 42, 63 and 84 days. pH in KCl was analyzed, ammonium-N and nitrate-N were extracted by 2M KCl, mineral-N was determined by combining the ammonium-N and nitrate-N, extractible P was extracted by AMBIC-2 procedure. Inorganic P fractions were separated by sequential extraction method as described by Kuo (1996), organic P fractions followed the procedures developed by Bowman and Cole (1978) and modified Ivanoff *et al.*, (1998).

Results and Discussion

Soil pH showed similar trends throughout incubation with the significant decrease starting after 14 days. Ammonium-N and nitrate-N were complementary to each other, when ammonium-N started to decrease was exactly the time when the nitrate-N increased. Mineral-N increased significantly after 28 days reaching the values from 60-105 mg kg⁻¹. Extractible P reduced after 7 days, only few trends recovered after 28 days. After incubation inorganic P fractions showed more P was bound to Al, Fe, mineral associated P (reductant P). Organic P fraction did not show any effect except P associated with fulvic acid reduced significantly. As organic matter decomposed most of the species associated with SOM mineralized, released to soil solution, interacted with each other. pH decreased because of nitrification releasing H⁺ ions, increased nitrate was because of ammonium being nitrified thus ammonia was reduced. The decrease in P was the complex interactions with Fe, Al and other mineral surfaces as this was also explained by P fractions. The high amount of organic P masked effect that might have occurred on the fractions.

Conclusions

The amount of nutrients released was considerable and within the range of most crop requirements. Mineralization and decomposition of SOM had the effect on organic P fractions thus P availability.

79) Effects of co-applying BGS and CF on spinach nutrient uptake and dry-matter yields

Presenter: LS Grootboom (grootbooml@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
LS	Grootboom	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
P	Muchaonyerwa	School of Agricultural, Earth and Environmental Sciences, University of KwaZulu- Natal, P/Bag X01, Scottsville, 3209, South
ME	Moeletsi	Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa

Introduction

Use of organic waste to produce biogas aids in waste management and produces an organic residue called biogas slurry (BGS), which has appreciable quantities of plant nutrients and the potential to improve soil productivity. The objective of the study was to determine the effects of BGS co-application with chemical fertilizer (CF) on nutrient uptake and yield of spinach and on residual soil chemical properties of two contrasting soils.

Materials and Methods

The soils used in this study were sampled from the 0-30 cm depth of Hutton and Avalon soil forms . The soils were characterized using standard analytical methods before use. The two soils (4 kg pot⁻¹) were amended with BGS co-applied with CF at BGS/CF ratios of 0/100, 40/60, 60/40 and 100/0 kg N ha⁻¹, before being homogenized. Two-week old spinach seedlings were transplanted and grown for 8 weeks in pots. Dry matter yield, nutrient uptake and soil residual fertility were determined at the end of the experiment. Effects of soil type and BGS/CF combinations were analyzed using analysis of variance (ANOVA).

Results and Discussion

Dry matter yield and uptake of N, P, K, Ca, Mg and Fe increased significantly with increasing CF proportion. A higher proportion of CF resulted in more readily available N, which supports the growth and uptake of other nutrients. However, co-application of BGS with CF had no synergistic effects. Although the dry matter yield was still lower than with 100% CF, if smallholder farmers supplement the 60 kg N ha⁻¹ that they normally apply (60% of recommended rate) with BGS at 40 kg N ha⁻¹, they can realise an 11% yield increase. The Avalon soil produced significantly more dry matter than the Hutton soil, irrespective of application rate. Soil residual pH was significantly higher in the Avalon soil compared to all equivalent treatments in the Hutton soil.

Conclusions

Co-application of BGS with CF at a ratio of 40/60 kg N ha⁻¹ resulted in improved nutrient uptake and yields for smallholder farmers, who would normally apply N at 60 kg ha⁻¹ due to financial constraints. This constitutes deriving value from BGS, which would otherwise present disposal challenges. Residual soil fertility was improved in both soils.

80) Nitrogen and phosphorus release from Duckweed and fertiliser value of Duckweed (*Lemna* sp.) relative to chicken compost

Presenter: K Jilimane (kanyajilz@gmail.com)

Initial	Surname	Authors Company/Organisation and Postal Address
K	Jilimane	School of Agricultural, Earth and Environmental sciences, University of KwaZulu-Natal, P. Bag X01, Scottsville 3209
P	Muchaonyerwa	School of Agricultural, Earth and Environmental sciences, University of KwaZulu-Natal, P. Bag X01, Scottsville 3209

Introduction

Intensive animal and crop production systems produce waste-water with high nutrient concentrations, which pollute the environment and water sources. High nutrient concentrations in surface water bodies encourage the growth of aquatic plants, and harvesting of these plants could improve water quality and provide an organic source of nutrients. The objectives of this study were to determine the effects of source of duckweed (*Lemna minor*) on (i) mineral nitrogen (N) and phosphorus (P) in soil under laboratory conditions and (ii) nutrient uptake and dry-matter yield of spinach (*Spinacia oleracea*) under field conditions, relative to chicken litter.

Materials and Methods

Duckweed was sampled from Baynesfield, where surface water was enriched with pig effluent (Lemna BF), and Wartburg, where surface water was enriched with crocodile effluent (Lemna WB). Both sites are situated in the Midlands region of KwaZulu-Natal. An incubation study was carried out using dried Lemna BF, Lemna WB and chicken litter at a rate of one percent in soil. The chicken litter was used as a control. The soil was moistened to field capacity and incubated at 25°C. Sampling was conducted after 0, 3, 7, 14, 28, 42 and 56 days of incubation. The samples were analysed for ammonium-N, nitrate-N, and extractable P. A glasshouse and field trial were conducted to determine the N and P fertiliser values of the duckweed on spinach (*Spinacia oleracea*) dry matter. The same incubation treatments were used in the glasshouse and field trials and replicated three times. Nitrogen was applied at rates of 100 and 200 kg N ha⁻¹ in the glasshouse, and 100 kg N ha⁻¹ in the field. All treatments, including the control, were incubated for two weeks prior to the glasshouse and field trials.

Results and Discussion

Lemna BF showed the highest amounts of the determined parameters (N and P). While the control had the least of all determined parameters. Ammonium-N was highest after 7 days of incubation and declined thereafter, while Nitrate-N increased. Under field conditions and in the pot trial, spinach grown with the Lemna BF treatment showed a higher dry weight than with Lemna WB, while both treatments had a higher dry weight than the control.

Conclusions

The results suggested that N in duckweed mineralises rapidly in soil, becoming available for plant uptake and increasing spinach yield to a greater extent than chicken litter compost. The effectiveness of duckweed depends on the source, which affects initial elemental composition.

81) Temporal soil moisture data estimation using Citizen Observatory data

Presenter: DMK Kibirige (ecodan@uni-miskolc.hu)

Initials	Surname	Authors Company/Organisation and Postal Address
DMK	Kibirige	University of Miskolc
E	Dobos	University of Miskolc
K	Kovács	University of Miskolc
L	Gál-	University of Miskolc
A	Dobos	University of Miskolc
B	Pinezits	University of Miskolc
D	Hemment	University of Dundee

Introduction

Soil Moisture (SM) is a key variable in the climate system as it controls a number of processes. From plant transpiration to photosynthesis, it has a direct impact on water, energy and biogeochemical cycles. Particularly in water and energy cycles, it impacts the amount of water following underground and on the earth's surface. The spatial and temporal distribution of SM is regarded as a key element in various hydrological and meteorological applications. There is a crucial need for high spatial and temporal resolution SM data. Datasets derived for global modelling are approaching the resolution of 1 to 3 km pixel size – like the SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 km EASE-Grid Soil Moisture, Version 2, but the majority of them still exceeds the 10-25 km resolution. These datasets cannot provide appropriate information for the land users, so alternative approaches are needed to provide these data. Citizen observatory data represent a great potential to fill this data gap.

Materials and Methods

The study comprised of in-situ soil sampling techniques to assess the soil conditions and scientifically deduce water retainability in the soil. Environmental covariate dataset was compiled from soil data (diagnostics, soil morphology and classification data, lab analysed physical and chemical properties, in situ soil sensor measurements with 15 minutes logging of fertilizer level – electric conductivity, light, temperature and soil moisture) digital terrain database and its terrain derivatives, satellite data of Sentinel-1 and 2 and indices derived from them. Data of these variables were collected using 68 soil sensors that were evenly distributed across the study area. Weekly datasets were selected for time series and for testing the estimation methodology. Correlation analysis was used to preselect the dataset explaining most of the spatial variability. Regression analysis and regression followed by the kriging of the residuals - the so-called regression kriging approach was used to interpolate the sensor measurements and derive the timely dataset. Spatial representativity of the monitoring dataset was analysed as well.

Results and Discussion

High spatial and temporal resolution dataset with the resolution of 20 meters were derived from the observations and the temporal and spatial patterns were described and interpreted. The regression kriging algorithm was proved to be efficient to predict soil moisture in a relatively data-rich environment. Digital terrain variables, NDVI and Sentinel-1 data layers explained a significant amount of SM variation.

Conclusions

This study further highlighted the need for more investigations into high-resolution data sets to support decision making of land users.

82) Evaluation of capacitance probes for the measurement of soil water and temperature on mechanically reconstructed soils under a grass mixture

Presenter: MV Kidson (michael@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MV	Kidson	ARC-SCW, P/Bag X79, Pretoria 0001
DJ	Beukes	229 Emmarentia Street, Meyerspark 0184
LD	Wiese	Dept of Soil Science, Stellenbosch University, P/Bag X01, Matieland 7602

Introduction

The ARC–Soil, Climate and Water (ARC-SCW) was contracted by Agron (Pty) Ltd, in collaboration with Fraser Alexander (Pty) Ltd, to evaluate in a 2-year study various rehabilitation methods as a function of topsoil thickness on soil chemical, biological and physical properties, as well as on the composition, growth and yield of a grass mixture. The probe sensors measure soil capacity changes caused by the effect of soil water content on soil electrical properties. As capacitance is a linear function of the dielectric constant of water, the measurement of the former offers a simple procedure to determine soil water content (Tomer and Anderson 1995).

Materials and Methods

A strip plot design was used to lay out in November 2014 a field trial consisting of four topsoil (TSs) thicknesses (0, 70, 150, 300 mm) and seven rehabilitation methods (RMs), including a control, at the Mimosa Coal mine site outside Carolina. The test crop was a mixture of annual and perennial grass species. The Aquacheck BASIC 0.8 capacitance probes that were used have sensors (water content) and thermistors (temperature) at six depth intervals, offering continuous readings of the mentioned properties, and incorporate a data storage facility. A temperature calibration of the thermistors was performed in the laboratory, followed by the field installation of the probes on selected plots. The calibration of the capacitance sensors to convert readings to SWC was done by determining gravimetric SWC at various dates.

Results and Discussion

The thermistor calibration yielded linear correlation coefficients, ranging from $R^2=0.99-1.00$. Seasonal warming and cooling of the soil was measured. Cooling of the soil following rainfall was evident. Soil temperature fluctuations decreased sharply with increasing depth. A diurnal time lag of soil temperature of up to 13 hours with increasing depth was observed. Diurnal and seasonal soil temperatures for a 0 mm TS were higher than for a 300 mm TS. The calibration of capacitance sensor readings vs. SWC gave a fair linear correlation coefficient. The sensors were very sensitive to changes in SWC caused by rainfall events.

Conclusions

Thermistor and sensor calibration of capacitance probes yielded good functional equations for the conversion of probe readings. Soil temperature data showed that this property was affected by a seasonal trend, diurnal fluctuations and soil depth. Soil water contents derived from the sensor data showed a response to rainfall events and RM. The use of capacitance probes on mechanically reconstructed soils to measure soil temperature and SWC proved to be very successful.

83) Automated soil CO₂ flux measurement

Presenter: MV Kidson (Michael@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MV	Kidson	ARC - ISCW, Private Bag X79, Pretoria, 0001
R	Wilson	ARC - ISCW, Private Bag X79, Pretoria, 0001
J	Laurens	ARC - ILI, Creswell street, Silverton, Pretoria, 0018
R	Adeleke	ARC - ISCW, Private Bag X79, Pretoria, 0001

Introduction

The understanding of the soil carbon cycle is imperative for the calculation of the soils potential sequestration rate. The Solvita® CO₂ burst method is used as an indicator of soil health and mineralization of plant nutrients (Brinton and Haney, 2013). The Vaisala Carbocap® infrared gas analyser was used for the measurement of soil CO₂ flux on a conservation agriculture – ploughing trial, at Zeekoeigat, near Roodeplaat (Kidson *et al.*, 2011). The limitation of using a single infrared gas analyser was the taking of a reading in the field, then moving the chamber, resulting in few measurements per day. To overcome the limitations of a single chamber, an automated system was built. Commercial instruments for the measurement of soil CO₂ flux, such as the LI-COR Soil Gas Flux Systems are available, but are pricy.

Materials and Methods

An automated system was designed and built around the Campbell Scientific data logger and the Vaisala infrared gas analyser. Soil air was pumped through the infrared gas analyser, from a chamber, for analysis. The programmed data logger controls the period of time that the soil air is pumped through the gas analyser by the opening and closing of solenoid valves. As the power output of the data logger was low, relays were required to activate the solenoids. The air sample was returned to the chamber, to maintain a neutral pressure. After the measurement of the air sample, the air in the pipe was vented, to prevent contamination. Then measurements for chambers two to three were taken, and returned to number one.

Results and Discussion

The program is functioning well with a smooth transition to the next operation. The program is written in such a way that additional chambers can be added to the system. Furthermore, the period for measuring the soil flux can be altered. This is important as the time required to measure the soil flux varies through the season. From preliminary results the soil flux gradually increases through the season, peaking in middle January.

Conclusions

This is an on going project. The preliminary results using the single chamber have shown that the instrument has: 1) good repeatability; 2) the automated instrument will gather more data values per day for a research plot and 3) more data values will compensate for soil variation, for an improved understanding of a soil's CO₂ flux.

84) Growth parameters of Swiss chard in response to Zeolite and irrigation applications

Presenter: MN Lewu (lewum@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
MN	Lewu	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
AR	Mulidzi	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
AO	Sindesi	Cape Peninsula University of Technology, Faculty of Applied Science, Agriculture Department, Wellington Campus. Wellington 7655, South Africa
B	Ncube	Cape Peninsula University of Technology, Bellville Campus, Symphony Way, PO Box 1906, Bellville 7535, Cape Town, South Africa
FB	Lewu	Cape Peninsula University of Technology, Faculty of Applied Science, Agriculture Department, Wellington Campus. Wellington 7655, South Africa

Introduction

Water scarcity and loss of applied nutrients (especially nitrogen) are the two main limitations of crop production in South Africa. Hence, the prudent use of water for agricultural purposes is always welcomed in a water-scarce country like South Africa. Zeolite is a soil conditioner which can be used to increase water retention ability of the soil and at the same time enhance more effective fertilizer consumption by the crop (Xiubin and Zhanbin 2001). However, information on zeolite use for crop production in South Africa is scanty. The main aim of the study was to assess the water saving ability of zeolite in sandy soil for the cultivation of Swiss chard.

Materials and Methods

A pot experiment was carried out using sandy soil to grow Swiss chard in a tunnel at the ARC Infruitec-Nietvoorbij campus, Stellenbosch in the winter of 2018. There were four zeolite treatments (T1 = 0% zeolite, T2 = 10% zeolite, T3 = 20% zeolite, T4 = 30% zeolite) replicated six times. Data were collected on a weekly basis on growth parameters from four weeks after seedlings transplant. Irrigation water was applied at 50% field capacity (FC) moisture depletion until it restores soil water to 70% FC.

Results and Discussion

Water requirement increased with age and vigour of the plants in all treatments. As the ratio of zeolite to soil increases, the amount of irrigation water applied to the soil also reduces and vice versa. T1 (0% zeolite) used the most water (4075 ml) while T4 (30% zeolite) required the least irrigation (1985 ml). Rapid water leach was observed in T1 but was re-absorbed by the soil because it was collected in the saucer at the base of the pot which appeared to help growth in the control. For growth parameters, T1 had the best performance in almost all the growth parameters measured but not significantly different from T3 performance ($P \leq 0.05$) in most observations. This was followed by T2 and T4.

Conclusions

Over the four weeks of assessment, 20% zeolite application saved 28% water compared to the control with comparable yield difference ($P \leq 0.05$). Although 30% zeolite application saved 51% water, the yield difference was significant compared to the control ($P \leq 0.05$).

85) Land suitability assessment for agricultural development in Gravelotte, Selwane and Prieska (GRASP) area of Ba-Phalaborwa Municipality in Limpopo Province, South Africa

Presenter: L Mamanyuha (mamanyuhal@yahoo.com)

Initials	Surname	Authors Company/Organisation and Postal Address
L	Mamanyuha	Chief Directorate: Agricultural Advisory Services, Limpopo Department of Agriculture and Rural Development, Private Bag X9487, Polokwane 0700, South Africa
MN	Ramahlo	Chief Directorate: Agricultural Advisory Services, Limpopo Department of Agriculture and Rural Development, Private Bag X9487, Polokwane 0700, South Africa
MW	Sefara	Chief Directorate: Agricultural Advisory Services, Limpopo Department of Agriculture and Rural Development, Private Bag X9487, Polokwane 0700, South Africa
KA	Tshikolomo	Chief Directorate: Agricultural Advisory Services, Limpopo Department of Agriculture and Rural Development, Private Bag X9487, Polokwane 0700, South Africa

Introduction

GRASP is an association of smallholder farmers in the Ba-Phalaborwa Municipality of Mopani District in the Limpopo Province, that was established in 2012 with the purpose of uniting smallholder farmers for a common course in the agricultural sector. The total area investigated was 812.7ha covering some 81 agricultural projects at the time of the survey. The scope of this part of the project was to determine the agricultural suitability (soil physical and chemical properties) and irrigation potential of GRASP projects which are in Mopani district under Ba-Phalaborwa Municipality, Limpopo Province as identified and provided.

Materials and Methods

The study area is situated along Letaba River from Letaba Ranch (Belasting) to Gravelotte in Mopani district under Ba-Phalaborwa Municipality, Limpopo Province. The soils were identified, described and classified in accordance with the South African Soil Surveyors Organisation Field Book (2013) and South African Taxonomic System (Soil Classification Working Group, 1991). A total of 168 samples from 168 representative profiles were collected and were analyzed in the laboratories at Madzivhandila College of Agriculture in Limpopo Province. The samples were analyzed in laboratory for physical (texture) and chemical properties. Based on the data collected, the suitability of the soil for agricultural production was determined. The broad principles outlined in the FAO Guidelines Land evaluation for irrigated agriculture (FAO, 1985) were followed to evaluate the suitability of the soils. More specific, a similar physical suitability classification, based on the experience of the authors gained over many years, was employed to rate the soils into five classes as follows: Class 1, highly suitable; Class 2, moderately suitable; Class 3, marginally suitable; Class 4, marginally not suitable and Class 5, not suitable.

Results and Discussion

Of the area surveyed, 25.12% of the land was found to be highly suitable agricultural land under irrigation and dry land (Class 1), 1.01% was moderately suitable (Class 2), 16.54% was marginally suitable (Class 3), 56.29% had severe limitations (Class 4), while 1.04% of the land was not suitable for agriculture (Class 5). Highly suitable soils were rated to be more irrigable than those that were less suitable.

Conclusions

Greater part (25.12%) of the land was suitable for agricultural production. Of the suitable agricultural land, 5.35% (or ha) was found to be unused while 1.10% (or ha) of used land was actually marginal. New investments should be considered for the suitable land currently not used while existing projects in marginal lands should be reconsidered.

86) Phosphorous and potassium requirement factors across different bio-resource groups

Presenter: A Mbangi (awonkembang15@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Mbangi	UKZN
N	Nonqgwen	UKZN
T	Mabhaudhi	UKZN

Introduction

Phosphorous and potassium in the soil exist in different fractions i.e. total amount of nutrient, the buffering fraction which governs the distribution between the solution and solid phases and the fraction held in the soil solution. Soil tests are used to determine the quantity and intensity factors of soil P and K. In many respects, soil test levels are operationally defined where the related soil buffering capacity of the soil is not included in the interpretation of the soil test results (Fox and Kamprath, 1970; Borling *et al.*, 2001; Berg and Joern, 2006). Lack of specificity in these processes contribute to the inconsistencies in the calibration process. Fertilizer requirements for both K and P are obtained by subtracting the soil test value from the optimum threshold that is not limiting to plant growth. In order to calculate the mass of nutrient element required per unit area, deficit is then multiplied by the fertilizer requirement factor (the amount of fertilizer required to raise a soil test by a single unit) which reflects soil properties and depth of fertilizer incorporation (Johnston *et al.*, 1999; Poswa *et al.*, 2014). Soil testing services continue to apply a constant requirement factor (RF) value when making fertilizer recommendations. The aim of this study is to determine nutrient requirement factors for phosphorus and potassium across different bioresource groups with different soil properties under different land uses.

Materials and Methods

Soil samples from each of the sites were incubated with four levels of K/P fertilizer. Potassium dihydrogen phosphate (KH_2PO_4) at K levels of 0, 50, 100 and 150 mg kg^{-1} (0, 75, 150, 225 kg ha^{-1} based on a sampling depth of 150 mm) and P levels of 0, 39, 79, 118 mg kg^{-1} (0, 59, 119, 177 kg ha^{-1}) was thoroughly mixed with samples of each soil. Phosphorous and potassium were extracted using four extractants namely: Melich 3, Olsen, Ammonium acetate and Bray 2 extracting solution.

Results and Discussion

The soils showed significantly different ranges of requirement factors for both potassium and phosphorous. There was a high correlation between requirement factors and clay content and a poor correlation between requirement factors and soil parameters.

Conclusions

Soil specific requirement factors should be used when making fertilizer recommendations

87) Assessing C sequestration potential and decomposition rates of different wheat residues

Presenter: NO Mbava (nozinyezini@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
NO	Mbava	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private BagX01, Scottville 3201, Pietermaritzburg, South Africa
R	Zengeni	University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private BagX01, Scottville 3201, Pietermaritzburg, South Africa

Introduction

Sequestration of atmospheric carbon (C) into plants and ultimately to soils is a credible strategy to mitigate against climate change, and restore C reserves of degraded land. Incorporation of crop residue can therefore be done to improve soil productivity. As these residues decompose in soil, they release mineral nutrients such as carbon, nitrogen, phosphorus and sulphur among others. Wheat is an important food crop to the South African economy. It is produced intensively as an irrigated crop on commercial farms. Not much is known however about the potential of its residues to sequester soil C or improve fertility once incorporated into the soil. The objective of the study was to assess decomposition patterns and soil C sequestration potential of wheat residues of different varieties upon incorporation into the soil.

Materials and Methods

About 0.25 g of either wheat root or shoot from variety 5 wheat varieties (BW152, BW162, BW140, LM70 and LM75) were thoroughly mixed with 100 g of soil then transferred into an air tight PVC pot. Samples were wetted slowly to 50% field capacity moisture. A vial containing 25 ml NaOH solution was also placed inside the incubation pot to trap CO₂ released during decomposition. The pots were covered with polyethylene sheets and incubated for 120 days with periodic sampling twice a week. At the end of each incubation period, the trapped CO₂ was precipitated with BaCl₂ then excess NaOH was titrated with 0.5 M HCl using phenolphthalein as an indicator. After titration 2 g of moist soil from each pot was extracted with 20ml of 1M KCl to analyse for NH₄⁺ and NO₃⁻ through a flow injection analysis.

Results and Discussion

CO₂ emission was higher in soil with shoots (283,3 mg kg⁻¹) than in soil with roots (160.6 mg CO₂ mg kg⁻¹). Amongst the wheat varieties, LM70 shoots produced the highest CO₂ emission (380,55 mg kg⁻¹ soil) and LM70 roots produced lowest CO₂ (165,80 mg CO₂ kg⁻¹). LM70 shoots with soil increased by 137% cumulative CO₂ compared to control. Generally NH₄⁺ was higher (60,32 mg kg⁻¹ soil) than NO₃⁻ (46,89 mg kg⁻¹). Highest NH₄⁺ was produced by LM70 shoots (92,32 mg kg⁻¹), whilst highest NO₃⁻ was produced by BW140 shoots (64,49 mg kg⁻¹). Lowest NH₄⁺ and NO₃⁻ amount were produced by BW152 roots with values of 23.78 mg kg⁻¹ and 24,78 mg kg⁻¹ respectively.

Conclusions

Wheat residues have a potential for improving soil fertility and carbon sequestration

88) Assessing soil fertility in an apple orchard using an enzyme based soil alteration index

Presenter: AH Meyer (meyera@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
I	Van Huyssteen	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
AH	Meyer	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
CJ	Fourie	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa

Introduction

The enzymes β -glucosidase, acid-phosphatase and urease are responsible for the biogeochemical cycling of carbon (C), phosphorous (P) and nitrogen (N), respectively, which are important elements in plant nutrition. These enzymes correlate strongly with the soil organic matter and clay content because they are protected through complexes formed with soil humic– or clay colloids, making them suitable indicators of soil quality. The enzyme-based alteration index (AI3) quantifies the balance between β -glucosidase, acid-phosphatase and urease activities, making the index sensitive to alteration in soil properties caused by management practices. The index may prove to be effective for quantifying soil quality in local apple orchards (Meyer *et al.*, 2014). This hypothesis was tested by evaluating AI3 in relation to cover crop treatments in a local apple orchard.

Materials and Methods

Three chemically controlled cover crop species were compared to a control in an apple orchard in the Vyeboom area. Composite soil samples, comprising of four sub samples, was obtained from the 0-150 mm and 150-300 mm soil layers for each replicate/treatment over three seasons. The activities of β -glucosidase, acid- phosphatase and urease were determined. AI3 index scores, using the individual enzyme data, were generated using the formula in Puglisi *et al.* (2006).

Results and Discussion

Soil quality was consistently higher in the top soil layers than in the sub soil throughout the entire trial period, confirming higher availability of metabolizable organic matter in the top- than the subsoil. Available metabolizable organic matter also increased over time, which was consistent with an increase in enzyme activity, indicating the ability of the AI3 to predict carbon (C) build-up over time.

Conclusions

After testing in an apple orchard, the AI3 was able to: a) reflect gradients in mineralizable substrates across a soil layer transect and b) predict soil nutrient status by being consistent with soil C availability.

89) Soil enzyme activity recovery after fumigation and amendment with biostimulants in an apple orchard

Presenter: AH Meyer (meyera@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
I	Van Huyssteen	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
Y	Mtimkulu	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
AH	Meyer	ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch 7599, South Africa
M	Webber	Department of Horticultural Science, Faculty of AgriScience, Stellenbosch University, South Africa
E	Lotze	Department of Horticultural Science, Faculty of AgriScience, Stellenbosch University, South Africa

Introduction

The nemacide 1,3-D-Chloropicrin is currently being used as an alternative fumigant to methyl bromide. However, little is known of the impact that it has on organic matter decomposition and nutrient cycling, which are enzyme mediated processes. Although common in the deciduous fruit industry, the application of soil biostimulants at planting to mitigate negative effects of fumigants, is poorly understood with respect to 1,3-D-Chloropicrin. The objective was to determine the recovery of enzyme activity in an apple orchard soil after fumigation with 1,3-D-Chloropicrin and the application of biostimulants.

Materials and Methods

A Katspruit/Longlands soil form, with signs of wetness, in an apple orchard, was fumigated with 1,3-D-Chloropicrin prior to planting. Seven different biostimulant treatments replicated 10 times were applied at planting according to product specifications. Soil samples were obtained from the 0-150 mm and 150-300 mm soil layers for each replicate/treatment at two and six weeks after fumigation and then again 55 weeks after planting. The activities of β -glucosidase, acid-phosphatase and urease were determined. Soil alteration index (AI3) scores, using the individual enzyme data, were generated using the formula in Puglisi *et al.* (2006).

Results and Discussion

After an initial decrease in enzyme activity at 6 weeks, the soil enzymatic status recovered after 55 weeks; the activities of β -glucosidase and urease increased, but the phosphatase activity was slightly inhibited. The sandy loam/sandy clay loam texture of the soil could have aided recovery through protection against denaturation of enzymes through clay-humus complex formation. Furthermore, enzyme activities remained high in the topsoil compared to the subsoil. When using individual enzyme activities as indicators of soil quality, no improvement with respect to the addition of biostimulants was shown. Contrariwise, when using the AI3 index, it was shown that addition of amino acids and plant growth promoting rhizobacteria (PGPR) improved soil quality significantly.

Conclusions

The nutrient gradient across a soil layer transect in fumigated soils is rebuilt about a year after fumigation. Amino acid and PGPR biostimulants showed potential for improving soil quality after fumigation with 1,3-D- Chloropicrin.

90) Yield and nutrient response of spinach (*Spinacea oleracea* L.) grown under Agrimat and grass mulch to humid and semi-arid conditions

Presenter: S Mgolozeli (mgolozelis@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mgolozeli	1Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
AD	Nciizah	1Agricultural Research Council - Institute for Soil, Climate and Water, P/Bag X79, Pretoria, 0001, South Africa
FN	Mudau	2University of South Africa, Dept. of Agriculture and Animal Health, P/Bag X6, Florida, 1710, South Africa
IIC	Wakindiki	3School of Agriculture, University of Venda, P/Bag X5050, Thohoyandou, 0950, South Africa

Introduction

Spinach is one of the popular and affordable green leafy vegetable crops in South Africa and is produced under a wide variety of climatic conditions. The production and consumption of Spinach is important because it supplies the body with nutrients such as Vitamin A, C and K as well as Calcium and Iron. Mulching with organic residues is a sustainable conservation and soil conditioning technique that increases soil organic matter and modifies soil physical properties (moisture, aeration, temperature, etc) and improves the general quality of the soil. The objective of this study was determine the effect of different organic mulches on yield and nutrient composition of Spinach in Semi-arid and humid conditions.

Materials and Methods

Two similar field experiments were conducted concurrently in Roodeplaat, Pretoria at ARC-VOPI and in Newlands East, Durban at Agro-Ecology Hub from July 2018. The treatments consisted of two levels of grass-mulch (3 t ha⁻¹ and 6 t ha⁻¹), two levels of agrimat mulch (full cover and half cover) and the control (bare soil). The experiments were laid out in a randomized complete block design with three replicates. Some plant growth parameters were recorded before each harvest. Spinach was harvested three times once a month – fresh and dry biomass yield was weighed and recorded. Dry matter was used for leaf elemental analysis. Least Significant Difference (LSD) was used to test significant differences between treatment means at 5% level of significance under JMP statistical package.

Results and Discussion

The results from each harvest demonstrate that most of the plant growth parameters (plant height, leaf length and leaf area) and fresh biomass yield was significantly higher in 100% agrimat mulch and 6 tons. ha⁻¹ grass mulch compared with the control. The nutrient analysis results of Spinach leaves show that the elemental concentration was higher in mulch treatments compared to the control but the differences were not significantly different regardless of agro-ecological zones.

Conclusions

Mulching is an effective conservation practice that can be adopted to increase the yield of spinach under different climatic conditions.

91) Soil organic carbon fractions and glomalin related soil protein in soils under different land uses

Presenter: A.D Nciizah (nciizaha@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
C	Mubekaphi	School of Agricultural, Earth and Environmental Sciences, UKZN, Scottsville, South Africa
AD	Nciizah	ARC-SCW, P Bag X79, Arcadia 0083, Pretoria, South Africa
P	Muchaonyerwa	School of Agricultural, Earth and Environmental Sciences, UKZN, Scottsville, South Africa

Introduction

Soil organic carbon (SOC) plays a crucial role in determining the soil's capacity to maintain its environmental functions and biological productivity. However, biologically active fractions of organic matter, such as microbial biomass carbon (MBC) and water-extractable organic carbon (WOC) could better reflect the changes in soil quality. Recent studies have highlighted the existence of a thermostable, water-insoluble soil glycoprotein operationally referred to glomalin-related soil protein (GRSP) that is crucial for preserving SOC (Wright, and Upadhyaya, 1996). However, the relationship between SOM fractions and GRSP, and effects of different land uses on these parameters and relationships are not clearly understood. Therefore, this study sought to determine the relationships between GRSP, SOC, WSOC, and MBC and evaluate its share in the total SOC under the different land-uses.

Materials and Methods

Soil samples were collected from the top 30 cm from three land-uses i.e. long-term no-till (NT), native forest (F), conventional tillage (CT) in Howick, KwaZulu-Natal. Nine centering points were georeferenced in grid sampling centered in a 1 ha plot, at a distance of 30 m from each other and 20 m from the edge in each land-use system. The EE-GRP and T-GRSP fractions were extracted with 20 mM sodium citrate, and 50mM sodium citrate respectively, and assayed using the Bradford total protein method (Wright and Upadhyaya (1996). The soils were further analysed for SOC, MBC and WSOC.

Results and Discussion

Soils under F had higher values ($P < 0.05$) of SOC and GRSP fractions whilst soil under CT had the lowest. There were strong positive linear relationships between SOC and both EE -GRSP ($R^2 = 0.84$) and T-GRSP ($R^2 = 0.83$). The linear relationships were moderate between WSOC and EE-GRSP ($R^2 = 0.67$) and T-GRSP ($R^2 = 0.53$). The relationships between MBC and EE-GRPSP ($R^2 = 0.58$) and T-GRSP ($R^2 = 0.50$), were similar to those with WSOC. The positive relationship between both GRSP fractions and all measured SOC fractions shows that GRSP significantly contributes to SOC sequestration. The poorer relationship between labile SOC fractions than total indicates that glomalin is more recalcitrant than these fractions. Zhang *et al.* (2017) observed higher recalcitrance index of GRSP than that of SOC, thus indicating that GRSP is vital for SOC sequestration.

Conclusions

This study demonstrated that greater accumulation of GRSP could cause the accumulation of SOC, particularly under native forest. Therefore, land use practices that mimic natural forest favour the accumulation of SOC and GRSP and should be widely adopted.

92) Effects of mulching on yield, water productivity and nitrogen use efficiencies of no- till planted Maize and preceding Cucumber

Presenter: C Pisa (cpisa2011@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
C	Pisa	Marondera University of Agricultural Sciences and Technology Box 35, Marondera, Zimbabwe
B	Nyamande	Marondera University of Agricultural Sciences and Technology Box 35, Marondera, Zimbabwe
E	Faranando	Marondera University of Agricultural Sciences and Technology Box 35, Marondera, Zimbabwe
W	Ngezimana	Marondera University of Agricultural Sciences and Technology Box 35, Marondera, Zimbabwe

Introduction

Under climate change scenarios, water availability is a challenge and a major constraint being faced by farmers as it involves a swing in the rainfall patterns. Experiments to assess the effects of mulching on water productivity on maize preceding cucumbers were done at Marondera University of Agricultural Sciences and Technology during the 2017/18 summer season.

Materials and Methods

The treatments used for this experiment included: Black plastic mulch, Maize cob mulch, Wheat straw mulch and the control which had no mulch. The treatments were laid out in a completely randomised block design, replicated three times. Variables recorded included number of days to emergence, plant growth rate (plant height), Leaf Area Index (LAI), days to tasselling, Soil Water Holding Capacity (SWHC), yield, WP (Water productivity) and NUE (Nutrient Use Efficiency). In Cucumbers, stem girth, flower number, fruit number, fruit mass and diameter, and fruity quality were also evaluated. The results indicate that Black plastic mulch gave the best results. There was a significant difference at $\alpha = 0.05$ across all treatments in almost all the parameters measured.

Results and Discussion

Results showed that mulching has a significant effect on maize emergence, LAI, plant height, grain yield, NUE and WP. Treatments mulched using plastic gave the overall best maize performance with a yield of 6.88 t ha^{-1} . The least maize performance was obtained in the control treatment with no mulch (5.06 t ha^{-1}). This proved that mulching have an effect on growth, yield, water, and nitrogen use efficiencies of no -till planted maize. Soil available moisture was highest under black plastic mulch plots in both maize and cucumber trials. In cucumbers maize cob mulch recorded the highest number of flowers and fruits. However, treatments with maize residue mulching are susceptible to nitrogen deficiency due to nutrient immobilization. Mulching techniques have to be applied in maize production as they come with increased water productivity, nitrogen use efficiency and yields.

Conclusions

In the event that maize residue mulching is to be utilized for mulching it has to be composted to ensure decomposition occurs before applying to the soil as failure to do so results in nitrogen immobilization from the soil. Maize residue mulching if to be applied should be accompanied with more fertilizer application so as to cushion the crops against nutrient deficiency.

93) Effects of no-till and rip on row cultivation practices on enzyme activities in sandy soil under maize production using a soil alteration index as indicator

Presenter: OHJ Rhode (rhodeo@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
OHJ	Rhode	Agricultural Research Council-Grain Crops, Private Bag X1251, Potchefstroom, 2520
DJ	Beukes	229 Emmarentia Street, Meyerspark, 0184
AA	Nel	22 Watsonia Street, Grimbeek Park, Potchefstroom, 2520
AH	Meyer	Agricultural Research Council-Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch, 7599

Introduction

Sandy soils in the north western Free State are known for their inherent compaction problem, low organic matter content, as well as low nutrient- and water retention capacity. Since the 1970's on-farm research was focused on these problems. The results led to the implementation of the rip on row (ROR) cultivation system with the result of higher yields on sandy soils. Unfortunately, the short-term residual effect of the system has been forcing farmers to annually repeat the action and thus undermining soil health. Against this background, ongoing scientific and practical evaluation of innovative and alternative cultivation and tillage practices is needed to address this problem. Identifying measuring tools to achieve this objective is equally important. One such tool, is the enzyme based alteration index three (AI3) that is sensitive to alterations in soil characteristics caused by cultivation practices. Thus, the aim of the study was to compare the impact of no-till (NT) and ROR cultivation practices on enzyme activities in sandy soil under a local maize based production system using the AI3 as an indicator.

Materials and Methods

This study was carried out in a maize trial in the Kroonstad district, Free State. Ninety-six rhizosphere soil samples were collected 100 days after planting and pooled to create 24 composite samples. The treatments consisted of NT and ROR under monoculture maize. Soil microbial activities were measured by determining alkaline phosphatase, β -glucosidase and urease activities in the soil samples from the trial. AI3 indices were generated using the formula by Puglisi *et al.* (2006). Data were statistically analysed using Statgraphics software.

Results and Discussion

β -glucosidase and alkaline phosphatase activities were significantly higher in NT compared to ROR treatments. No significant differences were observed for urease activity. However, when using the AI3 as indicator it was observed that the overall effect of ROR treatments on soil enzyme activities was significantly negative compared to NT treatments. The benefits of using ROR to address the inherent problems of sandy soil need to be weighed up against the negative impact it has on soil enzyme activities.

Conclusions

No-till practices promote soil enzyme activities in sandy soil under local maize based production systems implying better soil health. The AI3 could prove to be a useful tool for measuring soil health in local maize based production systems.

94) Glycoproteinaceous glomalin deposition and influence on aggregate stability of a sand

Presenter: T Seobi (Tshepiso.Seobi@nwu.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
T	Seobi	Centre for Environmental Management, North-West University, Private Bag X6001, Potchefstroom, 2520 Republic of South Africa
GL	Blatch	Vice Chancellery, University of Notre Dame Australia, PO Box 1225, Fremantle, WA 6959, Australia
JF	Dames	Department of Biochemistry and Microbiology, Rhodes University, P.O. Box 94, Grahamstown, 6140 Republic of South Africa

Introduction

This study aimed to determine the influence of arbuscular Mycorrhizal fungal inoculation of maize plants on the deposition of glomalin, and the influence of glomalin per se on water stability of soil aggregates.

Materials and Methods

For the first aim, maize plants were inoculated with an arbuscular mycorrhizal (AM) fungus, *Claroideoglossum* (previously *Glomus*) *etunicatum* and deposition of glomalin into the growth medium was investigated. Experimental split pots with two compartments separated by a nylon mesh were used; the root compartment where the seed was planted and the Mycorrhizal compartment alongside. For the second aim, glomalin was extracted from an undisturbed natural vegetation soil, using the easily extractable glomalin extraction method. The extract was applied to sand for comparison with humic acid treatments and untreated controls, before incubation for five weeks. Aggregate stability of sand treated with glomalin or humic acid was measured by wet sieving.

Results and Discussion

In the inoculation treatment, AM fungi deposited 1.7 times more immunoreactive easily extractable glomalin into the mycorrhizal compartment than into the root compartment (0.012 vs 0.007 mg g⁻¹). Inoculation treatment further significantly increased Bradford-reactive total glomalin by 9% (0.138 to 0.150 mg g⁻¹), and doubled immunoreactive total glomalin concentration and percentage in the growth medium (0.010 to 0.020 mg g⁻¹, and 4.1 to 7.6%, respectively). There was no interaction between treatment and compartment for any of the glomalin reactive forms. Secondly, glomalin 15 mg g⁻¹ was the only treatment that enhanced water stable aggregation when compared to other treatments (control, humic acid 1.5%, humic acid 6% and glomalin 2.5 mg g⁻¹). The enhancement was by more than three times (from 2.1% to 6.9% water stable aggregates).

Conclusions

Glomalin significantly stabilised aggregates against water disturbance, thus reducing the amount of sedimentation and erosion of sandy soil.

95) The effect of poultry litter and NPK fertilizer application on growth and yield of onion (*Allium cepa* L) in Hutton soil

Presenter: S Sina (sinamashishi@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
S	Mashishi	University of Venda, Department of Soil Science, Private bag, X5050, Thohoyandou 0950
SG	Lusiba	University of Venda, Department of Soil Science, Private bag, X5050, Thohoyandou 0950

Introduction

Application of poultry litter as a soil amendment may improve soil physical, chemical and biological properties, while inorganic fertilizer may enhance plant height, stem girth, and the number of leaves and pods in plants. The main aim of this study was to evaluate the effect of poultry litter and inorganic fertilizer application on rhizospheric pH, organic carbon and available P as well as growth and yield of onions in a Hutton (clay) soil.

Materials and Methods

The experiment was conducted at the University of Venda experimental farm during winter (April to September) 2018. Treatments consisted of poultry litter applied at 0 (control), 10, 20 and 40 t ha⁻¹, and nitrogen (N), phosphorus (P) and potassium (K) fertilizer at rates of 100, 100, and 75 kg ha⁻¹ respectively. The treatments were replicated three times and arranged in a randomized complete block design. Soil pH, available P, organic C, plant height, number of leaves/plant, bulb diameter, and bulb dry weight were measured. The parameters were analysed using two-way ANOVA and the means were compared using the LSD test at P ≤ 0.05.

Results and Discussion

Application of NPK fertilizer resulted in an increase in the number of leaves, bulb diameter and bulb dry weight. The response of onion performance with NPK fertilizer application was probably due to the increase in available P in the soil with NPK fertilizer application. There was an increase in available P in the poultry litter and NPK fertilizer treatments. Poultry litter application at 20 t ha⁻¹ significantly increased plant leaf height, bulb diameter and bulb dry weight of onions. Application of poultry litter at 10 to 40 t ha⁻¹ increased soil pH and organic C, and the increase was attributed to the chemical characteristic of the poultry litter applied. Available P, plant height and bulb diameter increased at 10 and 40 t ha⁻¹ poultry litter application when NPK fertilizer was applied. This suggests that the combination of poultry litter and NPK fertilizer could serve as a nutrient source for growth and yield of onion in Hutton clay soil.

Conclusions

Application of poultry litter at 10 and 40 t ha⁻¹ with NPK fertilizer addition improved growth and yield of onion. However, the performance of onion was better in the poultry litter treatment without NPK fertilizer application. This study suggests that poultry litter application with or without NPK fertilizer could improve growth and yield of onion when water is not limiting in Hutton clay soil.

96) Effect of acidic soils on specific spinach growth parameters

Presenter: TC Tsawe (chulezatsawe chush@gmail.com)

Initials	Surname	Authors Company/Organisation and Postal Address
C	Tsawe	Dohne agricultural development institute, private bag X15, Stutterheim, 4930
R	Moyo	University of Fort Hare, private bag X1314 Alice 5700
I	Gura	University of Fort Hare, private bag X1314 Alice 5700
Z	Nkolisa	Dohne agricultural development institute, private bag X15, Stutterheim, 4930

Introduction

Soil serves as an essential growing medium of plants in agricultural industry (USDA, 2018). Spinach is a valuable vegetable crop that provides essential vitamins and minerals to human beings. Spinach also helps keep cholesterol from oxidizing and protects your body from free radicals, particularly in the colon (Mercola, 2018). Spinach is sensitive to soil acidity lower than pH 4.5. Acidity increases the toxicity of aluminium which reduces root growth and branching. Spinach is a type of crop that is sensitive to acidic soil, which is to soil that has a pH of less than 4.5. (Schroeder *et al.* 2004; Miles 2013). Acidic soil increases the toxicity of aluminium which reduces the root growth and branching. The aim of this study was firstly to determine the effect of soil acidity soil on spinach growth parameters and secondly to determine the method that can be used to improve growth of spinach on acidic soils. Note: delete all references for an abstract.

Materials and Methods

The experiment was conducted at University of Fort Hare in a controlled environment glasshouse. Twenty pots were filled with soil collected at Hogsback, located in Alice, Eastern Cape which has an average annual precipitation of 974 mm. The soil pH was analysed using KCl solution.

Results and Discussion

Indications were there were no significant differences between sheep kraal manure and lime fertilizer in terms of pH, seed germination and plant leaf area. The sheep kraal manure introduced weeds into pots, which were removed by hand. In control pots most of the seeds did not germinate and the total plant leaf area was less than that of plants grown under lime fertilizer, poultry manure and sheep kraal manure. Spinach germination, pH and leaf area under treatment of poultry manure were less than sheep kraal manure and lime fertilizer but more than control. Poultry manure is known as a source of the macro-nutrients nitrogen, phosphorus and potassium which are essential elements for crop growth.

Conclusions

Acidic soils affect the germination and leaf area development of spinach. Lime fertilizers and sheep kraal manure have similar effects on spinach grown in acidic soils; both can therefore be used to improve spinach parameters in acidic soils.

97) Influence of conservations agriculture on topsoil stratification

Presenter: A van der Merwe (annemariemdmerwe@elsenburg.com)

Initials	Surname	Authors Company/Organisation and Postal Address
A	Van der Merwe	Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607
J	Labuschagne	Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607

Introduction

According to Sithole *et al.* (2016) more than 70% of farmers in Western and Southern Cape have adopted one or more of the principles of conservation agriculture (CA). As management practices change from conventional winter wheat production to CA, aspects like reduced tillage, crop rotation and improved stubble preservation caused changes in the composition and distribution of several topsoil physical, chemical and quality parameters. Du Preez *et al.* (2001) found that after only 10 years, residue management practices may cause significant stratification of soil fertility indicators, which may influence availability of nutrients in the different soil depths in the root zones. The study was done to determine if stratification has taken place at the Western Cape's Department of Agriculture's research farms, Tygerhoek on an existing project that has been under conservation and conventional agriculture for the past 12 years.

Materials and Methods

The effect of various degrees of soil disturbance on soil quality parameters were studied in four tillage treatments, namely: zero tillage (ZT), no-till (NT), minimum-till (MT) and conventional-till (CT), each replicated four times. One composite soil sample comprising of six sub-samples per treatment combination was collected at 0-5, 5-10, 10-15, 15-20 and 20-30 cm depth during November 2017. Samples were analysed for pH(KCl), Ca, Mg, Na, K, P, Cu, Zn, Mn, S and C.

Results and Discussion

Except for Phosphorus ($P = 0.02$) and Zinc ($P = 0.03$) where ZT resulted in higher concentrations ($P=0.05$) in the 0-5 cm layers, tillage treatment or crop rotation did not influence the distribution of the parameters included in the study. Depth of sampling significantly influenced all parameters included in the study. The highest significant mean pH(KCl) ($P=0.05$) was recorded in the 0-5 cm soil layer. As expected the accumulation of K ($P=0.05$), Ca ($P=0.05$) and C ($P=0.05$) was significantly the highest in the 0-5 cm soil layer. The mean pH values decreased with depth. Sulphur ($P=0.05$) and Mn ($P=0.05$) accumulated in the 0-10 cm layers. Sodium, Mg and Cu content increased with depth with significantly higher concentrations recorded in the 20-30 cm layer.

Conclusions

Nutrient distribution patterns of parameters studied within the top 0-30 cm soil were mainly the result of the potential of the element to leach through the profile and not by tillage or crop rotation.

98) Hydropedological grouping of South African soil forms

Presenter: JJ van Tol (vantoljj@ufs.ac.za)

Initials	Surname	Authors Company/Organisation and Postal Address
JJ	Van Tol	Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300
PAL	Le Roux	Institute for Groundwater Studies, University of the Free State, PO Box 339, Bloemfontein, 9300

Introduction

The science of hydropedology has progressed significantly in the past two decades, especially with regard to the interpretation of soil morphology and relating these interpretations to the hydrological behaviour of horizons, profiles, hillslopes and catchments. The link between soil forms and their hydropedological type has been established in several hydropedological studies (e.g. Le Roux *et al.* 2015; van Tol & Lorentz 2018), this was however reported on a case-by-case bases. With this in mind, it is timeous to present a unified and tested hydropedological concept grouping as applied to the soil forms of the South African soil classification system

Materials and Methods

This work relied on findings from approximately 115 hydropedological studies which were conducted over a wide geographical area, covering several geological formations and a wide range of climatic conditions. The dominant hydrological response of soil forms were identified from interpretation of soil morphology and supported with quantitative physical and hydrometrical measurements. The soils were then divided into groups with similar dominant hydrological responses.

Results and Discussion

Four main hydropedological soil types were identified. In Recharge soils (either shallow or deep), vertical flow and deep drainage into fractured rock the dominant flowpath. Interflow soils promote subsurface lateral flow either at A/B horizon interface or the soil/bedrock interface. Responsive soils generate overland flow, either due to saturation excess (wet soils) or due to small storage capacity being exceeded quickly after rain events (shallow soils). Lastly, in Stagnating soils, infiltration occurs readily, but infiltrated water seldom reach the soil/bedrock interface due to climatic factors favouring evapotranspiration. The 73 soil forms of the South African classification were then assigned to one of the hydropedological soil types.

Conclusions

This hydropedological grouping of soil forms will improve the development of conceptual hydrological response models for hillslopes. These models can be applied in land-use change assessments, wetland preservation studies, configuration of hydrological models and any other study where dominant flow processes must be understood.









