Combined Congress

20 - 23 January 2020

University of the Free State

Bloemfontein

Combined Congress 2020 – Participating Societies
Gesamentlike Kongres 2020 – Deelnemende Verenigings

South African Society of Crop Production
Suid-Afrikaanse Vereniging vir Gewasproduksie

E-mail: admin@sascp.org.za
Website: www.sascp.org.za

Soil Science Society of South Africa
Grondkunde Vereniging van Suid-Afrika

E-mail: admin@soils.co.za
Website: www.soils.org.za

Southern African Society for Horticultural Sciences
Suider-Afrikaanse Vereniging vir Tuinbouwetenskappe

E-mail: admin@sashs.co.za

Website: www.sashs.co.za

Southern African Weed Science Society
Suider-Afrikaanse Vereniging vir Onkruidwetenskap

E-mail: mikefe@elsenburg.com

Website: www.weeds.org.za

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ACKNOWLEDGEMENTS

Local Organizing Conmmittee:

Dr Cobus Botha

Dr Kobus Anderson

Dr Gert Ceronio

Dr Gesine Coetzer

Dr Elmarie van der Watt

Mrs Nancy Nortje

Symposium:

"SOIL FERTILITY AND CROP NUTRITION SYMPOSIUM: PRINCIPLES AND PRACTICES"

Dr Chris Schmidt; Kobus van Zyl, Vossie Wilschnach; Dr Pieter Hauman and Dr Johan van Biljon

Reviewers:

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Staff and students of the Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein & Agricultural Research Council – Soil, Climate, Water and Agricultural Engineering, Glen

Photo:

Dr Kobus Anderson

Venue

University of the Free State

MESSAGE FROM THE CHAIRMAN OF THE LOCAL ORGANISING COMMITTEE

The Local Organizing Committee (LOC) welcomes all delegates to the Combined Congress 2020, hosted by the Southern African Plant and Soil Sciences Committee (SAPSSC) in Bloemfontein – the "City of Roses". The Combined Congress 2020 is co-presented by the Soil Science Society of South Africa (SSSSA), South African Society of Crop Production (SASCP), Southern African Society for Horticultural Sciences (SASHS) and Southern African Weed Science Society (SAWSS). The theme of this Combined Congress "***Basic and applied sciences – Fundamentals of sustainable agriculture***" is particularly appropriate at a time that is characterized by drought and many other uncertainties.

Major challenges, associated with climate change and the environmental impact of the agricultural sector, emphasize the need for sustainable food production. Basic and applied sciences are the fundamental foundation of agriculture which provides food to feed our nation in a sustainable manner that conserves natural resources in a competitive global marketplace. Conferences like this are there to exchange and test new ideas, meet new scientists, stimulate new developments and innovative research, and accelerate applications that benefit farmers. For this reason, you are urged to make ample use of the tea and lunch breaks as well as the other social events for networking and knowledge exchange.

The Combined Congress 2020 has reputed keynote speakers here by invitation from the various societies, presentations by highly recognized individuals from industry, oral presentations by both experienced and young scientists, a variety of poster presentations, as well as a Symposium on "***Soil fertility and crop nutrition: Principles and practices***". A total of 280 delegates have registered, with 190 abstracts accepted from all over southern Africa and five from overseas, so the body of scientific knowledge involved is substantial. A special word of appreciation to all the presenters. Hopefully, each delegate will benefit in some way from that expertise.

We appreciate the open-hearted gesture of the Bloemfontein Main Campus of the University of the Free State for providing their excellent facilities and support in hosting this Congress on their premises.

Our sponsors and exhibitors, whose names and logos are published and displayed in numerous ways during the Congress, including on a leaflet in the Congress bag, deserve a special word of thanks and appreciation for their generous support, especially in the current economic climate. Several of them have supported the Combined Congresses for a number of years and their commitment is gratifying. Without your valuable support an event like this would not be possible. I trust that your investment in this Congress will bear fruit in the form of new technology to the benefit of both your own company and the agricultural sector in South Africa.

On behalf of the LOC and sponsors of the Combined Congress 2020, I wish each participant fruitful and productive deliberations, and an enjoyable time during the course of the next three days in the heart of the Free State.

Dr Cobus Botha
(Chairperson, LOC)

GENERAL INFORMATION

Registration

Registration will take place at the Centenary Complex – 29°6'44.45"S 26°11'13.39"E on Monday the 20 January from 15:00.

Opening and keynote addresses

This will take place in the Economic and Management Science Building.

Parallel sessions

Parallel sessions will be held in the Economic and Management Science Building ALG2, ALG8, AG2, AG3 and AG4 venues.

Refreshments, lunch and functions

Refreshments will be served in the Economic and Management Science Building Foyer at the times indicated in the programme. Bottled water will be provided during the first tea break and after lunch.

Lunch will be served at the Centenary Complex (GPS coordinates 29°6'44.45"S; 26°11'13.39"E). The cocktail and gala dinner will be held in the same venue.

The braai will be at the Free State Botanical Garden (GPS coordinates 29°'03'10.6"S; 26°12'42.2"E) / End of Rayton Rd continue on Bloemdal Rd off Dan Pienaar Drive.

The cocktail function is on Monday the 20th at 19:00. The braai is Tuesday 21st at 19:00.

Important information for presenters

All presenters must take note of the date, venue and time of their presentations. You have 15 minutes for an oral presentation and an additional 5 minutes for questions. Time allocated for questions may also be used for you to move to another venue.

Please remember to have your presentation on a flash drive, ready to be uploaded. All Powerpoint presentations need to be uploaded no later than the break before your session.

PROGRAMME

Monday 20 January 2020		
Time	**Event**	**Venue**
15:00 - 18:30	Registration	Centenary Complex (29°6'44.45"S; 26°11'13.39"E)
15:00 - 18:30	Posters	Economic and Management Science Building Foyer (29°6'31.97"S; 26°11'8.24"E)
19:00 - 20:30	Cocktail	Centenary Complex (29°6'44.45"S; 26°11'13.39"E)

Tuesday 21 January 2020			
Time	**Event**	**Venue**	
07:00 – 08:30	Registration	Economic and Management Science Building Foyer	
PLENARY SESSION – Room ALG2			
08:30 – 08:45	Welcome	Dr Cobus Botha	
Keynote adressess			
8:45 – 9:15	Opening address	Prof Prakash Naidoo	
9:15 – 9:45	SASHS	Prof Vaughan Hattingh	Industry – University partnership opportunity road ahead for Horticultural research
9:45 – 10:15	SASCP	Mr. Matome Ramokgopa	Innovative solutions for vegetable seed production for a growing population
10:15 – 10:40	**MORNING TEA - Economic and Management Science Building Foyer**		
10:45 – 11:15	SSSSA	Prof Klaus Kellner	Scientifically sound policies and practices to ensure food security and sustainable agriculture
11:15 – 11:45	Poster Session 1		
11:45 – 12:50	**LUNCH – CENTENARY COMPLEX**		

FIRST CONCURRENT SESSION – Tuesday 21 January 2020			
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Hort Indigenous & Medicinal plants**	**Soil fertility**	**Crop nutrition & Water management**
Chairperson	**Louisa Blomerus**	**Gerhard Nortjé**	**Diana Marais**
13:00 – 13:20	Impact of storage temperature and time on quality and phenolic compounds of Natal plum (*Carissa macrocarpa* L.) – **Mphaphuli T**	Accumulation and distribution of soil organic carbon in Oxisols, Tshivhase Estate, Limpopo Province – **Ntsewa MR**	Antidiabetic and nutritional activities of wild and cultivated Amaranthus spp. and isolated compounds – **Nkobole N**
13:20 – 13:40	Developing propagation technologies for indigenous plants used in the natural products industry – **Kleynhans R**	On-farm measurement of water and nutrient use efficiencies of potato-based rotation systems in North West Province – **Mukiibi AM**	An integrated approach to manage mycotoxin contamination in Southern African maize grain. - **Janse van Rensburg B**
13:40 – 14:00	Effect of harvesting intervals on plant growth and nutrient composition of *Moringa oleifera* seedlings – **Mashamaite CV**	Stabilization of soil organic carbon within silt+clay fraction in shrub- encroached rangeland shallow soil – **Khumalo MN**	Evaluation of kraal manure, inorganic fertilizer and lime on maize grain yields and selected soil chemical properties in acidic soils of Tsolo, Eastern Cape – **Mbangcolo MM**
14:00 – 14:20	Effect of growth conditions on phytochemicals in *Cleome Gynandra* L. harvested at different growth stages – **Masetla NL**	Effect of zeolite as a soil amendment on the performance of cabbage (*Brassica oleracea* Var. capitata L) – **Sindesi OA**	Resource use efficiencies of potato production in the Sandveld region of the Western Cape – **Steyn JM**
14:20 – 14:40	Application of medicinal plant extracts against maize seeds Fusarium pathogens and their effects on seeds germination – **Seepe HA**	Soil spectral characteristics and their predictive value in relation to spatial and temporal variability in wheat yield and soil quality within a long-term field trial. – **Ngejane N**	Assessing the raid susceptibility of crops grown in the Eastern Okavango Panhandle between 2008 and 2018 – **Matsika TA**
14:40 – 15:00	Effects of synthetic amalgamated agricultural phytohormones on the changes in leaf trichome morphology and density, selected essential oil yield and quality parameters of simulated hail-damaged rose geranium (*Pelargonium graveolens* L'Her.). – **Khetsha ZP**	Infrequent tillage could be used to reduce nutrient stratification in conservation agriculture systems – **Tshuma F**	The influence of foliar and application rate of nitrogen fertiliser on seed- and oil yield of canola – **Crous IR**
15:00 - 15:25	**AFTERNOON TEA - Economic and Management Science Building Foyer**		

SECOND CONCURRENT SESION – Tuesday 21 January 2020			
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Hort Biotechnology, Propagation and Post-harvest**	**Soil genesis, classification & mapping**	**Crop Physiology**
Chairperson	**Riana Kleynhans**	**Martiens du Plessis**	**Elmarie van der Watt**
15:30 – 15:50	Towards the elucidation of compatible litchi scion:rootstock combinations – **Hannweg K**	A New South African Soil Classification: A Review of Selected Downstream Impacts – **Barichievy KR**	Genotypic variation in water use and water use efficiency among four Cassava landraces grown in the Northeastern part of South Africa. – **Malele KP**
15:50 – 16:10	Molecular characterisation of Macadamia using simple sequence repeat markers – **Hajari E**	Mapping soil factors influencing erosion using machine learning algorithms in the T35D-E Catchment in the Eastern Cape Province - **du Plessis CJ**	Can crop physiology knowledge enhance sugarcane breeding? – **Singels A**
16:10 – 16:30	Prediction of macadamia shelf life and optimisation thereof – **Penter MG**	Soil moisture monitoring using Citizen Observatory data – **Kibirige DMK**	Drought adaptation mechanisms utilized by *Moringa oleifera* tree grown under semi-arid condition of the Limpopo Province - **Bopape-Mabapa MP**
16:30 - 16:50	Sweet potato production in sacks: potential utilisation of limited space in rural, urban and peri-urban areas – **Mudalahothe N**	Development of a refined land capability evaluation data layer for South Africa – **Collett A**	Remote sensing of physiological traits with drones to assist sugarcane breeding: preliminary results – **Hoffman N**
16:50 – 17:10	The efficacy of postharvest wax application in the reduction of chilling injury incidence in lemon fruit (*Citrus limon* (L.) Osbeck) – **North JJ**	An introduction to peat in the South African Soil Classification – **Grundling P**	Floret survival, effecty of soil fertilty and sowing date on the contribution of main stem, tillers, kernel position to grain yield and protein content of wheat (*Triticum aestivum* L.) – **Metho LA**
17:10 – 17:30	The role of glucose to signal and regulate 'Hass' avocado fruit skin colour change during ripening – **Mathaba N**	Saving urban infrastructure from water damage: Digital soil mapping combines with hydrological modelling to determine remedial actions - **van Zijl GM**	Evaluation of agronomic and drought response traits of two soybean (*Glycine max*) cultivars for cultivation in the Transkei region of the Eastern Cape – **Akanbi MO**
19:00 - Late	**Braai - Free State Botanical Garden (GPS coordinates 26°12'42.2"E; 29°'03'10.6"S) / End of Rayton Rd continue on Bloemdal Rd off Dan Pienaar Drive.**		

Wednesday 22 January 2020	
"SOIL FERTILITY AND CROP NUTRITION SYMPOSIUM: PRINCIPLES AND PRACTICES"	
Time	**Event**
07:30 – 08:00	Registration
08:00 – 08:10	Welcome and Opening - Dr Chris Schmidt – (Facilitator)
08:10 – 08:50	Soil Sampling for Soil Fertility Evaluation – Mr. Kobus van Zyl
08:50 – 09:30	Soil analyses – the certainty behind uncertainty – Mr. Vossie Wilsnach
09:30 – 10:00	Discussion
10:00 – 10:30	**MORNING TEA - Economic and Management Science Building Foyer**
10:30 –11:15	Factors affecting liming principles and practices - Dr Pieter Haumann
11:15 – 12:00	Fertiliser Guidelines – Lab to Field - Dr Johan van Biljon
12:00 – 12:40	Discussion
12:40 – 12:50	Summary and Closure
13:00 – 13:50	**LUNCH – CENTENARY COMPLEX**

Wednesday 22 January 2020	
Excursion	
Time	**Event**
09:00 – 12:30	Excursion to Vergezocht Oil and iTau Milling
13:00 – 13:50	**LUNCH – CENTENARY COMPLEX**

	THIRD CONCURRENT SESION – Wednesday 22 January 2020		
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Hort Production & Cultivation Practices**	**Crop Breeding, Quality, Physiology & Weeds**	**Soil Technology & Crop Protection**
Chairperson	**Martha Phofu**	**Juan Vorster**	**Cobus Botha**
14:00 – 14:20	Innovative sack production of *Beta vulgaris* in limited spaces: plant density effects – **Mtsweni MD**	Distribution of Russian wheat aphid biotypes in South Africa during 2018 and report of a new biotype in the Eastern Free State. – **Jankielsohn A**	Hydropedological response in a Savannah hillslope under different precipitation regimes - **van Tol JJ**
14:20 – 14:40	Physiological parameter and quality of baby spinach cultivars in Gauteng Province, South Africa – **Masufi NM**	Weed growth and crop yield responses to tillage and mulching under different crop rotation sequences in semi-arid conditions – **Mashingaidze N**	Identifying sources of suspended and deposited sediment at a sub-catchment level of the Caledon river basin – **Taeni TT**
14:40 – 15:00	Effect of plant growth substances on growth, yield and quality parameters of swiss chard (*Beta vulgaris* L.) – **Masondo SN**	Herbicide use within the commercial forestry sector in South Africa – **Roberts JC**	Can generalized erodibility models be applied for South African soils? - **Abd Elbasit MAM**
15:00 – 15:20	The effect of retain, swelpine and rhamnolipids on the inhibition of natural flowering in queen pineapple in South Africa – **Mbatha BW**	Oil content, oil and seed yield of sunflower as a function of hybrid and planting dates - **Ma'ali S**	Assessing Cocoa Swollen Shoot Virus (CSSV) disease prevalence in the Nawa region (South-West Côte – **Diby LN**
15:20 – 15:40	Effect of planting density on the growth and yield of chilli pepper (*Capsicum frutescens* L.) produced under field and closed hydroponics system – **Maphoto ML**	Germinability and growth of upland rice (*Oriza* spp.) cultivars as influenced by drought imposed at anthesis and storage temperature – **Dada OA**	
15:40 - 16:00	**AFTERNOON TEA - Economic and Management Science Building Foyer**		
ANNUAL GENERAL MEETING			
16:00 – 17:40	**SASCP - ALG2**	**SSSSA - AG2**	**SASHS - AG3**

THURSDAY 23 January 2020			
FOURTH CONCURRENT SESION – Thursday 23 January 2020			
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Hort Physiology & Indigenous plants**	**Soil Chemistry**	**Crop production & Modelling**
Chairperson	**Karin Hannweg**	**Andrei Rozanov**	**Michael van der Laan**
8:30 – 8:50	Effect of biostimulants on germination of *Abelmoschus esculentus* genotypes – **Makhaye G**	Effects of land use change on soil organic carbon concentrations and quality in the semi-arid Central South Africa – **Loke PF**	Response of rainfed maize root morphology to plant population under no-tillage – **Haarhoff SJ**
8:50 – 09:10	Investigating the diversity of morphological and physiological traits of selected Swiss chard (*Beta vulgaris* L. subsp. cicla) cultivars – **Mvukuzo X**	Adsorption potential of arsenic and selenium in soil substrates: A laboratory and pedo- geochemical modelling study – **Bouwer M**	Does application time of glyphosate affect maize yield parameters? – **Craven M**
09:10 – 09:30	Underutilised traditional vegetables in South Africa: their importance and state of characterisation conservation and utilization – **Mavengahama S**	Wetland soil properties associated with the abundance of potential rift valley fever virus vectors in Central South Africa – **Gqalaqha Z**	The relationship between conservation tillage practices for potato production and nematode activity in the Sandveld region of South Africa - **Van Zyl J**
09:30 – 09:50	The effect of fruit load on various fruit quality parameters of 'Hass' avocado – **Bertling I**	Manganese (II) oxidising potential of selected soils under differing oxidation conditions: Implication for irrigation management of mine-impacted waters. – **Heuer SN**	Seed-drills and their influence on uniformity of crop emergence – **Truter KJ**
09:50 – 10:10	Influence of Foliar *Moringa Oleifera* Leaf Extract (MLE) Application on growth, fruit yield and nutritional quality of cherry tomato – **Ngcobo BL**	Susceptibility of urban soils from the Cape Town and Stellenbosch areas to degradation by laundry greywater – **Madubela N**	Management strategies to increase winter herbage production of the lucerne phase in long-rotation cropping systems - **van der Westhuizen CG**
10:10 – 10:30	Biomass production and chlorophyll content of three *Corchorus olitorius* cultivars in relation to planting date – **Mothoa PE**	Making fertilizer recommendation based on soil sorption capacity and soil P test efficiency: Comparison of Phosphate Buffering Capacity, single-point sorption test and incubation methods – **White VG**	Benefits of increased maize plant population and narrow rows under no-tillage is season-specific in semi-arid environments – **Haarhoff SJ**
10:30 - 10:55	**MORNING TEA - Economic and Management Science Building Foyer**		

FIFTH CONCURRENT SESION – Thursday 23 January 2020			
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Crop Production, Water Management, Modelling & Agrometeorology**	**Hort/Crop Nutrition & Water management, Protection & New crops**	**Soil Biology, Chemistry, Fertility & Classification**
Chairperson	**John Annandale**	**Pippa Karsen**	**Kobus Anderson**
11:00 – 11:20	Trends in reference Evapotranspiration for South Africa using Hargreaves and Samani method – **Masithela TC**	The effect of water stress at different phenological stages on growth, production and postharvest fruit quality of avocado (*Persea americana* Mill. Cv – **Roets NJR**	Disaggregation of Land Types map: Why bother and how much could, it cost. – **Rozanov AB**
11:20 – 11:40	Finetuning nitrogen fertiliser norms for wheat under conservation agriculture in the Western Cape – **Labuschagne J**	Water productivity of selected indigenous fruit tree crops in South Africa – **Dzikiti S**	Potential of conservation agriculture to sequester carbon in cultivated maize and wheat fields – **Swanepoel CM**
11:40 – 12:00	Evaluation of bio-slurry application rates and soil management options on soil moisture conservation and maize water productivity – **Hadebe ST**	Estimating crop factors of apple orchards with varying age groups using in-situ measurements and satellite data in the Western Cape Province, South Africa – **Mobe NT**	Whats new in the new classification system? - **van Zijl G**
12:00 – 12:20	Assessment of water risk for sustainable crop production – **Grundling AT**	Effect of planting date on leaf production, yield and yield components of five Amaranth species under different growing conditions – **Makola TFM**	Relating the South African soil classification system with the World Reference Base - **van Huyssteen CW**
12:20 – 12:40	Response of quality protein maize varieties to different soil amendments and population densities in tropical rainforest – **Dada OA**	Water relations of apple trees under different irrigation systems: A case study of drip vs micro irrigation systems in South Africa – **Ntshidi Z**	Vital Soils for Sustainable Intensification of Agriculture: A chronosequence approach to organic agricultural research - **Mason-Jones K**
12:40 – 13:00	Influence of planting techniques and maturity group on soya bean (*Glycine max*) yield in different agroecologies in the North Eastern Free State - **van Zyl JP**	Potential use of seeds with hypogeous germination as carriers of active ingredients from nemafric-bl phytonematicide – **Mashela PW**	Analysis of soil enzymes and microbial diversity for effective crop production under agroforestry environment in Limpopo and Mpumalanga Province – **Makhwedzhana MM**
13:00 – 13:50	**LUNCH – CENTENARY COMPLEX**		

SIXTH CONCURRENT SESION – Thursday 23 January 2020			
VENUE	**ALG2**	**AG2**	**AG3**
Subject	**Hort Production, Cultivation**	**Crop Nutrition & Protection**	**Hort Weed management & Protection**
Chairperson	**Mark Penter**	**Maryke Craven**	**Isa Bertling**
14:00 – 14:20	The developmental growth and quality assessment of five selected cultivars of baby spinach grown in the north of Pretoria, Gauteng Province, South Africa – **Masufi NM**	Evaluation of trend of incursions of regulated pests and diseases of economic importance that are under official control in South Africa – **Rambauli M**	Weed management strategies for pumpkin – **Manyoni NN**
14:20 – 14:40	Effect of different growth media on growth, yield and quality of tomatoes grown using an open bag soilless system – **Chiloane TS**	Alleviation of residual herbicide phytotoxicity on dry beans using Brassinosteroids - **Van der Watt E**	Occurrence and diversity of nematodes around the rhizosphere of the kiwi trees in Limpopo province – **Sekhukhune MK**
14:40 – 15:00	Nutritional and phytochemical characterisation of sweet melon (*Cucumis melo* L.) cultivars grown in soilless culture – **Pulela LB**	Multiple resource limitation: Effect of nitrogen forms and phosphorus sources on potato grown in varying soil types – **Kiongo SC**	Host-status of 18 Fusarium-resistant sweet potato lines to Meloidogyne species in South Africa – **Pofu KM**
15:00 – 15:20	Performance and selection of soilless grown tomato cultivars for optimum yield and marketable quality – **Araya NA**	Should irrigation with mine-impacted water be considered part of the long-term strategy to manage acid mine drainage in the Witwatersrand Goldfields? – **Annandale JG**	Pelargonic acid as an alternative to paraquat for the preparation of fire-break tracer lines – **Little KM**
19:00 – Late	**AWARD WINNING DINNER - CENTENARY COMPLEX**		

ABSTRACTS: KEY NOTE PRESENTATIONS

KEY NOTE ADDRESS: SASHS

INDUSTRY – UNIVERSITY PARTNERSHIP OPPORTUNITY ROAD AHEAD FOR HORTICULTURAL RESEARCH

Prof Vaughan Hattingh
Citrus Research International, Department of Horticultural Science, Stellenbosch University, Victoria Street, Stellenbosch 7602, South Africa

In the international horticultural industry, which deals with the large scale production and export of fruit, there are three critical research areas which demand a focused effort for the next ten years to develop adequate technology required to ensure sustained market supply. The first area is **Market Access,** which relies heavily on scientific data to enable the government to government negotiations required to gain, retain and optimise market access. The access granted by a country to import fruit is based on two principals: firstly, a food safety assurance to consumers and secondly that the fruit poses no phytosanitary risk to the importing country. The next critical area of research is **Biosecurity.** Biosecurity requires countries to be vigilant of pest and disease threats, which could harm the environment and compromise future production and export of fruit. The third area of research revolves around **Climate Resilience** and requires multi-skilled research teams addressing commercial production constraints from a horticultural perspective. There is a clear need to improve the research and development value proposition in the South African fruit industry context, and two questions need to be answered. Firstly, what can the University do to increase its value proposition to the Industry? The second question is, how Industry can increase partnership value? The golden thread is researcher capacity, quality and attitude. Neither the University nor the Industry will obtain their research aims if adequate research capacity is not developed and sustained by accountable funding models. To reshape this mostly inefficient partnership, a few critical elements will need to be resolved. Going forward, it can't be business as usual, where the University expects the Industry to fund the pursuit of academic tradition and only reap coincidental benefits. There is a need to re-align the nature of partnerships to ensure greater cognisance of Industry needs. Academic elitist attitudes are not constructive in such partnerships and are the surest way of estranging Industry and funding. At the University and in particular the Agricultural faculty level, there is a need to drive the process, as it is not going to be achieved as a passive exercise. Leadership at this level should empower staff to set departmental and individual researcher staff goals and measure performance according to successes in building partnerships and responding to Industry requirements. University leadership needs to understand what the Industry requires in terms of research specialities and support the development thereof. Finally, Industry must commit to sustainable funding and there must be the buy in required to continue supporting successful research programmes at the University. The future for the South African fruit industry is bright, but will only survive the considerable threats it faces if strong research networks are built and maintained, with accountable partnerships between Industry and University being an important component.

KEY NOTE ADDRESS: SASCP

INNOVATIVE SOLUTIONS FOR VEGETABLE SEED PRODUCTION FOR A GROWING POPULATION

Mr. Matome Ramokgopa
Enza Zaden, Unit 3, The Shields, 33 Victoria Link, Route 21 Business Park, Centurion, 0178
Email: M.Ramokgopa@enzazaden.com

Food must be reliable, healthy and tasty with a strong focus on natural, authentic flavours and a high nutritional value. Climate change has encouraged innovative solutions in Agriculture, especially in plant production to continue feeding the growing population. Expanding production capability in the vegetable seed production industry has played a vital role in revolutionizing farming. Breeding varieties that can withstand disease pressure, climate fluctuations and allows for rapid seed increases while maintaining genetic purity is of high importance. Farmers expect high quality seed that leads to optimal profit and nutritious produce. Ensuring that the production of high-quality seed is possible, better methods of weed and insect control, improved fertilizers and modern equipment is needed. South Africa is fortunate, due to a favourable environment to be a leader in the African continent in vegetable seed production. Ensuring high-quality vegetables and a continuous drive to increase the sustainability of food production in Africa is needed to feed the African population and encourage trade globally.

KEY NOTE ADDRESS: SSSSA

SCIENTIFICALLY SOUND POLICIES AND PRACTICES TO ENSURE FOOD SECURITY AND SUSTAINABLE AGRICULTURE

Prof Klaus Kellner
School of Biological Sciences and Unit for Environmental Sciences and Management, North-West University, Potchefstroom.
E-mail: Klaus.Kellner@nwu.ac.za

In the interest of developing a comprehensive strategy for sustainable development at global level, three main international conventions were agreed upon at the 1992 Earth Summit in Rio de Janeiro, which all signatories are obliged to uphold. In essence, these conventions deal with preserving biological diversity, countering climate change and combating desertification. Of particular interest here is the United Nations Convention to Combat Desertification (UNCCD), since this convention's intention is to integrate research outputs with a view to accelerate the achievement of sustainable development goals (SDGs), to build resilience to land degradation and climate change and to prevent biodiversity loss.

As a signatory state, South Africa's participation in and adherence to all three conventions are managed by the Department of Environmental Affairs (DEA) which now resorts under the Department of Environment, Forestry and Fisheries (DEFF). All countries that have ratified the conventions can assign a Science and Technology Correspondent (STC) and a group of experts to represent them at scientific conferences as well as at the so-called Conference of the Parties (COP), where all signatories to the conventions meet.

To ensure that inputs at conferences and COPs are based on scientifically sound principles, a Committee on Science and Technology (CST) is appointed. This CST collects, analyses and reviews relevant scientific data with a view to promoting cooperation in a particular field of expertise on a sub-regional, regional and national basis.

The National Action Programme (NAP) of the UNCCD is a key instrument to ensure that the research, findings and knowledge generated at country level with regards to the processes that lead to desertification, land degradation and drought (DLDD), as well as the impact thereof on bio-physical and socio-economic systems, are imparted at the CST.

For the past 16 years, I have been the STC for the team of experts who represent the country at the UNCCD's scientific conferences and COPs and have also chaired the CST from 2009 - 2011.

In 2019, COP 14 for the UNCCD was held in New Delhi, India. Some of the main topics discussed were the adoption and implementation of land-based interventions for drought management and mitigation, achieving land degradation neutrality and ensuring food security through the effective dissemination and adoption of agricultural management practices that are more resilient and sustainable, especially during extreme weather events (e.g. droughts) in Eastern and Southern Africa.

ORAL PRESENTATIONS - HORTICULTURAL SCIENCE

LISTED ALPHABETICALLY

Performance and selection of soilless grown tomato cultivars for optimum yield and marketable quality

Presenter: NA Araya (IbraimoN@arc.agric.za)

Initials	Surname	Authors Company/Organisation and Postal Address
NA	Araya	Agricultural Research Council
S	Chiloane	Agricultural Research Council
SO	Amoo	Agricultural Research Council
M	Maboko	Hygrotech
CP	Du Plooy	Agricultural Research Council

Introduction

Cultivar selection is amongst the most important decisions growers must make in order to achieve optimum yield and good quality, particularly in crops like tomato where there is quite a large number of cultivars on the market that is available to the farmer. For more rapid return on investment, hydroponic growers should opt for high yielding cultivars. Therefore, the aim of this study was to test the performance of 16 tomato cultivars in terms of yield and marketable quality.

Materials and Methods

An on-farm trial was conducted for two consecutive seasons (2017/18 and 2018/19) in a non-temperature controlled plastic tunnel in Cullinan, Gauteng Province, South Africa. This was one of the three study sites included in a project funded by the Gauteng Department of Agriculture and Rural Development and implemented in collaboration with the Agricultural Research Council. Tomato seedlings were transplanted in 10L black plastic bags filled with sawdust, at a planting density of 2.5 plants m^{-2}. Fertigation, pests and diseases control were conducted optimally. The plants were grown in a locally used open bag hydroponic system. Sixteen tomato cultivars recommended by seed suppliers in South Africa were tested (Boudica, Clarisa, Heidi, Inga, Jimbo, Leon, Lindsay, Marutschka, Monet, Sisley, Star 9037, Trinity, Sniper, Staffie, Kennedy and Oasis) using a randomized complete block design with four replications. Data recorded on crop yield and marketable quality, including plant physiological disorders were subjected to analysis of variance using Genstat® 11.1 and the least significant difference test.

Results and Discussion

The 16 tomato cultivars tested performed significantly different, with a consistent performance over the 2-year period studied. On average, the highest marketable yield and quality was observed with cultivar Trinity (4.8 kg $plant^{-1}$), followed by Staffie (4.4 kg $plant^{-1}$). These cultivars also showed significantly better marketable quality (smaller number of fruits affected by physiological disorders such as cracking, catface and zippering). The selected cultivars showed on average 15% higher marketable yield when compared to the average yield of other cultivars tested (3.9 kg $plant^{-1}$).

Conclusions

The most promising tomato cultivars for use in a local, open bag hydroponic production system, with regard to yield and quality, were identified as Trinity and Staffie. Growers can potentially increase their crop productivity by 15% when using these selected cultivars as compared to the other cultivars tested. Further studies on cost-benefit analysis need to be undertaken across the range of cultivars tested.

The effect of fruit load on various fruit quality parameters of 'Hass' avocado

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Introduction

Avocado (*Persea Americana* Mill.) is a subtropical tree cultivated for its fruit of high nutritional quality. Avocado contains a high concentration of poly-unsaturated fatty acid, involved in inflammation, and of C7 sugars, postulated to reduce growth of fast dividing cells, such as cancer cells. Fruit set in avocado is typically below 1%, but there can be large differences between the number of fruit on different branches of trees within the same orchard or even on the same tree. The effect of this variation in fruit set on fruit quality parameters is, therefore, of great interest, as it might, as in other tree fruit crops such as apple (Volz *et al*., 1993) affect fruit quality parameters.

Materials and Methods

Two groups of branches from trees in a mature 'Hass' orchard in the KZN Midlands were selected after the first fruit drop period, separating 20 branch areas of 'high fruit set' (more than 20 fruitlets) from 20 branch areas of 'low fruit set' (5 to 10 fruit per area). On a monthly to bimonthly interval fruit drop was recorded and fruit size was measured. When fruit had reached commercial maturity they were harvested for analysis of % mesocarp dry matter, % mesocarp oil and sugar concentration.

Results and Discussion

'Hass' fruit diameter and fruit length were, at most dates of observation, significantly affected by the fruit load of the branch area, with 'higher fruit load' areas producing smaller fruit (in length and diameter). At the time of commercial harvest, fruit on 'high fruit set' branches were significantly smaller than on 'low fruit set' ones and had a lower oil percentage. Postharvest, during the softening, fruit from 'high fruit set' branches had only a tendency to soften faster than those from 'low fruit set' branches. The C7 sugar concentration was also affected by fruit load, as low fruit set branches produced fruit with higher mannoheptulose concentration. These results demonstrate that the relatively low fruit in avocado, positively influences fruit quality parameters, such as size and oil content.

Conclusions

There is a need to establish what can be termed 'low' and 'high' fruit set in 'Hass' avocado and how the apparent drawback of lower quality at higher fruit load can be overcome.

Effect of different growth media on growth, yield and quality of tomatoes grown using an open bag soilless system

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Introduction

Different growing media is introduced into the industry on a regular basis. The selection of a growing media is one of the critical decisions in soilless vegetable production (Samadi, 2011). In South Africa, sawdust has become the medium of choice for most hydroponic tomato producers. However, there is limited information on the use of other growth media like cocopeat, rockwool, perlite and washed river sand in the hydroponic production of tomatoes in South Africa. Therefore, the objective of this study was to evaluate the effect of different growth media on the performance of soilless grown tomatoes in terms of growth, yield and marketable quality.

Materials and Methods

The study was conducted under a plastic covered non-temperature controlled tunnel. The trial was laid as a randomized complete block design with five treatments (sawdust, rockwool, cocopeat, perlite and washed river sand) and eight replicates. Seedlings of tomato cultivar Galaxy were transplanted into 10L black plastic planting bags filled with the different growth media. Yield data was collected from 10 plants per treatment and the performance of the different growing media was evaluated using total yield, as well as marketable and unmarketable yield. Fruits were regarded as unmarketable when they exhibited pathological and physiological disorders (cracking, zippering, rotting, blossom end rot, cat-face) or fell into the extra small category (less than 40 mm diameter).

Results and Discussion

Yield of tomatoes was significantly affected by the treatments, whereby the use of sawdust and cocopeat gave significantly higher number of marketable fruits. Washed river sand produced significantly less fruits and total yield in comparison to all the other treatments. On the other hand, the use of cocopeat growing medium significantly resulted in the highest number of extra-large fruits and higher number of large fruits than all the other treatments.

Conclusions

The results indicated that the yield of tomatoes was significantly affected by the choice of growing media. Cocopeat, followed by sawdust gave the best performance i n terms of crop yield and marketable quality.

Water productivity of selected indigenous fruit tree crops in South Africa

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Introduction

Climate change is exacerbating water scarcity and causing frequent droughts in South Africa. This means that the production of conventional crops using conventional agricultural methods will encounter greater problems in future given that South Africa is already a water scarce country. So identifying and promoting alternative crops and cropping systems e.g. through agroforestry or the domestication of indigenous fruit trees is an important strategy to ensure food security and to create employment (Everson *et al*., 2012). This study aimed to quantify the water requirements of marula (*Sclerocaryea birrea*) and monkey orange (*Strychnos Spinosa*) species in Northern Zululand. We also derive the water productivity (WP) of these species defined as the yield produced per m^3 of water consumed. We put the indigenous fruit WP into context by comparing with those for exotic fruit tree species.

Materials and Methods

Transpiration by the trees was measured hourly over two years using the heat pulse velocity sap flow technique. Site micro-climate was monitored using an automatic weather station. Soil water content in the root-zone of the trees was measured using CS616 probes at 15, 40 and 120 cm depths. Tree phenology, fruit and canopy growth, and yield were also quantified at appropriate intervals.

Results and Discussion

There were clear differences in the water use patterns of the two species. Strychnos trees had high sap flow rates, which showed small responses to dry spells. Marula trees on the other hand, growing close to the Strychnos, showed much lower water use rates and the marula sap flow responded rapidly to precipitation pulses. Marula transpiration rates rose only after substantial rains and the stomata closed as the soil dried. At an annual time scale, water use by marula was lower than that of Strychnos with a similar leaf area index, because of the low transpiration rates and because marula had a long dormancy period. The average water productivity for Strychnos was about 3.5 kg of fruit per m^3 of water transpired compared to about 2.0 kg/m^3 for marula although a lot of marula fruit were lost to predation.

Conclusions

Marula and Strychnos trees growing in the wild have low water productivity than most exotic fruit trees with apples reaching up to 18 kg/m^3. But with management, it is probable that indigenous fruit trees may significantly increase their water productivity too.

Molecular characterisation of Macadamia using simple sequence repeat markers

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Introduction

Macadamia (Proteaceae) is an economically important crop valued for its edible kernel. Currently, cultivars grown locally are evaluated based on morphological characteristics. However, there are some disadvantages with this method including the fact that such characteristics might be influenced by environmental conditions, which can hamper cultivar identification and potentially lead to misidentifications. Molecular markers can provide a supplementary tool and have the advantage of discriminating amongst cultivars quickly and efficiently without environmental influence. Furthermore, molecular characterisation facilitates evaluation of genetic diversity, which is an important factor in breeding programmes.

Materials and Methods

Genomic DNA was extracted from leaves using a commercially available kit. The 12 Simple Sequence Repeat (SSR) markers were first screened with a select, but phenotypically diverse, sub-sample of cultivars. Primers that gave clear peaks and provided non-ambiguous scoring data was used to further analyse selections. The amplification products were visualised via capillary electrophoresis. All reactions were repeated to verify data. Data were analysed in GenAlex and the software programme MEGA was used to generate the final dendrogram.

Results and Discussion

Of the 12 tested primers, 11 generated clear, scorable bands that were used for subsequent analyses. This information was used to generate a molecular genotype reference database, which was used for subsequent statistical analyses. In this regard, the number of alleles ranged from 5 (primer Mac009) to 11 (primers Mac003 and Mac0012). The observed heterozygosity (H_o) was greater than the expected heterozygosity (H_e) for 9 of the 11 tested primers. Tests were also performed to calculate the genetic variation within the population by determination of Hardy-Weinberg Equilibrium (HWE). Nine of the tested primers displayed significant deviation from HWE. Two primers (Mac005 and Mac007) yielded non-significant p-values (0.186 and 0.085, respectively) indicating that the population was not in HWE for these primers. The results indicated that the tested primers were suitable for molecular characterisation of macadamia. Ongoing studies will determine if the tested primers can be used to determine the pollen parents from selected crosses.

Conclusions

The tested markers were found to be suitable to assess the genetic relatedness amongst macadamia cultivars and selections. The molecular genotype reference database established will be used in ongoing studies to investigate the parentage of selections.

Towards the elucidation of compatible litchi scion:rootstock combinations

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Introduction

The South African Litchi Industry requires suitable, high quality litchi cultivars to extend the short harvesting season. In recent years, several cultivars were imported into South Africa but unfortunately, grafting success was variable due to rootstock-scion incompatibility which is a pre-requisite for successful grafting, ensuring a proper continuum between rootstock and scion. This compatibility is dependent on several variables including anatomical, biochemical, physiological and genetic factors. The aim of the study was early detection of graft incompatibility for selected scion-rootstock combinations.

Materials and Methods

Preliminary studies included visual observations of the range of incompatibility and were used to determine which cultivars were more incompatible when grafted onto the industry standard rootstock, 'Mauritius'. Subsequently, several litchi cultivars were grafted onto clonal 'Wai Chee' rootstocks, ten grafts per combination. The grafts were removed from the rootstocks by cutting approximately 5cm below the graft union and placing into a 0.1% solution of Safranin T for several hours in the direct sun. Transverse sections of the rootstock, graft union and grafted cultivars were visualized for dye uptake and the relative uptake between rootstock and scion was determined. Further investigations included observations on dye distribution through the xylem vessels of cultivars and rootstocks as well as determining the chlorophyll content index (CCI) of each cultivar used in the study. Chlorophyll content index was recorded using an Opti-Sciences CCM-200 CCI meter.

Results and Discussion

Graft incompatibility caused by a poor rootstock-scion combination leads to unhealthy trees, which are prone not only to breakage at the graft union and premature death, but also the inability of surviving trees to perform optimally in the field. It is therefore critical that the callus differentiates and forms the vascular tissues. Although compatibility is difficult to predict, the success of graft compatibility generally only occurs between scions and rootstocks, which are taxonomically 'closely' related and therefore incompatible grafts do not form a proper vascular continuity due to insufficiently close genetic relationships. This means that a particular rootstock may not be compatible with all scions.

Conclusions

Future studies include three rootstocks as well as an assessment of the genetic relatedness of the cultivars and rootstocks, which will be compared with the grafting observations, with the aim of developing a model for predicting compatible scion-rootstock combinations prior to the production of trees in nurseries and subsequent planting.

Effects of synthetic amalgamated agricultural phytohormones on the changes in leaf trichome morphology and density, selected essential oil yield and quality parameters of simulated hail-damaged rose geranium (*Pelargonium graveolens* L'Her.)

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Introduction

Treating plants with amalgamated cytokinin (CK) and gibberellic acid (GA) under less favourable environmental conditions such as those following hail damage, mechanical cutting back, and severe browsing tends to cause alterations in morphological features, such as extra-large leaves or elongated stems, and extensive shoot proliferation (Barnes 2013). However, the response of plants to this treatment strategy may vary between species, variety, environmental conditions, endogenous phytohormonal balance, and stage of development (Verma and Sen 2008). This study was conducted to evaluate the effects of synthetic amalgamated agricultural phytohormones (CK and GA) on leaf trichome density, selected essential oil yield and quality parameters of simulated hail-damaged rose geranium (*Pelargonium graveolens* L'Her.).

Materials and Methods

The experiment (arranged in a 3 x 3 factorial treatment design, with a completely randomised block design) was carried out in a hail net-covered tunnel structure during the 2017/18 growing season. Treatments comprised of three simulated hail damage levels (0, 50, and 100% defoliation) and three levels of amalgamated phytohormones (control, CK 0.32 mg/L + GA 150 mg/L; CK 0.64 mg/L + GA 300 mg/L, applied following the hail damage simulations).

Results and Discussion

Regardless of any application of amalgamated phytohormones under simulated hail damage treatments, two groups of trichomes were identified. One group consisted of one type of non-glandular trichome, attenuate trichome. The second group consisted of three types of glandular trichomes, for which two groups belong to peltate type, while one belonged to the capitate type. The density of all trichome groups varied to some extent on both leaf surfaces between the treatments in this study. Yet, these trichome groups were observed more on the abaxial leaf surface than the adaxial surface. Under extreme simulated hail damage (100%), the density of the capitate, brevicollate, and the non-glandular trichomes affected the density of the asciiform trichome type on the adaxial leaf surface. This result was alluded to variations in density between asciiform and capitate trichomes, concluding that simulated hail damage affects the transformation of the asciiform trichome types. The selected essential oil yield parameters were not affected by the main treatments. *β*-phenylethyl tiglate and citronellol contents were negatively affected by simulated hail damage extent (100%). Yet, it was only the citronellol content which was improved by a low concentration of amalgamated phytohormones (CK 0.32 mg/L + GA 150 mg/L). Notably, citronellol in all treatments (including the control) was low, and also did not reach the minimum standard of 25% citronellol content for 'North Africa-type' as required by the ISO standard.

Conclusions

It can be concluded that simulated hail damage negatively affects the selected essential oil yield and quality parameters. In addition, it has been shown that foliar application of higher concentration of amalgamated phytohormones (0.64 mg/L + 300 mg/L) increases the asciiform and non-glandular trichomes. However, the asciiform trichome type originally comprises of shrivelled head, which could indicate a lack of stored essential oil in their sub-cuticular spaces. Thus, non-significant differences in the essential oil mass and essential oil content are attributed to the trichomes. Therefore, amalgamated CK and GA in synthetic form should not be applied on simulated hail-damaged rose geranium plants to recover and improve the essential oil yield and quality attributes.

Developing propagation technologies for indigenous plants used in the natural products industry

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Introduction

South Africa is endowed with diversity both in terms of plants and their uses amongst the indigenous people of the country. This diversity has prompted research on many indigenous plant species that can be used in the natural products industry. A sustainable supply of raw plant material that can provide the industry with a consistent quality of the desired natural ingredient at affordable prices are however needed for successful commercialization. Propagation and cultivation of the required plants are important to insure a sustainable supply, but most of these plants are not domesticated with limited available information on how to propagate, how to grow, when to harvest, what factors will influence the quality and quantity of the plant material, etc. This lecture shortly discuss some of the results and challenges obtained recently with regards to the propagation of various medicinal plants.

Materials and Methods

Standard propagation techniques are applied to investigate seed germination requirements and vegetative propagation (mostly through cuttings) requirements. Factors investigated for seed germination include: temperature, seed pre-treatments to break dormancy or enhance seed germination and seedling growth in different media. Factors investigated for vegetative propagation via cuttings include: cutting type, growth media, plant growth regulator application, season and cutting size. For some of the bulbous species various techniques of division and chipping were also investigated. Most data was analyzed with an ANOVA and student LSD test to separate significant means.

Results and Discussion

Results summarized for the purpose of this lecture includes: Seed gemination and seedling growth techniques for *Bulbine latifolia, Xysmalobium undulatum, Eucomis* varieties*, Buddleja saligna* and *Hypoxis hemerocallidea*. Vegetative propagation techniques for *Bulbine latifolia, Xysmalobium undulatum, Hypoxis hemerocallidea, Greyia radlkoferi* and *Plectranthus aliciae.* Factors affecting the success of these techniques are shortly discussed for each plant.

Conclusions

The development of propagation techniques forms the basis of any production system and optimized, cost effective techniques is necessary to ensure a sustainable supply to the market. Generating scientific information to assist in this regard contributes toward commercial success and enables growers to generate reliable projections for future market access.

Effect of biostimulants on germination of Abelmoschus esculentus genotypes

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Introduction

Agricultural production is faced with various challenges that negatively affect crop production. These challenges include inefficient seedling production and poor stand establishment. The use of biostimulants such as Kelpak® and Plant Growth Promoting Rhizobacteria (PGPR) in crop production is gaining recognition and is beneficial in organic farming. Biostimulants contain a number of plant-growth stimulating compounds. This study aimed to determine the effect of these two biostimulants on seed germination of five selected *Abelmoschus esculentus* genotypes.

Materials and Methods

The 2-factorial study involving five genotypes and two biostimulant treatments was conducted in a growth chamber set at a constant temperature (25C) and photoperiod (12/12 h dark/light). Treatments included different dilutions (v/v) of the two biostimulants: Kelpak 1 (1%), Kelpak 2 (2.5%), Kelpak 3 (5%), PGPR 1 (1:5), PGPR 2 (1:10), PGPR 3 (1:15) and control (distilled water). Seeds of five *Abelmoschus esculentus* genotypes (Okra PB1, PB2, PB3, PB4 and PB5) were soaked in different treatments for 24 h. Twenty-five seeds were randomly selected per treatment and placed on two layers of moistened filter paper in 9 cm petri-dishes. The petri-dishes were laid out in a completely randomised design and replicated three times. Germination was monitored daily for 14 days. Germination parameters were calculated including Final Germination Percentage (FGP) and Mean Germination Time (MGT).

Results and Discussion

Results indicate that germination is influenced by genotype and biostimulant application. The FGP was significantly influenced by the genotype type and biostimulant application, as well as their interaction. Genotypes PB1, PB2 and PB3 showed highest FGP and low MGT. Biostimulant application significantly affected the MGT. Both genotype and biostimulant application individually as well as their interactions significantly influenced germination index.

Conclusions

The application of biostimulants influenced germination of okra and may potentially affect seedling growth and yield. Further study is in progress to determine the influence of biostimulant application on the growth, yield and nutritional quality of the different okra genotypes.

Effect of planting date on leaf production, yield and yield components of five Amaranth species under different growing conditions

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Introduction

Amaranth (*Amaranthus* spp) is a rapidly growing vegetable crop and is highly nutritious. However, planting date can affect crop growth, yield and nutritional quality. Lack of documented information on appropriate planting date of *Amaranthus* in Limpopo Province is a general problem, since the crop is rarely produced and is regarded as a volunteer crop, which appears after first summer rains (DAFF, 2010). The study aimed at determining the effect of planting date under two different growing conditions on leaf production, yield and yield components of five amaranth species.

Materials and Methods

The experiment was laid out as 2 × 3 × 5 split- split plot design with three replications. The main plot consisted of two growing conditions: field and pot (in the shade house, the sub-plot was three planting dates (November, December and January) and the sub sub-plot was five amaranth species (*Amaranth local 33*, *A. applesbosch*. *A.Tanzania, A. caudatus* and *A. kobie).* Seedlings were raised in the shade house and transplanted at four weeks after seeding into pot or on the field.

Results and Discussion

The results of this study revealed that planting date, growing condition, and amaranth species had a highly significant effect on number of leaves ($P< 0.0001$), number of branches ($P< 0.0001$), initial stem dry weight ($P<0.01$) and initial root dry weight ($P< 0.0001$). Delayed planting reduced the overall yield components of all amaranth species irrespective of growing condition. In addition, amaranth species grown in the field had an overall high stem dry weight (66,3). *A. applesbosch* had the highest stem dry weight (54,2). However, it showed no significant difference among *A. kobie and A. caudatus* that had dry stem weight of 38,8 and 34,6 respectively. In contrary, *Amaranth local 33* had lower dry stem weight across all planting dates.

Conclusions

Findings revealed that amaranth grows better when planted in the field other than in the pots. For optimum leaf production and yield, it is recommended to produce amaranth under field conditions during November and December planting dates.

Weed management strategies for pumpkin

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Introduction

Pumpkin (*Cucurbita maxima*) is an annual crop belonging to the *Cucurbitaceae* family. In South Africa, *Cucurbit maxima* is one of the widely grown cucurbit species. It is grown as a leafy vegetable where its leaves, flowers and young fruits are harvested and cooked. Mature fruits are also cooked and consumed as a vegetable while its seed are eaten as a snack. One of the most important limiting factor in cucurbit production in South Africa is weed control due to lack of registered pre-emergence herbicides and lack of post-emergence herbicides that control broadleaved weed species. The aim of the study was to determine weed competitiveness between two pumpkin varieties and to explore various weed control methods in providing effective weed control in pumpkin.

Materials and Methods

Seeds of pumpkin cv. Flat white boer and cv. Mpampini were planted by hand under no-till. Two plant spacing's were used (2 m x 0.8 m and 1.6 m x1.25 m) resulting in plant populations of 6250 and 5040 plants ha^{-1}. Each plot was 5 m x 6 m and consisted of four rows. Weed control treatments used were; control (no weeding), hand weeding, intercropping with maize (cv. SC 701) and cover crop (oats cv. pallinup). Hand weeding was done at a three-week interval. Treatments were replicated three times on a general split plot design.

Results and Discussion

Seeds of pumpkin cv. Flat white boer and cv. Mpampini were planted by hand under no-till. Two plant spacing's were used (2 m x 0.8 m and 1.6 m x1.25 m) resulting in plant populations of 6250 and 5040 plants ha^{-1}. Each plot was 5 m x 6 m and will consist of four rows. Weed control treatments used were; control (no weeding), hand weeding, intercropping with maize (cv. SC 701) and cover crop (oats cv. pallinup). Hand weeding was done at a three-week interval. Treatments were replicated three times on a general split plot design. This information is the same as the information in the Materials and Methods

Conclusions

To save time and costs associated with weeding, results suggest that the cover crop could be a useful tool in reducing weed growth and improving pumpkin yields. Results suggests that intercropping alone is insufficient as the sole parameter to reduce weed competition.

Effect of planting density on the growth and yield of chilli pepper (*Capsicum frutescens* L.) produced under field and closed hydroponics system

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Introduction

Chilli (*Capsicum frutescens L.)* belongs to the family *Solanaceae* and is considered to be the third most produced crop following potato and tomato. The increasing demand of chilli requires strategies to increase its yield and production. Maximising the area of production and efficient use of land may be the solution to increase its supply. Plant population is an important factor in determining growth, development and yield of vegetable crops (Sayed and Hossein, 2010). This aim of the study was to evaluate the effect of planting density on the growth and yield of chilli produced under both field and hydroponics system.

Materials and Methods

Two experimental trials were conducted at the Agricultural Research Council-VOP Roodeplaat, subjected to two different systems of production namely, open field conditions and closed hydroponics system. All experiments were subjected to Randomized Complete Block design having four plant density treatments namely, 30 cm × 30 cm; 30 cm × 50 cm; 30 cm × 80 cm; 30 cm × 100 cm and four replicates each. Plant parameters that were taken were plant height, chlorophyll content, Leaf area index, days to flowering and fruiting. Data was subjected to analysis of variance using Statistix 10.

Results and Discussion

Spacing had a significant effect on plant height and yield produced under both the field and closed hydroponics system. Planting density of 30 cm × 30 cm had the highest plant height followed by 30 cm × 50 cm in both hydroponics and field. There was a significant difference in chlorophyll content observed under field conditions, where planting densities of 30 cm × 80 cm and 30 cm × 100 cm had the highest chlorophyll content. Spacing had a significant effect on the yield of chilli produced under both field and closed hydroponics systems ($P \leq 0.01$ and $P \leq 0.05$). The spacing of 30 cm × 30 cm had more fruits (198 fruit/plant and 195 fruit/plant) and higher fruit mass (2.84 t/ha and 2.61 t/ha) under hydroponic and field systems respectively.

Conclusions

The spacing of 30 cm × 30 cm is recommended for field and for closed hydroponics system respectively for increased yield. Adaptation of chilli production under hydroponics system is recommended to adequately maximize land use and continual production of chilli in and out of season. More studies on cultivation should be conducted under hydroponics systems as it shows potential to increased production of chilli.

Effect of growth conditions on phytochemicals in *Cleome gynandra* L. harvested at different growth stages

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Introduction

Cleome gynandra L. is one of the indigenous leafy vegetables recognised as possible contributors of both micro-nutrients and bioactive compounds to human diets. This is attributed to phytochemicals whose accumulation is influenced by growing conditions. A study was conducted to determine the effect of growth conditions on phytochemicals in *C. gynandra* harvested at different growth stages.

Materials and Methods

Greenhouse and micro-plot experiments were conducted at Green Biotechnology Research Centre of Excellence (GBRCE), University of Limpopo (23°53'10''S, 29°44'15''E) from December 2018 to April 2019. Pre-chilled *C. gynandra* seeds were sown in 30 cm-diameter pots containing a mixture of pasteurised loam soil and compost (3:1 ratio v/v). Seven treatments [fifth leaf stage (control), vegetative, flower bud, flowering, pod initiation, pod filling and physiological maturity stages], were arranged in a randomised complete block design, with 10 replications. Shoots were harvested weekly from the fifth leaf stage of *C. gynandra*, oven-dried and then ground prior to phytochemical analysis using a UV-spectrophotometer. Data was then subjected to ANOVA using the Statistix 10.0 and mean separation was achieved using Waller-Duncan Multiple Range Test.

Results and Discussion

Under greenhouse conditions, treatments had a significant effect ($P \leq 0.05$) on proanthocyanidins (PAs), contributing 57% to total treatment variation (TTV), and had no significant effect on total phenolics (TP) and total flavonoids (TF). Relative to the control, under greenhouse conditions, highest (100%) Pas were observed at bud initiation, whereas a reduction (80%) was from pod initiation towards physiological maturity. Under microplot conditions, treatments had significant effect ($P \leq 0.05$) on TP and TF, contributing 70 and 63% to TTV, respectively and had no significant effect on PAs. Under microplot conditions, relative to the control, highest (195%) TP was observed at bud initiation, whereas a reduction was from pod initiation to pod filling. Further, highest TF was observed at bud initiation, whereas a reduction was observed from flowering to physiological maturity.

Conclusions

The findings showed that growing conditions had no effect on phytochemicals at different growth stages.

Effect of harvesting intervals on plant growth and nutrient composition of *Moringa oleifera* seedlings

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Introduction

Moringa oleifera Lam. Is a highly-valued multipurpose plant due to its exceptional nutritional content and fast growth habits. The great potential benefits mean that there is a need to critically assess harvesting practices for biomass production of *M. oleifera* to optimize nutrient quality. Therefore, the objective of this study was to determine whether various harvesting intervals of *M. oleifera* seedlings had any impact on its nutrient content in order to establish suitable harvesting intervals for high yields with consistent or improved nutritional content.

Materials and Methods

The study was conducted under tunnel conditions at Welgevallen Experimental Farm, Stellenbosch University. Five plants were harvested at 30, 60, 90 and 120 days after transplanting to establish the appropriate harvesting period. Leaf nutrient content was measured after each harvest. Dried leaf powder was sent to Central Analytical Facilities (Stellenbosch University) for nutrient analysis. Data were analysed using the Statistical Package for Social Science (IBM SPSS Statistics version 25). We ran Kruskal Wallis test to compare the impact of harvesting interval on the growth parameter, followed by Multiple Mann-Whitney U test as Post Hoc with a Bonferroni correction for multiple pair wise comparisons (P=0.01). Multivariate ANOVA was used to compare differences in nutrient concentration by harvesting intervals and nutrient type (Ca, Fe, K, Mg, Mn, Na, P and Zn).

Results and Discussion

Measured plant growth parameters namely; plant height, leaf number, fresh leaf yield, dry leaf yield, dry root mass, dry shoot mass and leaf area index were influenced by harvesting intervals. Plant growth parameters improved with increment in harvesting days. Harvesting intervals had a significant effect on all selected nutrient elements. At 30 days, Ca, Mg and Zn were significantly higher whereas Na and Fe were highest at 90 days harvest. Only P was high at 120 days when compared with the other harvesting days.

Conclusions

The results of this study showed that harvesting days have an influence on plant growth parameters as well as on nutrient concentration. Calcium, Mg and Fe showed optimal concentrations at 30 days harvesting while Fe and Na were optimal at 90 days and P at 120 days. For optimal production of most of these nutrients in *M. oleifera,* leaves may be harvested at between 30 and 90 days after planting.

Potential use of seeds with hypogeous germination as carriers of active ingredients from NEMAFRIC-BL Phytonematicide

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Introduction

Most seedlings have high overall susceptibilities to cucurbitacin-containing phytonematicides and the former could serve as potential carriers of active ingredients in management of plant parasitic nematodes. On the basis of emergence, seedlings that leave the cotyledons below the soil surface have hypogeous germination, whereas those that pull the cotyledons out of the soil surface have epigeous germination (Bewley, 1997). The objective of the study was to determine the amount of Nemafric-BL phytonematicide to be used in priming of pea seeds with hypogeous germination without inducing phytotoxicity.

Materials and Methods

Pea seeds primed for 2 h in 0, 2, 4, 8, 16, 32 and 64% phytonematicide solutions, post-8 h drying in shade, were sown in pots with growing mixture under greenhouse conditions. Treatments were arranged in randomised complete block design, with 8 replications. Standard cultural practices were carried out. At 56 days after sowing, plant variables were collected and subjected to the Curve-fitting Allelochemical Response Dose (CARD) model (Mafeo and Mashela, 2009). The experiment was validated in time. Since seasonal interactions were not significant ($P > 0.05$), data for the two experiments were pooled and re-analysed ($n = 112$).

Results and Discussion

Using the CARD model, dry shoot mass ($R^2 = 0.91$), plant height ($R^2 = 0.93$), stem diameter ($R^2 = 0.90$), chlorophyll content ($R^2 = 0.87$) and flower number ($R^2 = 0.92$) versus increasing Nemafric-BL phytonematicide concentration exhibited positive quadratic relations. The relations allowed the determination of the Mean Concentration Stimulation Point (MCSP) of Nemafric-BL phytonematicide at 2.18% for pea seeds, with the overall sensitivity of zero. The derived MCSP was within the range of those derived from weekly drench applications using similar phytonematicide concentration, which necessitate the development of the application interval (Mafeo and Mashela, 2009). The added advantage of using 2.18% phytonematicide for seed priming is that the active ingredients would be released into the rhizosphere at the early stages of seedling development, which is critical for infection and damage by *Meloidogyne* species.

Conclusions

The successful validation of pea seeds primed in 2.18% Nemafric-BL phytonematicide under field conditions would expand the application methods of the product, thereby enhancing its potential use on seeds with hypogeous germination.

Effect of plant growth substances on growth, yield and quality parameters of Swiss chard (*Beta vulgaris* L.)

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Introduction

Swiss chard is a valuable vegetable species, cultivated in many parts of the world. It is a good source of vitamins A, B and C, phenolic acids, flavonoids and mineral elements such as iron, potassium, calcium, magnesium and manganese (Ninfali & Angelino, 2013). The use of biostimulants can stimulate growth and yield, and substantially influence nutritional value and bioactive compounds. The aim of this study was to determine the effect of selected plant growth–promoting substances on growth, yield, nutritional and phytochemical contents of Swiss chard.

Materials and Methods

The study was carried out at the Agricultural Research Council Research station, Roodeplaat, Pretoria. Four-week-old seedlings (cv. FordHook Giant) were transplanted on a prepared field (spacing 15 cm x 30 cm) and supplied with water using dripper lines having emitters at 0.3 m spacing (drip rate ±2.0 L/hour at operating pressure 150 kPa). Four different growth stimulants, each at three different dilutions namely, Kelpak® (12.5, 25 and 50 ml/L), Seagro® (2.5, 5 and 10 ml/L), Ascogro® (5, 10 and 20 ml/L) and benzyladenine (2.5, 5 and 10 mg/L) were foliar applied. The treatments were arranged in a RCBD with three replicates. Growth parameters (leaf area, chlorophyll content, number of leaves, fresh and dry leaf mass) and nutritional indicators (antioxidant activity, ascorbic acid, β-carotene, total phenolics and mineral element content) were measured.

Results and Discussion

Kelpak® application at 50 ml/L dilution showed the highest number of leaves with an average of 31 leaves per plant. Kelpak® at 12.5 ml/L and 50 ml/L dilutions showed the highest leaf area with an average of 2048 cm^2 per plant and 1999 cm^2 per plant, respectively. Plant growth stimulants had no significant effect on the leaf fresh mass, dry mass and chlorophyll content. Benzyladenine application at 5 mg/L concentration and Kelpak® at 12.5 ml/L dilution gave the highest β carotene content (38.60 mg/100 g) and total phenolic content (15.05 mg GAE/ g DW), respectively. Kelpak® at a dilution of 12.5 ml/L showed the highest antioxidant activity (52%). The control treatment had the highest ascorbic acid content (422.3 mg/100 g sample).

Conclusions

The use of plant growth stimulants had moderate effect on growth parameters. Variations in the application of plant growth stimulants also had an effect on Swiss chard nutritional value. Therefore, the type and concentrations of plant growth substances must be taken into consideration when selecting the best plant growth stimulant for increased production of nutritionally-rich crops.

The developmental growth and quality assessment of five selected cultivars of baby spinach grown in the north of Pretoria, Gauteng Province, South Africa

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Introduction

Baby spinach is a relatively new crop in South Africa that has a commercial significance in retail stores (Nemadodzi *et al*. 2017). The crop is also deemed to have beneficial health benefits (Zhang *et al*. 2017). Currently, Seed companies have developed varieties that have not been evaluated in northern parts of the Gauteng province. Thus, the aim of this study was to investigate the growth, development and quality of five selected baby spinach cultivars.

Materials and Methods

Treatment consisted of five selected baby spinach cultivars viz., Ohio, Dash, Monstrous Viroflay, Guitar F1 and Lazio, arranged in a randomised complete block design (RCBD), replicated three times. The parameters recorded were morphological characteristics (plant height, petiole length, leaf blade length, and the number of leaves per plant), biomass (fresh and dry leaf mass, and fresh and dry root mass), physiological parameters (chlorophyll content, leaf area index, and photosynthetically active radiation), minerals, and amino acids.

Results and Discussion

The results showed that cultivar Dash had a longer leaf size, petiole and leaf blade, and was not significantly different from Ohio, which had the highest leaf number (8.4). Monstrous Viroflay had a higher biomass ranging from 13.43 g to 15.11 g, compared to other cultivars. Cultivar Ohio indicated a significantly higher level of photosynthetically active radiation 893.00 µmol m^{-2} S^{-1} and leaf area index of 0.05 cm^{-2}. Cultivar Dash had the highest mineral concentrations, ranging from 0.11 to 36.40 mg g^{-1}, compared to other cultivars. The aliphatic (isoleucine, leucine, valine), aromatic (phenylalanine, tryptophan, tyrosine), acidic (aspartic acid), basic (arginine, histidine), sulphur (cysteamine, methionine) and amidic amino acids (asparagine, glutamine) were dormant in baby spinach.

Conclusions

The cultivation of Dash baby spinach by both small- and large-scale producers in the north of Pretoria, Gauteng Province of South Africa is recommended.

Physiological parameter and quality of baby spinach cultivars in Gauteng Province, South Africa

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Introduction

Baby spinach is a relatively new crop in South Africa that has a commercial significance in retail stores (Nemadodzi *et al*. 2017). The crop is also believed to have beneficial health (Sillani and Nassivera 2015; Zhang *et al*. 2017). Currently, seed companies have developed varieties that have not been evaluated in northern parts of the Gauteng province. Thus, the aim of this study was to investigate the physiological parameter and quality of five selected baby spinach cultivars in Gauteng Province of South Africa

Materials and Methods

The trials were conducted at the Agricultural Research Council-Vegetable and Ornamental Plants Institute (ARC-VOPI), situated about 25km north of Pretoria on KwaMhlanga Road (R573), Gauteng Province, South Africa. Seeds of baby spinach cultivars (Lazio, Ohio, Viroflay, Guitar F1 and Dash) were planted in seedlings trays in green house at the University of South Africa (Florida Campus) and seedlings were transplanted to a shade net structure at ARC-VOPI. Plants were fertilized with a balanced nutrient solution, as described by Nemadodzi et al. (2017). Treatment consisted of five selected baby spinach cultivars namely Ohio, Dash, Monstrous Viroflay, Guitar F1 and Lazio, arranged in a randomized complete block design (RCBD), replicated three times. The parameters recorded were morphological characteristics (plant height, petiole length, leaf blade length, and the number of leaves per plant), biomass (fresh and dry leaf mass, and fresh and dry root mass), physiological parameters (chlorophyll content, leaf area index, and photosynthetically active radiation) and minerals. The trial was initiated on 7 February 2017 and terminated on 23 March 2017 (mid-summer to early autumn) which is recommended growth period for baby spinach (35 days). All the results were subjected to ANOVA to test the differences between the five-treatment effects. Statistical analyses was performed using IBM SPSS statistic 25.0. Duncan was used to test the difference between the mean with a probability level less or equal to 0.05.

Results and Discussion

The results showed that cultivar Dash had a longer leaf size, petiole and leaf blade, and was not significantly different from recommended cultivar (Ohio), which had the highest leaf number (8.4). Monstrous Viroflay had a higher biomass ranging from 13.43 g to 15.11 g, compared to other cultivars. Cultivar Ohio indicated a significantly higher level of photosynthetically active radiation 893.00 µmol m^{-2} S^{-1} and leaf area index of 0.05 cm^2. Cultivar Dash had the highest mineral concentrations, ranging from 0.11 to 36.40 mg g^{-1}, compared to other cultivars.

Conclusions

The cultivation of Dash baby spinach by both small- and large-scale producers in the north of Pretoria, Gauteng Province of South Africa is recommended because it yielded higher physiological parameters and quality than Monstrous viroflay, Lazio and Quitar F1 cultivars. Dash is an alternative to the cultivar Ohio which is already recommended in Gauteng, since it perform similar.

The role of glucose to signal and regulate 'Hass' avocado fruit skin colour change during ripening

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Introduction

In the last decade, markets importing South African 'Hass' avocado fruit have been complaining about poor skin colour change during ripening. During ripening, 'Hass' avocado fruit supposed to change skin colour from emerald green to purple and to black. In 'Hass' avocado fruit, skin colour change is used by producers, exporters and consumers as an indication of maturity. In previous studies, it has been established that poor skin colour change is pre-dominantly an early season fruit conundrum (Mathaba *et al*., 2015). Early-season 'Hass' avocado fruit are postharvest recalcitrant as they are less mature, high chilling sensitive and low sugars. In this study, we have investigated a possible role of glucose-sugar in signaling 'Hass' skin colour development during ripening.

Materials and Methods

In 2019, early-season 'Hass' avocado fruits were harvested with pedicle, thereafter, transported to the Agricultural Research Council – Tropical and Subtropical Crops (ARC-TSC) laboratory in Nelspruit, Mpumalanga Province. On arrival, 15 fruits per treatment were continuously pulsed with different glucose concentrations (0.05, 0.13 and 0.28 mM/fruit) and control (fruit with pedicel and pulsed with distilled water), thereafter, stored at 5.5°C for up to 28 days. After cold storage, fruits were ripened at ambient temperature (±25°C). During ripening, fruit firmness, objective skin colour parameters (*L**,*C** and *h**), subjective skin colour and total colour change (TCC) During ripening, fruit were sampled, skin removed, freeze-dried, milled to powder and stored at -80°C for further physiological pigments analysis. Total skin pigments (chlorophyll, carotenoids, and anthocyanin) were analyzed spectrophotometrically and cyanidin 3-O-glucoside was quantified using HPLC.

Results and Discussion

In general, the results showed that glucose-sugar pulsing improved 'Hass' avocado skin colour change when compared with the control and distilled water treatment. Therefore, there was a significant ($P < 0.05$) reduction in fruit firmness with ripening period in treated fruit compared with control. The 'Hass' avocado fruit skin colour objective parameters (*L**, *C** and *h**) decreased for all the investigated treatments. However, fruit pulsed with glucose-sugar showed a significant change in skin colour change from green to purple then black when compared with control and distilled water treatments. Furthermore, total anthocyanin and cyanidin 3-*O*-glucoside content varied with treatment and was higher in 0.05 mM pulsed fruit when compared with other treatment. It has been suggested that glucose sugar may play an important role in the regulation of anthocyanin biosynthesis of fruit (Gu *et al*., 2019).

Conclusions

This study demonstrated that cyanidin 3-O glucoside content increases at the key point in 'Hass' fruit ripening (at the transition from green to purple then black skin colour). In addition, glucose pulsing greatly increased cyanidin 3-O glucoside content, therefore, improved skin colour change. Our results show that glucose sugar may be an important signal molecule in the regulation of anthocyanin cyanidin 3-O-glucoside synthesis in 'Hass' avocado skin.

Underutilised traditional vegetables in South Africa: Their importance and state of characterisation conservation and utilisation

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Introduction

Underutilised African leafy vegetables have the potential to solve the problem of household food insecurity prevalent in rural parts of South Africa including the North West province (Jansen van Rensburg, 2007). A combination of erratic and insufficient rainfall and poor soils contributes to food insecurity in rural South Africa (Blignaut, 2009). This food insecurity is compounded by reliance on introduced and un-adapted crops that require high water and fertility levels, which are almost always limited in the smallholder farming sector (Mavengahama, 2013). However, the affected people usually live among a wide range of adapted indigenous vegetables, which they are not utilising on as a large a scale as exotic vegetables (Lewu and Mavengahama, 2011). The reasons for the low consumption are not yet well understood and need the combined efforts of agricultural and social science experts to unravel them. However, from a crop improvement viewpoint, the collection, characterisation, conservation and utilisation of germplasm are aspects that also impact on the efforts to promote these species as mainstream crops, especially in Southern Africa.

Materials and Methods

This presentation is a result of my research on underutilized crop species for a decade now. It draws from own experiences and interactions with various researchers on underutilised from around the world. It is also a result of the various literature searches and reviews over the years using search engines on the internet.

Results and Discussion

There has not been uptake as far cultivating them as mainstream crops is concerned. In some cases, researchers who have up followed up in areas where underutilised crops had been introduced through research projects, all the farmers had lost the germplasm they had been given (Shonhayi, 2016). In other areas such Mafikeng, farmers indicated that they are aware of these species, would like to grow them but they do not have seeds. The benefits of locally occurring genotypes have not been realised as most of the germplasm used in research in Southern Africa originated was obtained from the World Vegetable Centre and was not from Southern Africa. For example, some farmers preferred the taste of locally occurring biotypes but the problem was that they have too small leaves and therefore very low yield. They would like them to have the high yield of imported lines but have the taste of the local biotypes. The other finding was that locally collected germplasm from the SA national genebank is not being utilised in research programmes. If germplasm is not utilised, then its collection and conservation is not beneficial and this leads to the abandoning of collection, characterisation and conservation.

Conclusions

Although research and promotional efforts for efforts for underutilised leafy vegetables are increasing, these vegetables are still not being cultivated on large scale. Some farmers have lost germplasm that they have been given but yet others in different areas do not know where to get seeds of these species. Currently most of the genotypes being promoted in South Africa have been imported. Locally occurring biotypes of the underutilised species. A lot of research and promotion of TVs is taking place currently and with an anticipated increase there is need for more collection missions to be undertaken in South Africa.

The effect of retain, swelpine and rhamnolipids on the inhibition of natural flowering in queen pineapple in South Africa

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Introduction

Natural flowering (NF) is a severe problem in the production of Queen pineapple in South Africa. Natural flowering is mainly induced by short days/long nights and low temperatures, but total radiation and extremes in water supply can also play a role. Plants must also be of a certain size or age to be susceptible for NF. In Hluhluwe 20-70% of natural flowers are induced during May to July, this leads to over production in January and lower market prices. NF can be partially controlled by cultural practices and chemical control. The chemicals used in the industry is Retain, Swelpine [2-(m-chlorophenoxy) propionic acid], fertilizer combination of Urea + $MgSO_4$ and $(NH_4)_2SO_4$ and Rhapynal (RHL) a rhamnolipid biosurfactant. A trial was conducted to determine the effect of Rhapynal applied as a surfactant on the efficacy of retain as well as the efficacy of swelpine applied in combination with fertilizer and/ retain to inhibit natural flowering.

Materials and Methods

There were 8 treatments and 3 replicates in randomised block design namely; T1. Retain 800g/ha x 7 sprays T2. Retain 400g/ha x 7 sprays T3. Retain 400g/ha + RHL (0.5g/l) x 7 sprays T4. Retain 400g/ha + RHL (2g/l) x 7 sprays T5. Urea +$MgSO_4$ + $(NH_4)_2SO_4$ x 8 sprays T6. Swelpine (1l/ha) + Retain 600g/ha + Urea (100kg/ha) +$MgSO_4$(25kg/ha) + $(NH_4)_2SO_4$(25kg/ha) (7 sprays alternating) T7. Swelpine (0.5l/ha) + Urea +$MgSO_4$+ NH_2SO_4T8. Control Application was with a gps-guided variable rate boom sprayer at a spray volume of 2000 l/ha. The assessments were: 1. Plant mass at beginning of trial (5 plants/rep) 2. Daily temperature 3. Flower counts prior to chemical flower induction (August) and again in October. Note flower stages 4. Plant weight at chemical flower induction (5 plants/rep) 5. Yield: - Fruit mass on 100 fruit per replicate. 6. Sucker growth

Results and Discussion

T5 and T6 had the lowest percentage of NF (4% and 5.3% respectively), while the highest percentage of NF was in the T8 (42.3%). Fruit yield was higher in T6 (86 t/ha), while the lowest yield was in T5 (70 t/ha).

Conclusions

Treatment 6 (T6) a combination of Swelpine, Retain (R600 g/ha) and fertilizer can control NF in Queen pineapple when applied at/ during adverse conditions. This combination is much cheaper than the recommended dosage of retain (800g/ha). T6 treatment had no negative effect on plants and it produced higher fruit yield

Estimating crop factors of apple orchards with varying age groups using in-situ measurements and satellite data in the Western Cape Province, South Africa

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Introduction

The FAO-56 crop factor (K_c) approach is widely used for making irrigation decisions. Allen and Pereira (2009) (A&P) extended this approach by developing a method for estimating K_c using a density coefficient (K_d), which is estimated from the fraction of ground covered by vegetation and plant height. This study shows that there is need to adapt the A&P method to accurately determine crop factors for apple orchards under South African conditions.

Materials and Methods

A&P approach was evaluated by using detailed measurements of transpiration (T), evapotranspiration (ET), soil attributes, weather, and tree physiological variables in 12 apple (*Malus domestica*) orchards with different canopy covers. All orchards were irrigated using micro jets according to standard farm practice. Heat pulse velocity and thermal dissipation probes were used to measure transpiration rate. Actual evapotranspiration was measured using the open path eddy covariance system. Volumetric soil water content and microclimatic parameters were measured on an hourly basis. Irrigation volumes were measured using in-line flow meters.

Results and Discussion

The Allen and Pereira (A&P) method significantly overestimated the basal crop factors (K_{cb} = T/ reference ET) in all the orchards by between 47 and 103% in mature and young orchards, respectively. However, improved K_{cb} estimates were obtained by adjusting the ratio of the resistances (i.e. *rl* /100) in the A&P method, where *rl* represents the mean leaf resistance and 100 s/m is the typical resistance for annual crops. This consistent with the results on citrus orchards by Taylor *et al*., 2015.

Conclusions

From our assessment, the input data requirements to accurately determine the Kc and Kcb values of crops using the improved A&P method. This included the fractional vegetation cover, tree height, average wind speed at 2.0 m, minimum relative humidity, and the bulk canopy resistance of the species concerned. This is yet to be tested on other fruit tree species.

Biomass production and chlorophyll content of three *Corchorus olitorius* cultivars in relation to planting date

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Introduction

Jew's mallow (*Corchorus olitorius* L.) is a leafy vegetable, consumed either fresh or dried for its nutritional benefits. Jew's mallow is largely consumed as a health vegetable because it contains carotene and other carotenoids, vitamins and minerals (Mahmoud *et al*., 2014). Jew's mallow is a summer crop and grows naturally in the field. There is little scientific literature available about appropriate planting time for this crop in Limpopo Province of South Africa.

Materials and Methods

The experiment was a 2 x 3 x 3 split-split plot design with three replications. These were: two growing conditions (field and pot in the shade house), three planting dates (November, December and January) and three *C. olitorius* cultivars (Local, 'Oniyaya' and 'Amugbadu').

Results and Discussion

The results indicated that there were significant differences ($P<0.001$) in leaf production in relation to growing conditions and planting date, with the highest production in cultivar \'*Oniyaya*\'. Highest leaf production was obtained in plants grown in December. This may be attributed to the fact that *C. olitorius* is a heat demanding crop (Shiwachi *et al*., 2008) and, therefore, thrives in December when temperatures are high in summer. The growing conditions, planting date and cultivar had a significant effect ($P>0.05$) on stem diameter of *C. olitorius*. For the mucilage content of *C. olitorius* at 8 WAT (Weeks After Transplanting), there was a significant effect ($P<0.01$ and $P \leq 0.05$, respectively) of both growing conditions and planting date on *C. olitorius* cultivars. Crops grown in the field had higher chlorophyll concentrations than those grown in pots.

Conclusions

The greatest biomass production of *C. olitorius* was obtained in the field during December planting with '*Oniyaya*'. Thus, the '*Oniyaya*' cultivar can be grown in December, under the field conditions in Limpopo Province.

Impact of storage temperature and time on quality and phenolic compounds of Natal plum (*Carissa macrocarpa*)

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Introduction

The utilization and commercialization of indigenous fruit has in the past been overlooked by extension agencies due to the misconception that wild fruit does not play a major role in contributing to the rural livelihoods or nutrition intervention or diet diversification programmes of these communities. The incorporation of indigenous fruit can improve the diet and aid in healthy living for rural and urban communities. However, there is no in-depth information available on the phytochemical properties and physicochemical components of indigenous fruit such as Natal plum *(Carissa macrocarpa)*. Natal plum can be promoted as a fresh fruit snack, but no information is available on storage temperatures, shelf life (time), changes in phytonutrients and physicochemical properties during storage, etc. The aim of the proposed study was to investigate the appropriate storage temperature and the shelf life (time) that enables marketing of Natal plum with minimum changes in physiochemical and phytonutrient properties.

Materials and Methods

Carissa macrocarpa fruit samples were harvested randomly from Tshwane University of Technology main campus, Pretoria west. Fruit maturity was determined subjectively by colour with the focus only on stage 4, which is the red stage of maturity. After harvest, fruits were grouped and placed in four different storage categories: category (1) at 2°C, category (2) at 4°C, category (3) at 10°C and category (4) at 25 °C. Fruits were then stored over a period of 12 days, with parameters recorded at day 4, day 8 and day 12. Quality parameters (weight, colour, titratable acidity, soluble solid content, ascorbic acid) and physico-chemical parameters (total phenols, anthocyanin, antioxidant capacity, phenolic acids, and flavonoids) were determined according to the methods mentioned by Ndou *et al.* (2019).

Results and Discussion

The results showed that after storage at 2°C, 4°C and 10°C, weight loss was less than 3% until the 12th day, which is the commercially-acceptable weight loss. At 25°C, weight loss reached 9,8%. Colour *a** values increased during 2°C of storage, this can be attributed to the increase in anthocyanin. Soluble solids were maintained in cold storage, whereas titratable acidity decreased with storage. Ascorbic acid increased at 4 days at both 4°C and 10°C and reached peak values at day 8 for both temperatures, then declined at day 12. Overall, all the flavonoids increased at days 8 and 12 with naringenin 4-O-glucoside as an exception. Even quinic acid (the predominant phenol) showed a similar increasing trend.

Conclusions

Natal plum fruit stored at 2°C for 12 days can be used as functional ingredient for baking, smoothies and making juice, due to the abundant functional compounds found in fruits stored at 2°C. However, for the consumption of the fruit in fresh form, 4°C can be used to store Natal plum for up to 8 days, as the quality is maintained throughout storage.

Innovative sack production of *Beta vulgaris* in limited spaces: Plant density effects

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Introduction

Beta vulgaris is one of the most important vegetable crops with multi nutritional benefits cultivated by both commercial and subsistence farmers, as well as urban, peri-urban and rural household individuals for consumption and combatting malnutrition. The need for a fresh supply of vegetables to combat malnutrition and generate household income has led to new innovative yet affordable methods of cultivating vegetables utilising limited space available especially in urban and peri-urban areas where farming space is a challenge to obtain (Gallaher *et al*., 2015). Sack production of vegetables in limited space is becoming a solution to many vegetable consumers and has been practiced with success in Kenya and many other African countries. However, in South Africa, sack production of vegetables is still a new concept. The objective of this study therefore was to investigate the effect of planting density on the production of *Beta vulgaris* grown in sacks.

Materials and Methods

Greenhouse raised seedlings were hardened and transplanted into 50 kg sacks filled with 40 kg mixture of steam pasteurised loam soil and organic composted (3:1 v/v) growing media. Treatments comprising 5, 10, 15 and 20 seedlings per sack were planted, with the 5 seedling-sack representing the standard. Treatments in sacks were kept in an open-field growing condition and arranged in a randomised complete block design, replicated 10 times. At the 120th day after transplanting into sacks, data on plant height, chlorophyll content, number of leaves, harvestable root diameter and fresh root mass were recorded. Collected data was subjected to analysis of variance through SAS software version 10.0. Significant treatment means were separated using Fischer's least significant difference test at 5% probability level.

Results and Discussion

Plant density had significant (P≤0.05) effects on number of leaves, harvestable root diameter and fresh root mass only. Treatments contributed 78, 86 and 80% to total treatment variation of the respective variables. Relative to the standard, number of leaves, harvestable root diameter and fresh root mass reduced by 39-51, 34-56 and 60-79%, respectively. Plant density had an effect on the productivity of *B. valgaris* in sacks. Higher planting density reduced productivity and yield parameters.

Conclusions

In conclusion, sack production can improve the livelihood of many South Africans with limited farming spaces through affordable yet innovative means vegetable production. For better yield, it is recommended that *B. valgaris* should be planted at a lesser density in 50 kg sacks of between 5 and 10 seedlings.

Sweet potato production in sacks: Potential utilisation of limited space in rural, urban and peri-urban areas

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Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is a dicotyledonous root crop belonging to the family Convolvulaceae, bearing edible roots. Sack gardening is an important form of urban agriculture where the cultivation of crops takes place in large sacks filled with growing media (Erulkar and Matheka, 2007). A study was conducted in order to determine the effect of sweet potato (SP) production in sacks on growth and development of the root crop.

Materials and Methods

Fifty kg sacks containing 40 kg growing media as a mixture of loam soil and compost (3:1 v/v) was used. Eight stem cuttings were planted, 4 on top and the other four on the side-holes of the sack. Five SP cultivars, namely, 'Blesbok' (control) 'Mvuvhelo' 'Bosbok' 'Bophelo' and 'Mafutha' served as treatments. The cultivars were arranged in a RCBD, with 10 replications. At 150 days, data on chlorophyll content (CC), vine length (VL), number of shoots (NS), dry shoot mass (DSM), fresh tuber mass (FTM) and dry tuber mass (DTM) were collected and subjected to analysis of variance through SAS software, version 10.0. Mean separation was achieved using Fischer's Least Significant Difference test at the probability level of 5%.

Results and Discussion

Sweet potato cultivars had a significant ($P \leq 0.001$) effect on CC, VL, NS, DSM, FTM and DTM, contributing 25, 43, 30, 18, 73 and 63% to total treatment variation, respectively. Relative to control, 'Mvuvhelo', 'Bosbok' 'Bophelo' and 'Mafutha' increased CC by 10, 34, 39 and 42%, respectively. Dry shoot mass was increased in 'Bosbok' 'Bophelo' and 'Mafutha' by 8, 61 and 19%. However, in 'Mvuvhelo' DSM reduced by 9%. Vine length was increased in 'Mafutha' by 11%, whereas in 'Mvuvhelo', 'Bosbok' and 'Bophelo' the variable reduced by 47, 18 and 30%, respectively. In contrast, relative to the control, NS, FTM and DSM were all reduced in the tested cultivars. In 'Mvuvhelo', 'Bosbok' 'Bophelo' and 'Mafutha', NS was reduced by 37, 24, 19 and 12%, respectively. Fresh tuber mass was reduced by 1, 2, 45 and 27% in 'Mvuvhelo', 'Bosbok' 'Bophelo' and 'Mafutha', respectively. Dry tuber mass was observed to reduce in 'Mvuvhelo', 'Bosbok' 'Bophelo' and 'Mafutha' by 1, 4, 54 and 35%, respectively.

Conclusions

Findings indicated that sack production of SP using plant density of 8 stem cuttings in 50 kg sacks was unsuitable for successful production of the tested cultivars

Investigating the diversity of morphological and physiological traits of selected Swiss chard (*Beta vulgaris* L. subsp. cicla) cultivars

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Introduction

Swiss chard (*Beta vulgaris L. subsp. cicla*) is a biennial leafy vegetable cultivated for its nutritious, luscious thicker leaves and petioles. It is a vegetable enjoyed by many South Africans and adapted to a wide range of environmental conditions. It is popular amongst almost all South Africans, so that the development of the new cultivar 'Bright Lights' has been given much attention, as a visually more attractive and more nutritional cultivar. There is, however, great variation between individual plants in this cultivar, resulting in the potential to further classify its strains.

Materials and Methods

Two selected Swiss chard cultivars, 'Fordhook Giant' and 'Bright Lights' were purchased locally. Seeds were grown in a glasshouse and four (4) weeks old seedlings with three to four leaves were transplanted into 25L pots. The recommended commercially quantity of NPK (2:3:2) fertiliser was equally applied to all plants five days after transplanting. After forty-eight (48) days, leaf samples were collected and analysed for certain morphological and physiological parameters.

Results and Discussion

'Fordhook Giant' plants formed one group with large, strong green leaves and white petioles, whereas 'Bright Lights' plants could be divided into seven groups, according to colour of petioles ('dark green', 'green', 'white', 'gold', 'yellow', 'pink' and 'red'). Further analysis was carried on the blade and petiole part of the leaves, comparing mass, length, width, thickness, hairiness, crunchiness, blade chlorophyll and carotenoid concentration, where three replicates were used within each. 'Fordhook Giant' had a significantly higher fresh mass and yield than all 'Bright Lights' groups, but a lower carotenoid concentration than 'Bright Lights'.

Conclusions

'Bright Lights' produces crops with a variety of pigmentations, with many health benefits. Yield, however, is significantly lower than that of 'Fordhook Giant'.

Influence of foliar *Moringa oleifera* leaf extract (MLE) application on growth, fruit yield and nutritional quality of cherry tomato

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Introduction

Tomato (*Solanum lycopersicum*) is the most commonly produced, and most-widely consumed horticultural commodity in South Africa and, indeed, worldwide. The demand for high-quality tomato fruit is increasing significantly due to the health benefits associated with its consumption. Consequently, application of moringa (*Moringa oleifera*) leaf extract (MLE), that has been shown to increase yields and or quality of agricultural food crops, could also enhance tomato quality

Materials and Methods

To investigate the potential of MLE to enhance tomato production, a pot experiment was conducted to determine the effect of foliar MLE application on improving plant growth parameters, yield and quality of tomatoes. Red cherry tomatoes, grown from seed, were transplanted and grown in a glasshouse with a fan-cooling system and heat pumps. Twenty-five tomato plants, five plants per replicate, received the first foliar application of MLE two weeks after transplanting. This treatment was repeated weekly until first fruit set. The treatments included: control, where only water was added (M0), second control, where methanol 95 % was added (ME), and three concentration of MLE (20, 50 and 80 % (v:v) of a 95% methanolic extract). Observations on plant growth and development and fruit sampling were carried out weekly.

Results and Discussion

Foliar application of 20 and 50 % MLE gave the best growth and tomato yield. Total soluble solids were not significantly influenced by MLE; however, foliar application of 20 % MLE had a tendency to influence the carotenoids and colour (a*) of cherry tomato.

Conclusions

Although further studies on the most suitable concentration of MLE are required, the potential of MLE as a biostimulant to improve quality and yield of cherry tomatoes has been demonstrated.

The efficacy of postharvest wax application in the reduction of chilling injury incidence in lemon fruit (*Citrus limon* (L.) Osbeck)

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Introduction

To maintain citrus fruit quality and ensure acceptability to the consumer, various postharvest control measures throughout the supply chain should be implemented. Cold storage of fruit is one of the most effective postharvest measures used to preserve fruit quality. However, lemon fruit are known to be chilling sensitive and therefore storage of these fruit below 7°C should be avoided. The sensitivity of lemon fruit to cold conditions present a challenge when exporting lemon fruit to countries with phytosanitary requirements, where long term cold storage at temperatures of between -0.6 °C and 2 °C is required. These conditions are likely to result in blemishes of the fruit rind, giving rise to a postharvest disorder described as chilling injury (CI). The incidence of the disorder is known to increase with the duration of storage at a threshold temperature. CI manifests as brown, sunken, necrotic areas in the rind due to cell membrane damage, followed by a cascade of secondary events. The objective of this study was to obtain a better understanding of how the temperature and storage duration interaction affects lemon fruit and to evaluate various postharvest methods for its efficacy to control CI symptom development.

Materials and Methods

The fruit used was allocated to nine treatments, each with ten replications, of ten fruit each. The unblemished fruit, of similar size (50-60 mm) and colour (nr. 4-5 on CRI, 2004 standard colour chart), was assigned to the different wax treatments, according to a complete randomized design. Treatments consisted of a chlorine-drenched control and eight different wax treatments. The waxed fruit were then dried in a tunnel at approximately 30°C prior to removal from the line, where after fruit were packed in carton boxes for transportation to the laboratory. After the application and drying of the different wax treatments, the fruit was transported to the Department of Horticulture at the University of Stellenbosch to commence a storage period of 32 d of cold storage at -1°C. Following this cold storage period, fruit was kept at ambient temperature of 20.2 °C for seven days to simulate shelf life and to allow for CI symptom development.

Results and Discussion

Lemon fruit when stored at temperatures of 2°C or lower showed distinct symptoms of CI, which was enhanced by prolonged storage. However, the incidence of CI was reduced with an increase in the solid content of the various wax types, suggesting that wax applications with a higher solid percentage provides better protection to the fruit rind against postharvest cold stress than waxes with lower solid percentages.

Conclusions

In general results indicate that shipment of ‘Eureka’ lemon fruit at 2°C, irrespective of the postharvest wax treatments, are still not commercially viable. However, storage at higher temperature ranges between 4°C and 7°C, when used in combination with high solid content wax applications, have the potential to reduce CI to commercially acceptable levels.

Water relations of apple trees under different irrigation systems: A case study of drip vs micro irrigation systems in South Africa

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Introduction

South African agricultural industry contributes billions of rands to the GDP, thereby sustaining the economy of the country. More than 60% of water is used for farming, therefore measures to conserve water in the agricultural sector must be taken since frequent droughts are predicted. Different irrigation systems use water differently, the drip irrigation system has drippers that are underground depositing water in the subsurface. Micro-sprinkler irrigation systems have their sensors sprinkling water to a wider area on the surface. The main aim of this research is to quantify the water use of apple trees in a trial where 12 trees are under micro sprinkler and another 12 trees under drip irrigation in the same row.

Materials and Methods

The micro-climate of the study site was measured using an automatic weather station which measured components like solar radiation, temperature, relative humidity, wind speed and direction and calculated reference evapotranspiration (ETo) using the penman Monteith approach (Allen, 1998). Transpiration was measured using the Heat Pulse Velocity (HPV) method of the sap flow technique (Burgess, 2001). Three trees with varying sizes for both treatments were installed with sap flow sensors. The sap flow rates were measured at hourly intervals throughout the study period.

Results and Discussion

Micro sprinkler irrigated trees used more water compared to drip irrigated trees. The drip irrigated trees showed signs of stress and their leaf area index (LAI) was smaller compared to the trees under micro sprinkler irrigation system. The water use was strongly correlated to the solar radiation with R^2>0.9. Drip irrigated trees produced smaller sized fruits with poor quality, while micro sprinkler irrigated trees produced bigger fruits with good quality. Using the drip irrigation system saves water, but compromises the quality of the fruit, and subsequently overall farm production.

Conclusions

Drip irrigated apple trees used less water as compared to micro irrigated trees, however the drip irrigated apple trees were more stressed. Subsequently produced smaller in size fruits with poorer quality as compared to the micro-sprinkler irrigated apple trees. Solar radiation was the main climatic driver of water use in these apple orchards. The drip irrigated trees had smaller canopies as compared to the micro sprinkler irrigated trees. Using the drip irrigation system saves water, but compromises the quality of the fruit, and subsequently overall farm production. Farmers who use the drip irrigation system should add more dripper lines and reduce the litres of water, in order for the top layers of the soil to receive more water, rather than having two drippers that send water straight to the bottom of the soil profile while the apple tree roots are shallow and lateral.

Prediction of Macadamia shelf life and optimisation thereof

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Introduction

In 2017, the South African macadamia industry produced a crop of 44 610 tons nut in shell (NIS), with a value of R3.2bn. With rapid increases in area planted (5000 Ha in 2017 alone), and with young orchards continually coming into production, the crop is expected to reach 65 000 tons by 2020. The industry has achieved its early goals of significant new plantings and production increases, and has matured to the point that South Africa is currently the largest producer of macadamia in the world, with 99% of the crop destined for export markets. With increasingly large volumes being processed, stored and exported, quality has become key to South Africa retaining a reputation as a source of premium product. This presentation will examine some of the factors affecting shelf life and means of setting sell-by dates.

Materials and Methods

In the first experiment commercially-sourced style 1 and 5 kernel was sourced at three harvest dates and subjected to extended storage at various temperatures to determine the effect of these combinations of factors on shelf life as determined by peroxide development. In the second experiment, style 1 and 5 kernel sourced from different growing regions in the late season was stored for 12 months at 15°C, with peroxide value and Rancimat induction time being utilised as pre-storage assessments of quality. These analyses were correlated with post-storage quality parameters to determine whether they were an effective means of predicting shelf life. In the third experiment, kernel of several cultivars were harvested from the tree throughout the season and its quality assessed to determine whether cultivar or growing region played a role in quality. Peroxide value, induction time, fatty acid profile and oil content were all assessed as determinants of quality.

Results and Discussion

The experiments with the commercially-sourced kernel showed that the time of harvest, storage temperature and the size of the kernel pieces all play a role shelf life. Furthermore, both induction time and peroxide value are suitable parameters for predicting kernel quality after 1 year in storage. The results of the third experiment show that kernel oil and fatty acid also play a role in kernel quality.

Conclusions

Macadamia quality is affected by a number of interacting parameters. However, at this time it appears that routine peroxide testing may be sufficient for setting sell-by dates, albeit that industry may need to alter the current minimum acceptable peroxide level for exported kernel.

Host-status of 18 Fusarium-resistant sweet potato lines to Meloidogyne species in South Africa

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Introduction

Root-knot (*Meloidogyne* species) nematodes in sweet potato (*Ipomoea batatas*) poses economic challenges for production (Pofu *et al*., 2016). Thus, the Sweet Potato Programme (SPP) of the Agricultural Research Council (ARC) in South Africa has since included screening for host-status of certain soil-borne pathogens in its breeding-selection activities (Laurie *et al*., 2015). This activity had since demonstrated that a number of several commercially important sweet potato cultivars have a non-host status to *Meloidogyne* species in South Africa (Pofu *et al*., 2016). Recent advances demonstrated that several sweet potato lines being researched by the SPP-ARC were resistant to *Fusarium* species, with limited information on their host status to *Meloidogyne* species. The objective of this study was to investigate whether fusarium-resistant sweet potato lines were non-host to three *Meloidogyne* species.

Materials and Methods

Seventeen *Fusarium*-resistant sweet potato lines and one *Meloidogyne*-susceptible sweet potato cultivar as standard were inoculated with 5 000 eggs + juveniles of *M. incognita* race 2, *M. incognita* race 4 and *M. javanica* in three separate experiments in pot trials. Lines were arranged in RCBD since conditions in the greenhouse were not homogeneous. Standard cultural practices were executed. At 56 days after inoculation, the reproductive potential (RP = total eggs + juveniles in root/g total root) of *Meloidogyne* species on sweet potato lines were subjected to analysis of variance and separated using Tukey test.

Results and Discussion

Most *Fusarium*-resistant sweet potato lines were hosts to the *Meloidogyne* species as shown by RP values that were greater than unity. The results showed high variability among the three *Meloidogyne* species in different lines. A few lines were non-host to *Meloidogyne* species and are currently being subjected to nematode-resistance tests at different levels of inoculation. Results in the study demonstrated that resistance to *Fusarium* species did not necessarily imply resistance to *Meloidogyne* species, supporting observations in other studies (Mashela *et al*., 2016).

Conclusions

Lines with possible resistance have been identified. Since only post-infectional resistance genes can be introgressed in plant breeding, it is important that the lines with possible nematode resistance are further subjected to determine the mechanism of nematode resistance.

Nutritional and phytochemical characterisation of sweet melon (*Cucumis melo* L.) cultivars grown in soilless culture

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Introduction

Consumer preference is becoming largely influenced by nutritional and phytochemical properties in relation to health benefits, amongst other factors. Cultivar differences and production system can influence nutritional and phytochemical content. The objective of this study was to determine variation in vitamin C, β-carotene, total phenolic, flavonoid and mineral element contents of fruits obtained from ten sweet melon cultivars grown in soilless culture.

Materials and Methods

The study was carried out at the Agricultural Research Council – Vegetable and Ornamental Plants, Roodeplaat research station. Sweet melon cultivars were grown in soilless culture, using an open bag system. A randomized complete block design with four replicates was adopted. Fruits were harvested from ten data plants per plot per cultivar. Fruits were peeled, seed cavity removed, cut into cubes and freeze-dried before analyses. Total phenolic and flavonoid contents were determined using spectrophotometric methods. Vitamin C and β-carotene contents were quantified using HPLC [Prominence-i-HPLC-PDA] with sample cooler (LC-2030 C). Antioxidant activity was measured using the 2,2-diphenyl-1-picryl hydrazyl (DPPH) free radical scavenging assay. Mineral element content (P, K, Mg, Ca, and Zn) were determined using inductively coupled plasma mass spectrometry (ICP-MS).

Results and Discussion

The highest vitamin C content was obtained in the orange-fleshed cultivars Adore and E25F.00075. Cultivar E25F.00075 exhibited the highest total phenolic content while the lowest occurred in cultivar Magritte. The flavonoid content was higher in cultivar E25F.00185. The β-carotene content for the Honey Brew and Honey Star cultivars was significantly lower than all other tested cultivars. Magritte with deep orange flesh colour had higher β-carotene content. Significant variations in antioxidant activity, vitamin C, and mineral element contents were also recorded. Vitamin C content correlated positively with phosphorus, calcium and zinc content.

Conclusions

Sweet melons may be a healthier food choice to be included in the human diet. However, the nutritional and phytochemical variation among the cultivars even when grown in the same production system indicates the need for careful cultivar selection.

The effect of water stress at different phenological stages on growth, production and postharvest fruit quality of avocado (*Persea americana*)

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Introduction

Water stress, as a result of poor water management and occasional drought, leads to considerable crop losses and poor fruit quality. This subsequently leads to financial losses for the grower. Unfortunately, the effects of water stress at different phenological stages have not been studied in much detail for avocado. The aim of this study was therefore to investigate the effects of water stress at different phenological stages on avocado growth, production and postharvest fruit quality.

Materials and Methods

The trial was carried out in a 'Hass' avocado orchard grafted on 'Duke 7' rootstocks on the ARC experimental farm in Nelspruit. The trial was initiated prior to fruit set in 2018 and is still ongoing. The experimental design was a randomized block design with initially two treatments (stressed versus wet) during the first season (2018/19), and which was extended to four treatments during the second season (2019/20). These four treatments were a stressed, moderately stressed, moderately wet and wet treatment. Data collected included, soil water content, midday stem xylem water potential, fruit set, retention and fruit size, vegetative vigour, yield and postharvest fruit quality data

Results and Discussion

Fruit set was negatively affected by water stress (soil matric potential below -50 kPa), with a 25 and 29% reduction for the 2018/19 and 2019/20 seasons, respectively. The highest fruit set was obtained when soil matric potential was between -20 and -40 kPa. This indicated that too wet conditions (higher than -20 kPa) may also be non-optimal for fruit set. Water stress also caused a significant reduction (~11%) in vegetative vigour. At harvest, fruit from the stress treatment were significantly smaller than fruit from the wet treatment. Lower fruit set and smaller fruit for the 2018/19 season caused an approximate 44% decrease in yield. In terms of postharvest fruit quality, fruit harvested from the stress treatment had a significantly higher incidence of vascular staining (physiological disorder) and anthracnose. Moisture loss during cold storage was lower for the stress treatment, possibly because of lower fruit moisture content.

Conclusions

Water stress at different phenological stages for avocado showed negative effects on fruit set, size and postharvest fruit quality. Indications are that for a sandy soil the matric potential should be between -20 and -40 kPa for optimal fruit set. Optimal soil matric potential norms are currently being investigated for other phenological stages.

Application of medicinal plant extracts against maize seeds Fusarium pathogens and their effects on seeds germination

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Introduction

Maize is one the most important grain crops. It plays a key role in food security and economic well-being in sub-Saharan Africa. In South Africa, maize production by small-holder farmers is faced with challenges of climate change, pest and diseases, and spoilage. Small-holder farmers, especially in rural areas rely on indigenous knowledge and traditional methods to control crop diseases in the field and during storage. This study aimed to evaluate efficacy of plant extracts as protective agents against stored maize seeds *Fusarium* pathogens.

Materials and Methods

Medicinal plant species were selected from literature based on their antimicrobial activity against human or animal pathogens. Leaf extracts of selected plant species were prepared and evaluated for antifungal activity (Masoko *et al*. 2005). Extracts showing good activity were combined and their fractional inhibitory concentration index was calculated. Those with potent antifungal activity were evaluated for *in vivo* antifungal activity against *F. proliferatum*, *F. semitectum*, *F. subglutinans* and *F. verticilloides*. Antifungal activity (% inhibition) of the extracts was recorded. Active extracts (≥ 50 %) were used to treat maize seeds; which were germinated in petri dishes lined with wet double layered filter paper and percentage germination was recorded after 12 days. Data were recorded in triplicate and treated statistically using STATISTICA-8 software.

Results and Discussion

In vitro antifungal activity of selected plants species showed that a number of plant extracts had minimum inhibitory concentration of ≤ 0.1 mg/ml against one or more tested *Fusarium* pathogens. *In vivo* antifungal activity of extract from *Melia azedarach* showed 97% inhibition against *F. proliferatum.* Percentage inhibition recorded for *Combretum erythrophyllum* and *Quercus acutissima* combined extracts was 95% against*F. verticilloides.* None of the extracts had negative effects on percentage germination of the maize seeds.

Conclusions

This study indicates the potential application of medicinal plant extracts as agents to reduce spoilage caused by *Fusarium* pathogens during post-harvest storage of maize seeds. Medicinal plant extracts present affordable alternatives that can be used in poor resource farming to control maize seed diseases.

Occurrence and diversity of nematodes around the rhizosphere of the kiwi trees in Limpopo province

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Introduction

Kiwifruit is becoming one of the most important crops in areas with high altitudes in Limpopo Province. Despite the nematodes been recorded from different localities in the world (Akyazi and Felek, 2013), to date, no study has been conducted to study the biodiversity and identifying the plant parasitic nematodes associated with kiwifruit in South Africa. Therefore, the objective of this study was to identify plant parasitic nematodes and its diversity, collected from different kiwi fruit orchards in Limpopo province of South Africa.

Materials and Methods

During a survey on plant-parasitic nematodes in five Kiwi fruit orchards, 15 samples belonging to different zones of orchards were collected. Samples were transferred to the Nematology laboratory of the Green Biotechnology Research Centre of Excellence, Department of Plant production at the University of Limpopo, South Africa within 24 hours of collection for processing and identification of the nematodes. Nematodes were extracted from 100 cm^3 composite soil samples over 72h using 40 × 25-cm plastic trays according to the modified tray technique. The nematodes were counted with a stereomicroscope (Zeiss) and their genera identification finalized using a light microscope (Omax). Nematodes were then fixed with a hot 4% formaldehyde solution and transferred to anhydrous glycerine. The relationships between nematode population density (MPD) and frequency of occurrence (FO) of each nematode genus identified were expressed as prominence value (PV) for each locality to determine which genera were predominant in Limpopo Province in kiwifruits rhizospheres (Bolton *et al*., 1989; De Waele and McDonald, 2000).

Results and Discussion

Thirty-two nematode genera were identified from the soil samples across the orchards in Limpopo province. Out of the 60 soil samples, the most prevalent nematodes encountered were *Cephalobus*, *Ditylenchus, Rhabditis, Helicotylenchus, Aphelenchus* and *Aphelenchoides* with 46.34, 45.12, 45.12, 26.83, 21.95 and 20.73% frequency of occurrence, respectively. Frequency of occurrence (FO) of the nematodes varied between orchards. Prominence Value (PV) of *Cephalobus* (14329.70), *Ditylenchus* (6045.56), *Helicotylenchus* (2719.34), *Meloidogyne* (2169.28) and *Aphelenchoides* (2686.39) was higher as compared to other nematode genera. *Cephalobus* were one of the mostly occurred and abundant nematode suggesting that they are major nematodes in all the surveyed kiwifruit orchards in Limpopo Province.

Conclusions

In conclusion, the high altitude-kiwi fruit producing regions suggested a wide range of both plant-feeding and free-living nematodes.

ORAL PRESENTATIONS – CROP SCIENCE

LISTED ALPHABETICALLY

Evaluation of agronomic and drought response traits of two soybean (*Glycine max*) cultivars for cultivation in the Transkei region of the Eastern Cape

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Introduction

Drought is a major stress affecting crop production in South Africa and across the globe. Amongst major crops impacted by drought is soybean, which is a globally important legume possessing a high-quality protein source for human and animal nutrition. Soybean is produced in different provinces of South Africa, with the Eastern Cape producing the only economically insignificant amounts despite a favourable climate.

Materials and Methods

Under drought stress, reactive oxygen species (ROS) accumulate and lead to oxidative damage of the DNA, proteins, and lipids. Plants possess antioxidant defences to scavenge ROS to reduce these damages. We aimed to evaluate the agronomic traits and drought responses of two soybean cultivars denoted UWC1 and UWC2 in the Transkei region of Eastern Cape (OR Tambo and Alfred Nzo districts). The yield of the soybean was measured after field cultivation. The physiological and molecular responses of both cultivars under drought stress were assessed.

Results and Discussion

The results show that UWC1 has higher yield than UWC2. Drought stress upregulated ROS levels, causing lipid peroxidation to the soybean tissues. Drought resulted in stunted growth, chlorophyll disruption and leaf-rolling. However, the damages were less pronounced in the UWC1. Although there were significant changes in antioxidant enzyme activities and proline content, the changes were not effective in alleviating drought-induced damage in the UWC2.

Conclusions

We conclude that the UWC1 is more suited for maintaining high yield in the OR Tambo and Alfred Nzo district than UWC2, and also performs better under drought stress than UWC2.

Should irrigation with mine-impacted water be considered part of the long-term strategy to manage acid mine drainage in the Witwatersrand Goldfields?

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Introduction

As a result of South Africa's mining legacy, large volumes of acid mine drainage (AMD) are produced that threaten the quality of our water resources. Treatment technologies exist, but are expensive and high users of electricity. In the Witwatersrand Goldfields, three High Density Sludge (HDS) water treatment facilities have been established as an emergency measure to neutralise the large volumes of AMD in the Eastern, Central and Western Basins. These have been effective short-term measures, but sustainable long-term solutions to this problem are sought.

Materials and Methods

Water quality before and after treatment with HDS process was obtained for the Eastern, Central and Western Basins of the Witwatersrand Goldfields from the Department of Water and Sanitation (DWS). Data was processed to indicate threshold maximum constituent concentrations experienced 95% of the time, and 5th percentile pH values, to provide a worst case scenario for assessment of irrigation water quality. The newly developed Decision Support System (DSS) called the "Risk-based, site-specific, irrigation water quality guidelines" was used to highlight potential concerns with the use of these mine-impacted waters for irrigation.

Results and Discussion

Although treated and untreated waters contain fair amounts of Na and Cl and a high total salt concentration (EC), they are primarily gypsiferous waters from which gypsum precipitation is expected. Consequently, the negative effect of salinity is expected to be less pronounced than when irrigating with a water of similar EC, but that is non-gypsiferous. It is mainly trace element concentrations and corrosiveness of untreated waters that seem to limit their suitability. Where it is possible to overcome these problems and without yield reduction, irrigation with untreated waters may be considered. Soil salinity is assessed to not accumulate to levels that will negatively affect the yield of relatively salt tolerant crops, such as soybeans. Maize is a more salt-sensitive crop than soybean, and will therefore not always be an appropriate choice of summer crop. Between 40 and 60% of salts added through irrigation are predicted to precipitate in the soil as gypsum. Trace elements that are highlighted as being of potential concern by the DSS are Mn, Fe and U.

Conclusions

There is an opportunity with irrigation to save the country large sums of money. In addition, productive use can be made of such mine-impacted waters. It seems prudent, therefore, to make a concerted effort to overcome any potential problems identified with the utilisation of goldfields water for irrigation.

Drought adaptation mechanisms utilized by *Moringa Oleifera* tree grown under semi-arid condition of the Limpopo province

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Introduction

South Africa is already experiencing extreme weather conditions, due to climate change (Maponya and Mpandeli, 2013). This condition worsens food insecurity and negatively affecting farmers and communities at large. Farmers need to come up with alternative farming strategies, to adapt to this changing cropping environment. One of the mechanisms can be the introduction of drought-tolerant and nutritious crops such as moringa in their farming systems. The tremendous nutritional benefits of moringa for both human and livestock are reported by several authors (Thurber and Fahey, 2009; Leone *et al*., 2016; Mabapa *et al*., 2017). The study aimed to evaluate drought mechanisms utilized by moringa trees grown under harsh environmental conditions.

Materials and Methods

The study was conducted for twelve months to cater for the four seasons during 2014 – 2015. An existing moringa (*Moringa oleifera*) trial, planted at a population of 5000 plants ha^{-1} was used in this study. The other two naturally growing tree species of mopane (*Colophospermum mopane*) and marula (*Sclerocarya birrea*) trees growing within the moringa trial vicinity were included in the study as a control. Eight trees from each species were sampled for data collection in the study. The photosynthetic rate (A), stomatal conductance (gs), transpiration rate (E) and sub-stomatal CO_2 (Ci) measurements were performed using a fully-expanded leaf on the abaxial side of each selected leaf using a non-destructive method. Furthermore, three fully expanded leaves were sampled from one tree per each species to determine leaf stomatal density. Data was analyzed using Statistix 10.0.

Results and Discussion

The tree species differed significantly in gaseous exchange. Moringa showed the highest activity in all the parameters measured. Frosi *et al*. (2017) revealed that drought leads to progressive stomatal closure with a parallel decline in gas exchange. Stomatal density was also different among the three tree species, being 281.8, 355.2 and 930.6 per unit area for marula, mopane and moringa species, respectively. According to Xu and Zhou (2008), the increase in leaf stomatal density leads to an increase in stomatal conductance and a net CO_2 assimilation rate. Moringa maintained good leaf yield even under drought condition, this is an indication that moringa could act as a good sink for carbon dioxide absorption.

Conclusions

The results strongly showed with no doubt, the superiority of moringa in capturing more carbon among the three species. It can therefore be recommended for many parts of Limpopo province for climate change mitigation where semi-arid conditions prevail.

Does application time of Glyphosate affect maize yield parameters?

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Introduction

Yield loss following glyphosate application has been reported for glyphosate resistant cotton. Local maize producers were concerned that this "*yield drag*" might also occur in Roundup-Ready maize hybrids. The objective of this study was to determine the effect of application time of glyphosate and generic variations on four maize yield (RR hybrids) through field studies

Materials and Methods

Four randomised block design trials were repeated over two seasons (2017/18 and 2018/19) at the ARC-Grain Crops research farm (Potchefstroom). Each trial consisted of a RR-maize hybrid (DKC 74-74BR, KKS 4581, BG 5785BR and P1814R). The treatment design was a strip-split with application at V4, V4+V6, V6 and V8 growth stages respectively as main plot factor and the four glyphosate products applied (Roundup PowerMax®; Slash Plus; TouchdownForte® and Mamba™ DMA 480 SL) as sub-plot factor replicated in three blocks. An untreated control was included as the fifth treatment. Parameters measured included rows per cob (RpC), kernels per row (KpR), thousand kernel mass (TKS) and yield (t ha^{-1}). All parameters were expressed as % of control. An appropriate analysis of variance was done on the data of the four cultivars repeated over two seasons combined to compare means of significant source effects using GenStat for Windows 18th Edition.

Results and Discussion

KpR and yield were not affected by any of the treatments. Product applied resulted in significant differences in RpC (P=0.10) but none of the treatments differed significantly from the untreated control. TKM was significantly affected by the cultivar x application time x product interaction (P=0.10). All four products resulted in significant lower TKM in BG5785BR when applied at V8 stage *vs.* V4. None of the treatments differed significantly from the untreated control.

Conclusions

Preliminary results indicated that the application of glyphosate irrespective of the time of application had a limited effect on yield parameters measured. Although BG5788BR demonstrated some sensitivity regarding application time and TKM obtained, yield was not affected. The current study will be expanded to more products and hybrids.

The influence of foliar and application rate of nitrogen fertiliser on seed- and oil yield of Canola

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Introduction

Canola was successfully included in the cropping systems of the Western Cape during the early 1990s. Current N fertiliser guidelines for canola are adopted from international literature or from wheat guidelines. The adoption of conservation agriculture caused changes in soil N and N availability that will influence the optimal N fertiliser rates. The aim of this study was to investigate the response of seed- and oil yield of canola to different N application rates (topdressed and/or foliar application). This forms part of a bigger study in which N fertilizer guidelines will be developed to predict the most efficient rate of N fertiliser for a specific area according to the inherent soil, climate and rainfall characteristics of the specific area.

Materials and Methods

Canola was planted at five different locations differing in soil properties and climatic conditions in the grain producing areas of the Western Cape. The study was a randomised block design consisting of seven N treatments (0, 25, 50, 75, 105, 135 and 165 kg ha^{-1}) plus a control, replicated in four blocks. Except for the control, that did not receive any N fertiliser, 25 kg N ha^{-1} was applied at planting. The remainder was topdressed and applied to split-plots to accommodate a foliar N application of 20 kg N ha^{-1} UAN (32% N) plus humic acid (2%). Crops were harvested with a combine harvester and seed yield as well as oil content determined.

Results and Discussion

With exception of Darling (deep sandy soil), where yields increased to a rate of 105 kg ha^{-1} (2016) and 75 kg ha^{-1} (2018), Tygerhoek (Riviersonderend) to a rate of 105 kg ha^{-1} (2016 and 2018), and Riversdale to a rate of 105 kg ha^{-1} (2017) and 135 kg ha^{-1} (2018), the general trend was a decrease in seed yield as N rate increased (R^2 = 0.03 – 0.88). Oil yield decreased as N rate increased (R^2 = 0.02 – 0.99). Generally, foliar N applications did not increase ($P > 0.05$) seed- or oil yield.

Conclusions

Preliminary results show that the optimum topdressed N rate will be site specific as the recommended top dressed N rate is expected to be within the 25 - 75 kg N ha^{-1} range and will be site specific. Final recommendations will be formulated on completion of 2019 data capturing**.**

Response of quality protein maize varieties to different soil amendments and population densities in tropical rainforest

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Introduction

Maize supplies almost 1/3 of dietary calorie need of more than ¾ of the population in 94 developing countries including Nigeria apart from its intensive use in livestock and agro-allied industries. However, declining soil nutrient especially nitrogen severely undermines grain yield and alter amino acid content of Quality Protein Maize (QPM) a cultivar known for its extraordinary tryptophan content. Information on response of QPM maize to different soil amendments and population density is scanty. Therefore, response of three quality protein maize (QPM) varieties to different rates of organomineral and compost fertilizer with three plant population densities was investigated.

Materials and Methods

The trial was conducted during 2016 and 2017 planting seasons at the Teaching and Research Farm, University of Ibadan to investigate response of three QPM varieties (EYQH-12, EYQH-14 and EWQH-21) to different soil amendments (Compost, Organo-mineral and NPK 15-15-15 fertilizer) and population densities (1 plant pot^{-1}, 2 and 3 plants pot^{-1}), respectively. The trial was a 3 x 3 x 9 factorial fitted into a CRD and replicated three times. Growth and yield attributes of the crop were assessed following standard procedures.

Results and Discussion

Plant height (50.96 cm), stem girth (6.77 cm) number of leaves (7.58), leaf area (310.70 cm^2) and grain yield (42.12 g $plant^{-1}$), were significantly ($p \leq 0.05$) higher in pots supplied 100 kg compost ha^{-1} relative to the control. Variety EWQH-21 had significantly tallest plant height (44.57 cm), stem girth (5.51 cm), number of leaves (7.69), leaf area (243.75 cm^2) and (49.21 g/ plant) grain yield. Maize plant with lowest plant density significantly enhanced plant height (44.64 cm), leaf area (258 cm^2) and grain yield (30.11 g $plant^{-1}$). Agricultural wastes have been found to increase the contents of nutrients in soil and its uptake by maize. Variety EYQH-12 showed significantly better growth than other two varieties. It implies that it may have high hybrid vigour for nutrient use efficiency on soil low in nutrients augment with compost. Plant density of 1 plant pot^{-1} had better growth parameters than other densities. It has been reported that high plant density heightens interplant competition for light, water and nutrients particularly during the period bracketing silking, favouring apical dominance, decreasing both yield $plant^{-1}$ and ratio of cob to tassel growth rates.

Conclusions

The results showed that application of 100 kg compost ha^{-1} enhanced growth and yield of QPM varieties. Variety EWQH-21 was superior to the other two varieties while 1 plant $hill^{-1}$ outperformed other plant densities. Different amendment had marginal residual effects on performance of QPM varieties.

Germinability and growth of upland rice (*Oriza spp*.) cultivars as influenced by drought imposed at anthesis and storage temperature

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Introduction

There has been several information on yield response of upland NERICA cultigens to moisture stress in many countries of sub-Sahara regions. Despite the significance of NERICA varieties in advancing rainfed upland rice production in sub-Sahara African nations, information is inconsistent on water use efficiency including moisture deficit tolerance level by NERICA varieties. Furthermore, reports on how drought affects viability of rice seed when water deficit occur during anthesis are still incoherent. This study investigated effect of limited moisture supply during grain filling period on growth and germinability of *Oryza* species.

Materials and Methods

A greenhouse study conducted in 2017 and 2018 investigated components of yield from upland rice plants predisposed to water stress at anthesis and germinability indices of harvested seeds stored at different storage temperatures. Sixteen treatments comprising four rice cultivars: CG-14, NERICA2, NERICA4 and FARO-66 predisposed to four periods of water stress [5, 10, 15 day interval and 100% Field capacity (control)] at grain filling were laid out in a completely randomized design (CRD) with six replicates. Morphological and yield parameters and GI were evaluated following standard procedures. Data was analyzed using linear regression and ANOVA with means separated using Duncan's multiple range test ($p \leq 0.05$).

Results and Discussion

Occurrence of water stress at grain filling had deleterious effects on components of yield and GI of seeds of FARO-66 cultivar. NERICA4 and CG14 tolerated moisture stress better than NERICA2 and FARO-66. Sterility, unfilled grain and germinability indices are strongly (R^2=0.87) related to prolonged drought incidence. The deleterious effect of moisture stress on generative organs of rice cultivars followed the order: adequate moisture<5≤10<15 day drought intervals during grain filling depending on the cultivar. Reduced grain weights under drought especially prolonged water deficit might be related to inhibition of photosynthesis and impairment of assimilates translocation towards grain filling due to soil moisture stress. Germination indices of different rice cultivars were adversely affected by and moisture stress. This suggests that germination characteristics are affected by cultivar and moisture stress. Storage temperature had no significant influence on germination indices and seedling length of water stressed upland rice seeds dried to 12% moisture content and stored for 14 days.

Conclusions

Occurrence of drought at generative growth stage in rice could cause total crop failure and poor seed germinability. Considering the unpredictability of rainfall season in rainfed farming system, irrigation plan should be essential cultural practice that must be factored into upland rice production to avoid crop failure.

Assessing Cocoa Swollen Shoot Virus (CSSV) disease prevalence in the Nawa region (South-West Côte d

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Introduction

Cocoa swollen shoot virus (CSSV) is a viral disease transmitted by mealy bugs vectors to cocoa trees and other host species. The rapid spread of CSSV disease has caused huge damage to cocoa production in West Africa. However, no reliable information exists on the prevalence of the disease, or on the factors driving the disease dissemination. Assessing the prevalence of CSSV across the landscapes is crucial to provide evidenced-based information to decision-makers and to develop and implement disease control measures.

Materials and Methods

The study was carried out in five agricultural landscapes dominated by cocoa along a North-South transect in the South-West of Cote d'Ivoire: Kipiri (6°29\' W and 6°8\' N), Petit-Bouake (6°23\' W and 5°53\' N), Koda (6°33\' W and 5°50\' N), Petit-Bondoukou (6°38\' W and 5°36\' N) and Kragui (6°37\' W and 5°26\' N). Data was collected in cross-sectional study using the Land Degradation Surveillance Framework (LDSF) developed by ICRAF. At each sampling point, we delineated a 50 m radius circle in which cocoa trees were visually inspected for CSSV disease symptoms, and density and diversity of cocoa companion trees species were recorded.

Results and Discussion

Land uses were dominated by cocoa cultivation, which represents 81% of the landscapes in Petit-Bouake, 68% in Kipiri, 66% in Kragui and Petit-Bondoukou, and 57% in Koda. The study revealed a large variability of CSSV disease prevalence in the study areas, with an average of 43%. We observed high disease infection prevalence of 83% (95%CI: 68.1 – 91.3) and 76% (95% CI: 59.9 – 87.4) at Kipiri and Petit-Bondoukou respectively. Disease prevalence rate of 3% (95%CI: 0.8 – 9.9) and 8% (95%CI: 3.6 – 18.8) were observed at Koda and Kragui respectively probably due to the low presence of cocoa and host species in the landscape which limits the spread of the mealy bugs. We observed no correlation between the cocoa companion trees density and diversity and CSSV prevalence.

Conclusions

This large variability of CSSV prevalence calls for the design of context-specific disease control measures. Landscape diversification appears to limit the spread of the disease. The LDSF provided a realistic estimate of the prevalence of the disease, however using pedestrian to conduct the survey was time-consuming and expensive, which limits the areas skimmed by the surveyors. Drones and satellites imageries are being explored to develop disease prevalence models over large areas.

Assessment of water risk for sustainable crop production

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Introduction

Water availability represents a major risk for agricultural production in South Africa. The interaction between land use and water is mutual. Agricultural production expansion will affect the water balance at catchment level. Land use changes usually affect the catchment's hydrological response in different ways. For example, land use can modify the streamflow regime quantitatively and qualitatively. The change in streamflow usually increases or decreases the flow volume during various periods, leading to either flooding or water shortage downstream. Not only will land use change in catchments have an impact on water resources in agriculture but also on climate change predictions. The challenges range from too little water (drought) to too much water (floods). Therefore, sustainable agricultural practices need to incorporate water availability and the efficient use of water. If water availability and efficiency is not determined, then crop production will be at risk.

Materials and Methods

The study approach was as follows: 1) Map land use changes and water trends (i.e. streamflow regime) from 1990 to 2013 for the selected catchments that include irrigation schemes in the North West, Limpopo, Northern Cape and Free State provinces. 2) Determine suitability map by combining climatic variables other than rainfall, e.g. temperature, to achieve suitable areas for barley production in summer rainfall regions. The suitability map is based on land type classes and soil characteristics at each land type as well as climatic suitability (e.g. potential evaporation from soil and plants, which leads to the depletion of soil moisture). 3) Predict future climate change scenarios using an ensemble of high-resolution climate model simulations for the period 1960 - 2100. The regional climate model used is the conformal-cubic atmospheric model, a variable resolution global climate model.

Results and Discussion

The percentage changes from different land uses to agricultural land (cultivated) were small. However, there was an increase in the area that is cultivated under centre pivot irrigation system in the period from 1990 to 2013. The suitability map indicated that most of the catchments in summer rainfall regions have agricultural production capabilities. An increase in annual average near-surface temperatures and general decrease in rainfall are projected to occur over the interior of southern Africa during the 21st century.

Conclusions

Future agricultural expansion is not an option with the decrease of water availability. Moving from a low efficiency to higher efficiency irrigation system could have a positive impact on the water balance and water availability. However, intensive agricultural systems have an impact on water quality, which should also be considered.

Benefits of increased maize plant population and narrow rows under no-tillage is season-specific in semi-arid environments

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Introduction

Maize plays a significant role in meeting global food demands. Recent yield increases are 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, highlighting the importance to adjust plant population and row spacing accordingly. The aim of the study was to explore the growth and yield of rainfed maize in response to varying plant population and row spacing under no-tillage.

Materials and Methods

Field trials were conducted during the 2017/2018 (Season 1) and 2018/19 (Season 2) seasons near Ottosdal, North-West. Row spacing (0.52 and 0.76 m) and plant population (from 20000 to 60000 plants ha^{-1}) were evaluated. No-tillage planters were used to establish the trials and the trial site has been under no-tillage since 2011. A single Pioneer (P2864WBR) cultivar was used and the previous crop was maize in both seasons. Plant architecture, biomass production, water use efficiency, grain yield and components were evaluated.

Results and Discussion

At 0.52 m row spacing, plant height was lower (P<0.05) at any plant population compared to plant populations at 0.76 m row spacing in Season 1. In Season 2, minimum and maximum plant heights were found at 60000 at 0.52 and 20000 plants ha^{-1} at 0.76 m, respectively. Maximum biomass at physiological maturity was recorded at 50000 plants ha^{-1} at 0.76 m in Season 1 and at 20000 plants ha^{-1} at 0.76 m row spacing in Season 2. Leaf area index increased (P<0.05) with increasing plant population at both row spacings in both seasons. In Season 1, grain yield was the highest (P<0.05) at 50000 plants ha^{-1} at 0.76 m row spacing. Due to challenging growing conditions in Season 2, grain yield decreased as plant population increased at 0.52 m row spacing, with no differences (P>0.05) between plant populations at 0.76 m row spacing. In both seasons and row spacings, grain yield per plant decreased (P<0.05) as plant population increased, demonstrating the effects of interplant competition for soil resources. Across all treatments, water use efficiency was higher (P<0.05) in Season 1 mainly due to more timely rainfall compared to the drier Season 2.

Conclusions

Maize growth and yield responded inconsistently to plant population and row spacing between seasons due to variable growing conditions. Agronomic growth and yield were more affected by plant population at 0.52 compared to 0.76m row spacing when drought conditions occurred. It is recommended that maize density stands are further researched using new cultivar releases across various soil types.

Response of rainfed maize root morphology to plant population under no-tillage

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Introduction

Plant morphology is used as an indicator to assess growth response to agronomic practices such as plant population and soil tillage. Although aboveground maize growth response to agronomic practices is well-researched, a paucity of data exists on how interplant competition affects maize root morphology. The aim was to quantify the effects of plant population on rainfed maize root morphology under no-tillage.

Materials and Methods

Field trials were established on sandy loam soil during the 2017/2018 (Season 1) and 2018/19 (Season 2) seasons near Ottosdal, North-West. The trial site has been under no-tillage since 2011. Treatments were three plant populations (20000, 30000 and 40000 plants ha^{-1}) established at 0.76 m row spacing. Acrylic minirhizotron tubes were installed after planting at a 45° angle, centred, and parallel with two adjacent rows. Digital images were taken at 15 cm increments to 60 cm soil depth, using a CI-600 *In Situ* Root Imager minirhizotron at the sixth leaf collar, tasselling and kernel filling growth stages. Images were analysed using *RootSnap!* software.

Results and Discussion

At the sixth leaf collar and tasseling growth stages in Season 1, 30000 plants ha^{-1} had a higher (P<0.05) number of roots at 0 - 15 cm depth compared to 40000 plants ha^{-1}, while total root length was similar (P>0.05) between treatments. In Season 2, no differences (P>0.05) in number of roots were observed between treatments at 0-15 cm depth at the sixth leaf collar and tasseling growth stages, however, total root length was higher (P<0.05) at 20000 plants ha^{-1} compared to 40000 plants ha^{-1}. At the tasseling growth stage in Season 1, 40000 plants ha^{-1} had a higher (P<0.05) total root volume at 0 - 15 cm depth compared to 30000 plants ha^{-1}, while no differences (P>0.05) were found at deeper depths. In contrast, at the tasseling growth stage in Season 2, total root volume was found similar (P>0.05) across all plant populations at 0 - 15 cm depth, and 30000 plants ha^{-1} had a higher (P<0.05) total root volume at 30 - 60 cm depth compared to 20000 and 40000 plants ha^{-1}. This indicates shallow maize root morphology was more strongly influenced by plant population in Season 1 compared to the drier Season 2.

Conclusions

Differential maize root morphology responses were recorded at different soil depths as a result of interplant competition. Variability of growing conditions between seasons further influenced the relationship between root morphology and interplant competition.

Evaluation of bio-slurry application rates and soil management options on soil moisture conservation and maize water productivity

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Introduction

Low soil moisture and poor nutrient balances caused by low, erratic rainfall and high evaporative demand are major contributing factors to low maize yields in different geographic areas of Southern Africa under dryland crop production. Bio-slurry is an organic fertilizer whose contributions to soil maize water productivity and soil moisture conservation have not been previously studied, especially where various different mulching methods have been used. The aim of the study was to evaluate the effect of bio-slurry application rates and soil management options on soil moisture conservation, rainwater productivity and maize water productivity under in-field rainwater harvesting.

Materials and Methods

This dryland study was conducted at Fort Cox College farm, Eastern Cape over two seasons (2016/2017 and 2017/2018) as a four (0, 3, 5 and 7 t ha^{-1} bio-slurry application rates) by three [maize-stover mulch, cover crop and bare soil] factorial experiment replicated four times in a randomized complete block design, under in-field rainwater harvesting. Soil moisture was measured at different depths at four key phenological stages of maize development. Maize grain and biomass yields were harvested at the end of each season. Daily weather information was collected in both seasons. These variables were used to compute rainwater productivity, crop water use and crop water productivity of maize for different treatment combinations.

Results and Discussion

The 2016/17 growing season received 274 mm of rainfall, which was lower than 308 mm received during the 2017/18 growing season. Application of bio-slurry significantly increased soil moisture at flowering, this was attributed to bio-slurry ability to form a hard cap on top of the soil surface thereby reducing soil evaporation. However, the effect of bio-slurry application rates and soil management options interaction insignificantly affected rainwater productivity, and water productivity. Yields, rainwater productivity, and water productivity were significantly higher in 2017/18 growing season compared to 2016/17 growing season due to higher rainfall received.

Conclusions

Long-term studies on bio-slurry and various mulching methods are required to evaluate their effect on soil moisture conservation and water productivity under various rainfall.

Remote sensing of physiological traits with drones to assist sugarcane breeding: preliminary results

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Introduction

Sugarcane breeding is resource intensive and time consuming, and could be enhanced with high-throughput screening of physiological traits. The aim of this study is to assess the feasibility of phenotyping sugarcane for photosynthetic capacity and drought tolerance using aerially captured imagery. Specific objectives were to determine the reliability of estimating leaf area index (LAI) and stomatal conductance (g_s) from aerial imagery, and to determine trait correlations with yield.

Materials and Methods

A pilot experiment was conducted at Mount Edgecombe where two genotypes were grown under well-watered (WW) and water deficit (WD) conditions. Ground measurements included soil water content, LAI and g_s. Spectral data in the visual, near infrared and thermal bands were obtained using drones and related to ground measurements. A similar methodology was followed in a larger field experiment conducted at Komatipoort, where 54 genotypes were grown under WW and WD conditions.

Results and Discussion

In the Mount Edgecombe experiment, g_s was significantly correlated with remotely sensed canopy temperature ($R^2 = 0.59$) suggesting that crop water status can be estimated from thermal imagery. There was also a strong correlation between LAI and the normalized difference vegetation index (NDVI, $R^2 = 0.80$) (Hoffman & Singels, 2019). In the Komatipoort experiment, it was confirmed that crop water status and LAI can be estimated from aerial imagery. However, further refinements in data capture and processing procedures (sensor calibration and pixel classification) are required to identify genotypic differences in photosynthetic capacity and drought tolerance. Cane yield was significantly correlated with seasonal average g_s ($R^2 = 0.65$). WW yields were also significantly correlated with seasonal average gs ($R^2 = 0.57$) suggesting that photosynthetic capacity could be used as an indicator of yield performance.

Conclusions

Preliminary results suggest that LAI, photosynthetic capacity and crop water status could potentially be estimated accurately from aerially captured data. However, refinements in data capturing and processing are needed to reliably determine genotypic differences in some of these traits. Strong correlations between traits and yield hold promise for breeding application.

Distribution of Russian wheat aphid biotypes in South Africa during 2018 and report of a new biotype in the Eastern Free State

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Introduction

Resistance in crops is an effective management tool for insect crop pests, but this management option can result in virulent biotypes. Up until 2018, four RWA biotypes were known in South Africa. During 2018 there were reports of wheat cultivars, resistant to all four biotypes that showed RWA damage symptoms in the field at Reitz and Danielsrus. Screening of RWA samples collected in these areas confirmed that a new RWA biotype, with additional virulence to the *Dn*x resistant gene in wheat, occurred in these areas. This biotype was recorded at eight different sites in the Eastern Free State.The newly observed RWA biotype is designated RWASA5. This is the most virulent RWA biotype recorded to date.

Materials and Methods

RWA samples were collected in the Western Cape during July 2018, in the central and western Free State, and Northern Cape during August 2018 and in the Eastern Free State during September 2018. All main wheat production areas, known to be affected by the RWA, were sampled. A single female aphid from each sample collected in the field was transferred to a wheat plant and caged (gauze size: 315 micron) to produce a clone colony. The biotype of each RWA clone was determined by screening its feeding damage on 11 previously established plant resistant sources containing designated resistance genes *Dn*1 to *Dn*9 and *Dnx* and *Dny.*

Results and Discussion

During 2018 RWASA2, RWASA3, and RWASA4 were distributed in the Eastern Free State. RWASA5 was recorded only in the Eastern Free State. RWASA5 was the dominant biotype in the Eastern Free State making up 15.4 % of the biotype complex, followed by RWASA3 (7.7%), RWASA4 (5.8%), RWASA2 (3.85%) and RWASA1 (1.92%). Only RWASA1 was recorded in the wheat production areas of the Western Cape.

Conclusions

As an invasive aphid species RWA is well established in the wheat production areas of South Africa. Not only do the known RWA biotypes persist in these areas, but RWA adapts to changing environments to develop new biotypes as was the case with the newly recorded RWASA5 during 2018. Presently the more virulent biotypes, RWASA3 and RWASA4, and RWASA5 only occur in the Eastern Free State, while only RWASA1 occurs in the winter rainfall region and the Central Free State and Northern Cape. There was, however, a 100% infestation rate of the fields surveyed in the Western Cape, indicating that RWA is well established in the winter rainfall area.

An integrated approach to manage mycotoxin contamination in Southern African maize grain

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Introduction

Mycotoxigenic fungi infecting maize grain can be detrimental to both human and animal health. Disease management strategies include tillage practices and crop rotations which have not been sufficiently evaluated in South Africa. The first aim of this study, was to establish the effect of cropping systems on the infection of mycotoxigenic fungi and mycotoxin production in maize grain. Certain cropping systems can increase the amount of maize residue, which can serve as a source of primary inoculum for several important foliar diseases. Therefore, the second aim of this study was to establish the effects of prophylactic fungicide applications on the infection of mycotoxigenic *Fusarium*spp. and mycotoxin production in maize grain.

Materials and Methods

The effect of cropping systems on maize ear rot accumulation and mycotoxin contamination was investigated in Erfdeel (2011/12 – 2014/15) and Buffelsvallei (2009/10 – 2014/15). Cropping systems included monoculture maize (MM), conventional tillage, MM no-till, and no-till two- and three-year rotation systems (maize/cowpea and maize/cowpea/babala) respectively. In Buffelsvallei, two additional crop rotations, maize/sunflower and maize/sunflower/babala were included. The effect of prophylactic fungicide spray regimes on mycotoxigenic *Fusarium* spp. and resultant mycotoxins were evaluated in the 2017/18 and 2018/19 seasons at Cedara, Potchefstroom and Vaalharts in randomised split-split plot experiments using two cultivars. Four spray combinations were administered at five different plant growth stages with time intervals relating to pre-flowering, flowering and soft dough stage. Mycotoxin analyses and target DNA quantifications in both studies were conducted with HPLC and qPCR.

Results and Discussion

Disease incidence and mycotoxin contamination at Buffelsvallei were inconsistent throughout the cropping system study period, results from Erfdeel was not significant (Mabuza *et al*., 2018). In the prophylactic fungicide spray trial, infection of maize grain by *F. verticillioides* and *F. boothii* (target DNA) was the highest in Cedara and the lowest in Potchefstroom. Cultivar BG3292 was always more susceptible to fungal infection and mycotoxin production compared to its isoline BG3492B. None of the mycotoxin levels exceeded South African regulatory limits. Spray combinations containing Azoxystrobin 200g/l + Difenoconazole 125g/l was 50% less effective in reducing fungal infection (Janse van Rensburg *et al*., 2016) when compared to the other spray combinations irrespective of application dates. In an environment conducive for fungal infection, a 50% growth reduction can still be relatively high and thus considered as a yield constraint.

Conclusions

CA systems under the environments evaluated, did not increase the risk of maize ear rots and mycotoxin production. Certain fungicide spray combinations can reduce maize ear rots in the field.

Multiple resource limitation: Effect of nitrogen forms and phosphorus sources on potato grown in varying soil types

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Introduction

Potato (*Solanum tuberosum L.*) is an important food crop in Africa. Potato has high nutrient demands and is sensitive to supply disruptions, resulting to poor yields. The crop has an inefficient root system, hampering nutrient uptake. Phosphorus (P) is a fundamental nutrient in energy transfer, photosynthesis and respiration. Most soils have high P content, but it is usually fixed, with only ~0.1% of P available to plants. Farmers thus have to apply P fertilizers, of which only 4% is plant available. Phosphatic fertilizer production consumes energy, is expensive and emits fluorine. Rock phosphate (RP) reserves are getting depleted, hence an urgent need to develop sustainable fertilizer management. Nitrogen affects P directly and indirectly with a brawny synergy by affecting the rhizosphere through pH alteration. This study seeks to further understand the effect of different N forms and P sources on P availability.

Materials and Methods

A greenhouse pot trial was set up. Nitrate and ammonium (split at planting and tuber initiation (TI) and P (all at planting) as superphosphate (SP), RP and zero P (P_0) were applied for 60 ton ha^{-1} yield potential. Low and high P soils were used. Cultivar Mondial was planted in 10 L pots with 10 kg soil. A laboratory column trial was also set up without a test crop to further understand the N-P chemistry and its effect on P availability. This is due to multiple reports indicating that P availability is a factor of plant exudates and not N-P interaction. Clay and sandy soils were used (treatments same as pot trial) replicated four times (48 columns). Four watering events were conducted to leach out P and the leachate was collected for analysis.

Results and Discussion

Nitrogen form and P sources significantly affected TI and yield. Ammonium+SP gave highest TI and yield. SP had higher TI and yield followed by RP and P_0. Despite optimal N with RP and P_0, growth was hampered, suggesting a co-limitation. Ammonium recorded the lowest soil pH, resulting in higher available P. Column leachate P was highest after the first leaching and lowest at the fourth. Leached P was highest for SP, followed by RP and P_0. Ammonium treatments gave highest leachate P.

Conclusions

Ammonium+SP gave the highest available P thus higher yields. RP and P_0 could not support optimal growth, regardless of N form. Ammonium+SP gave a significant gain in yield.

Fine tuning nitrogen fertiliser norms for wheat under conservation agriculture in the Western Cape

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Introduction

Since the early 2000's, many farmers in the grain producing areas of the Western Cape adopted at least one or more of the principles of conservation agriculture (CA). Current nitrogen (N) norms are derived from N response trials under conventional tillage and wheat mono-culture, as well as adopted from research conducted mainly in Western Australia. There is a need to develop scientifically sound N norms for wheat in the region. The aim of this study was to evaluate wheat N requirement and to determine optimal N top dress rates under CA.

Materials and Methods

Wheat was planted at a rate of 80 kg ha^{-1} at five different locations between 2016 and 2019. Cropping systems included wheat after canola, wheat after medics or lupin and wheat after lucerne. Nine trials were laid out in a randomised block design with eight N top dress rates and four replicates. The N topdress treatments comprised of planting with 25 kg ha^{-1} N and different N rates (0, 25, 50, 75, 105, 135 and 165 kg N ha^{-1}), applied as top-dressing. The control treatment was planted without any N and received no further N. Grain yield and quality were recorded for all sites. Linear and segmented linear models where fitted to the replicate normalised data.

Results and Discussion

Preliminary results show that the N rate had a statistically significant impact on yield in three of the six locations. At the Darling location the average control yield was 1282.53 kg ha^{-1} for the canola-wheat rotation and 1347.53 kg ha^{-1} for the medics-wheat rotation. Yields increased by 0.87% kg^{-1} of N applied between N application rates of 0 and 34.56 kg ha^{-1} where after the increase slowed to 0.11% kg^{-1} of N applied. At the Porterville location the average control yield was 1996.7 kg ha^{-1} for the canola-wheat rotation and 2591.32 kg ha^{-1} for the medics-wheat rotation. Yield increased at a rate of 0.16 % kg^{-1} of N applied between N application rates of 0 and 72.92 kg ha^{-1} where after the increase was reversed to a yield decline of 0.07 % kg^{-1} of N applied. At the Tygerhoek location the average control yield was 3059.68 kg ha^{-1}. Yield increased at a rate of 0.55% kg^{-1} of N applied between N application rates of 0 and 59.72 kg ha^{-1} where after the increase was reversed to a yield decline of 0.05% kg^{-1} of N applied.

Conclusions

Model results can be improved with more data and alternative functional forms. Preliminary results suggest biologically optimum yields can be reached at lower total N application rates than currently prescribed. Finally, the economically optimum N application rates will be determined.

Genotypic variation in water use and water use efficiency among four cassava landraces grown in the north-eastern part of South Africa

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Introduction

Water use efficiency (WUE) is a ratio of biomass or root yield per unit of crop water use and is influenced by physiological traits such as biomass accumulation and daily crop water use. Therefore, any variation above the soil surface affects WUE since it impacts on the soil water balance via water evaporation and penetration. Improving cassava production in water limiting conditions requires the use of cassava varieties, which are efficient in the use of limited soil moisture to maximize yield but cassava WUE varies greatly largely depending on environment and genotypes. This study evaluated the variation in the water use and water use efficiency of four cassava landraces grown in the North-Eastern part of South Africa

Materials and Methods

The field trials were laid in a RCBD consisting of four cassava landraces (ACC#1, #2, #3, and ACC#4) replicated 3 times. Mature cassava stem cuttings of 30 cm long, were planted manually at a spacing of 1 m x 1 m in both seasons in 2016/2017 and 2017/2018 cropping season. Each experimental unit consisted of six plant rows of 6 m length (36 m^2) and 8 rows of 8 m length (64 m^2) in both seasons, respectively.

Results and Discussion

Water use efficiency of root yield (WUE_{rt}) and Water use efficiency of biomass production (WUE_b) varied ($P<0.05$) with landraces from 37.0 kg ha^{-1} mm^{-1} (ACC#4) to 46.60 kg ha^{-1} mm^{-1} (ACC#3) and between 71.30 kg ha^{-1} mm^{-1} (ACC#2) to 86.0 kg ha^{-1} mm^{-1} (ACC#1, respectively. Genotypes varied in soil water extraction at the 30 cm depth only and WUE_{rt} and WUE_b in the varied in the season I, plants could have accessed moisture in the top soil layer (up to 30 cm) in the early growing days and reached a peak extraction around the bulking period. There was a significant positive correlation between root yield and water use efficiency of root yield (0.963***) and water use efficiency of biomass production (0.847***). Although we expected greater WUE in the drier season, it happened that greater WUE was observed in the wetter season partly because of dry matter accumulation, evapotranspiration, and photosynthesis within the genotypes.

Conclusions

ACC#3 and ACC#1 used water more efficiently in 2016/2017 and thus outperform the other two landraces but did not appear to have any water use and yield advantage in the drier cropping season. However, there is a need for further evaluation of the landraces and different moisture regimes, within the same landraces, for precise results.

Trends in reference evapotranspiration for South Africa using Hargreaves and Samani method

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Introduction

Climate change causes major changes in air temperature, precipitation, solar radiation and relative humidity and is likely to cause changes in hydrological cycle by affecting evaporation and precipitation. Reference evapotranspiration (ETo) is used for different applications such as hydrological and climatological studies, as well as for water resources management and planning. Therefore, understanding climate change trends and their effects on ETo is essential for sustainable agricultural and water resource management

Materials and Methods

There are several methods used to estimate ETo and the FAO Penman-Monteith equation is considered the standard model for reference evapotranspiration (ETo) estimation due to better accuracy. The Penman-Monteith method requires many parameters (solar radiation, relative humidity, air temperature and wind speed). However, Hargreaves-Samani (HS) equation is regarded as alternative in regions where meteorological variables such as relative humidity, solar radiation and wind speed are not measured. Hargreaves-Samani (HS) method requires minimum and maximum air temperatures. Therefore, the aim of this study is to analyze the trends in ETo using Hargreaves-Samani method. Changes in temperatures and ETo for the periods of 2036-2065 and 2066-2095 under RCP 4.5 and RCP 8.5 for South Africa were investigated using data from the Coordinated Regional Climate Downscaling Experiment (CORDEX) Africa models. The maximum and minimum daily temperatures from the Rossby Centre Regional Atmospheric Model (RCA4) driven by the nine Global Climate Models participating in the Coupled Model Inter-comparison Project Phase 5 (CMIP5) were utilized to calculate ETo using HS method.

Results and Discussion

The results indicated that under both RCPs there will be an increase in air temperatures and therefore resulting in a change in ETo. Increases in ETo coupled with changes in rainfall patterns will have a negative impact on crop and livestock production in most regions of South Africa.

Conclusions

In the current research, the trends in evapotranspiration for the period of 1975-2005 were done and the historical data was obtained from RCMs models and observed data from SAWS. The trends in evapotranspiration was done for the periods of 2036-2065 and 2066-2095 under RCP 4.5 and RCP 8.5 emission scenarios in South Africa using RCM models.

Assessing the raid susceptibility of crops grown in the Eastern Okavango Panhandle between 2008 and 2018

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Introduction

Elephants have consistently raided farmers' crops and reduced the productivity of in the Eastern Okavango Panhandle of Botswana. Many studies have examined field susceptibility to raids based on field characteristics like size and proximity to water sources. There are limited studies on how different crops individually and in combinations influence crop susceptibility to elephant raiding in this region. Similarly, the year-to-year variation in elephant raids has not been examined. We hypothesize that increased crop diversity in cropland influences their susceptibility to elephant raiding, and that such raids vary according to year.

Materials and Methods

This study utilized data collected by the Ecoexist team from fields, which were raided by elephants between 2008 and 2018 in the Okavango Panhandles of Botswana. Data on crops and crop grown, number of crop-raiding incidences for each crop, and elephant raiding incidences were recorded for each field assessed. Incidence risks (IR) and field risk value (RV) were computed using an adaptive epidemiological approach (Nijman and Nekaris 2010).

Results and Discussion

The results showed that incidence of elephant crop raiding varied significantly amongst crops, and also between the years of study. There was a significantly decrease in elephant crop raiding from 2012 to 2018. The year 2008 had the highest elephant crop raid incidents, and 2013 had the lowest incidents. The incidence of raiding differed significantly between conventionally grown crops ($P<0.0001$). The highest incidence of raiding averaged across years occurred on millet followed by maize, watermelons, sorghum and sweet sorghum, respectively. A significantly lower incidence of raiding occurred in groundnut and cowpea compared to millet, maize, watermelon and sorghum. Cowpeas and groundnut had the lowest risk to elephant raiding. Field RVs significantly varied depending on which crop was present on the farm. Pearson's correlation coefficient showed that an increase in the number of crops planted significantly reduced the susceptibility of the field to raiding ($R^2 = -0.680$, $P<0.0001$).

Conclusions

Therefore, farmers could considerably minimize the susceptibility of their farms by manipulating individual crops and crop combinations planted within fields. Groundnuts and cowpeas are less susceptible to raids compared to cereals. The two crops can therefore be grown to minimize elephant raids and hence increase food security in the Okavango Panhandles of Botswana.

Oil content, oil and seed yield of sunflower as a function of hybrid and planting dates

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Introduction

Planting date and selection of an appropriate hybrid is critical components in optimizing sunflower (*Helianthus annuus* L.) yield and quality. Information on the effect of planting dates on sunflower is, however scarce. The objective of this study was to investigate the impact of different planting dates (early, optimum and late) of sunflower hybrids on oil content and oil and seed yield in South Africa

Materials and Methods

Two years (2016 & 2017) of experiments were conducted at each of seven planting dates (locality) in North West and Free State provinces). Eighteen commercially sunflower hybrids from different local seed companies were used in the first season 2016-2017, nineteen used in the second growing season 2017-18 and twelve hybrids were tested in both growing season under fourteen localities (planting dates).

Results and Discussion

Analysis of variance showed highly significant effect of hybrids, planting date, location and planting dates nested with location on studied parameters. Within hybrids the mean oil content ranged from 37.06% - 47.37% while, oil yield varied from 0.85 -1.23 t ha^{-1} and seed yields varied from 2.04 - 2.82 t ha^{-1}. Oil content and oil and seed yields were higher with optimum and early planting dates and decline linearly as the planting dates were delayed. Oil content and oil and seed yield decreased by (7.86%, 34% & 37%) respectively, when the planting dates were delayed until to the last week of January

Conclusions

Considering the obtained results, the optimum planting dates is from middle of November to end of December and there should not be planted after the second week of January. Later planting (after 20th of January) may significantly decrease oil content and oil and seed yield of sunflower as confirmed in other studies and in other areas with similar environmental conditions.

Evaluation of kraal manure, inorganic fertilizer and lime on maize grain yields and selected soil chemical properties in acidic soils of Tsolo, Eastern Cape

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Introduction

Maize (*Zea mays* L.) is one of the most important crops cultivated by small-scale farmers in the Eastern Cape. However, most soils in the former Transkei are acidic, which results into poor maize yields. Kraal manure has a potential to improve soil pH during its decomposition. The aim of this study was to evaluate the effect of kraal manure and inorganic fertilizer (with or without) lime on maize grain yields and selected soil properties under the acidic soils of Tsolo, Eastern Cape.

Materials and Methods

The experiment was a Randomised Complete Block Design with five treatments, namely: {recommended rate of fertilizer with lime (RFL+), recommended rate of fertilizer without lime (RFL-), 5 tons ha^{-1} of sheep kraal manure with lime (5 KML+), 5 tons ha^{-1} of kraal manure without lime (5 KML-) and the unfertilized plot}, replicated three times for two years. Soil samples were collected to determine selected soil 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

The combination of kraal manure and lime (5 KML+) significantly improved soil pH (3.94 to 4.7) and soil acid saturation (39% - 4.6) in the first sampling (V3) compared to other treatments in both years. At flowering (VT-R), RFL+ significantly improved soil pH, while 5 KML+ showed consistency in the improvement of soil acid saturation. At harvesting, RFL+ significantly improved grain yields compared to other treatments in both years. In both years, the control (0 application) showed poor responses in all the tested parameters.

Conclusions

Sheep kraal manure combined with lime improved soil pH and soil acid saturation in the short-term. A combination of fertilizer and lime showed a significant but delayed effect on soil pH. Similarly, fertilizer and lime significantly improved grain yields compared to other treatments. Neither, fertilizer nor kraal manure was effective when applied without lime, which indicates the importance of lime in amending acid soils.

Floret survival, effect of soil fertility and sowing date on the contribution of main stem, tillers, kernel position to grain yield and protein content of wheat (*Triticum aestivum L*.)

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Introduction

Individual wheat (*Triticum aestivum* L.) shoots (MS, T_1, T_2, T_3, and T_n) differ in grain number, potential grain yield and protein content. So too, grain mass and protein content at floret positions (F_1…F_2…F_3...and F_n). The the ability of wheat genotypes to produce potential florets, *per se,* is assumed to be of overriding importance to improved grain yields. Potential florets abort and the final grain number per spikelet and hence, per ear is reduced to less than potential florets number. The important question is, by how much and why?

Materials and Methods

Expt 1. University of Western Australia (Merredin Agricultural Research Station). Three (3) spring wheat cultivars (Insiginia, Gamenya and Gutha) were sown on 15 May (SD1), 13 June (SD2) and 13 July (SD3) under rainfed conditions in a split plot arrangement. *Expt 2*. University of Pretoria (Hatfield Experimental Farm). Variations in maximum and potential floret number, and partitioning of biological between the grains were quantified for four (4) SA wheat cultivars (Inia, SST86, Kariega and Carina) sown on 15 & 16 May (SD1). Main treatment plots consisted of two fertility treatments (NPK and NPKM) as well-balanced soil fertility situations.

Results and Discussion

Expt 1. Grain numbers were less than spikelet numbers and yield was insensitive to maximum floret number. Insignia developed a large number of floret primordia but was unable to convert these primordia into grain. Floret survival varied from 17% for Insigina, 19.3% for Gamenya and to 35% for Gutha. Insignia produced more spikelets than Gamenya and Gutha but fewer contained grain at harvest. Survival of florets was highly, negatively correlated with maximum floret number. *Expt 2.* Similar trends were observed with the four (4) SA wheat cultivars showing increased potential floret number survival from Inia, SST 86 to Kariega, and to Carina with year of cultivar release, respectively. Significant interaction ($P \leq 0.05$) between genotype and soil fertility was observed on grain yield per ear, potential floret number, grain number, grain protein content and mean kernel mass at specific floret positions. More fertile florets per ear is sound objective provided new wheat gerplasm, can be accompanied with modified wheat ear morphology and reduced TS apical dominance to release assimilates to lift-up percentage (%) of floret number survival.

Conclusions

There have been significant gains in grain yield as result of earlier apical TS formation (*TS) and floret survival in the progression of WA wheat cultivar releases from Insignia (1946), Gamenya (1967) to Gutha (1983), and similarly to SA wheat cultivar releases from Inia (1966), SST 86 (1987) to Kariega (1993), and Hybrid Carina (1989), respectively.

Antidiabetic and nutritional activities of wild and cultivated Amaranthus spp. and isolated compounds

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Introduction

Amaranthus has been rediscovered as a promising food crop mainly due to its ability to endure and thrive in diverse environments and its potential to store diverse micronutrients. The existing studies focus mainly on the wild Amaranth variety and there is a dearth of information with regards to the effect of cultivation on both primary and secondary metabolites which affect the activity of the plant. Thus, the study seeks to evaluate the effect of wild and cultivated *A. cruentus* and *A. hybridus* on *in vitro* α-glucosidase and α-amylase enzymes. Furthermore, hypoglycaemic compounds from *A. cruentus* will be isolated and elucidated.

Materials and Methods

Different concentrations of plants (0.124 – 2 mg/ml) of methanol extracts of cultivated and wild *plants* were evaluated for α-amylase enzyme and α-glucosidase assays. Acarbose was used as a positive control. On the basis of the chemical composition, *A. cruentus*, was selected for the isolation of compounds. The methanol extract of *A. cruentus* was subjected to column chromatography yielding 13 major fractions, which resulted in three compounds.

Results and Discussion

All the extracts showed good α-glucosidase inhibition with wild *A. hybridus* showing the highest inhibition (89.9%) at a lowest concentration (0.125mg/ml). However, none of the extracts inhibited α-amylase enzyme activity beyond 50%. Three known compounds; α-spinosterol, palmitic acid and pheophorbide A-methy ester were isolated from *A. cruentus*. Pheophorbide A-methy ester was reported for the first time in *A. cruentus*. All three compounds showed excellent α-glucosidase inhibition with palmitic acid demonstrating high enzyme inhibition of 91% at a lowest concentration (0.03mg/ml). When the compounds were tested separately, all the compounds showed activity of less than 50% inhibition on α-amylase, however, when combined, the compounds demonstrated moderate enzyme inhibition of 53.6% at the highest concentration tested. Wild and cultivated *A. hybridus* samples showed differences with iron concentrations at 15.8 and 124 mg/100g respectively. Wild *A. cruentus* accumulated more zinc (19.6mg/100g) as compared to cultivated samples (8.3 mg/100g) and spinach (0.5 mg/100g).

Conclusions

It can be concluded that the wild and cultivated extracts of *Amaranthus* spp effectively inhibited the activity of α-glucosidase enzyme. This inhibitory property of the extract is attributed to the presence of phytochemicals that were isolated from the plant (Kazeem *et al*, 2013).

Evaluation of trend of incursions of regulated pests and diseases of economic importance that are under official control in South Africa

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Introduction

Plants and plant commodities are deliberately imported for various purposes, but unintended introduction of regulated pests also occurs. Importation of plants and plant commodities are increasing. The phytosanitary risks posed by introduction of alien invasive pests and diseases are also rising. The WTO-SPS Agreement acknowledges the sovereign right of member countries to protect the life and health of plants within their territories by means of phytosanitary regulatory controls. In South Africa (SA) the national phytosanitary regulatory system is currently administered under the Agricultural Pests Act 1983 (Act No. 36 of 1983). The current study evaluates incursions and trends of introduced alien pests and diseases subject to official control in SA.

Materials and Methods

Since 1984 amendments to the National Control Measures were made for the management of alien pests and diseases in South Africa in terms of the Agricultural Pests Act 1983 (Act No. 36 of 1983)**.** To evaluate the trend of introduced alien pests and diseases that were subject to official control in SA, we used descriptive statistics (frequency) to present the data on the percentage of regulated pest incursion in SA since 1984 to date. This analysis could predict the future movements based on observed data.

Results and Discussion

The results of the current study revealed that 61 amendments to national control measures since 1984 were made for the control of pests and diseases. *Radopholus similes, Fusarium oxysporum f. cubense, Liberibacter africanus, Synchytrium endobioticum, Trioza erytreae, Tilletia indica, Phyllosticta citricarpa, Candidatus Phytoplasma asteris, Xylophilus ampelinus, Bactrocera dorsalis, Chilo sacchariphagus, Trioza erytreae, Spodoptera frugiperda, Ditylenchus dipaci, Globodera rostochiensis* and Banana bunchy top virus were introduced to the country and are currently under official control. *Liberibacter asiaticus*, *Bactrocera cucurbitae, B. latifrons* and *B. zonata* are not yet occurring in the country, but were proactively included in the list of pests and diseases under official control. The highest number of pest introduction was recorded in 2009 during the review process. Majority of these pests and diseases are capable of spreading and establishing in SA.

Conclusions

This study highlights the importance and needs for increased search efforts at ports of entry to prevent introduction of exotic pests and diseases. Bio-security legislation is important in securing the country's domestic and international trade in plants and plant commodities. Considering its active agricultural and forestry sectors, SA needs a sound, nationally coordinated phytosanitary systems in order to maintain and expand its competitive position in the global environment.

Can crop physiology knowledge enhance sugarcane breeding?

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Introduction

Sugarcane breeding is resource intensive and slow, requiring repeated evaluation of large numbers of genotypes over a period of up to 13 years to produce a new variety. Compared to other crops breeding gains have been slow. The question is: How can knowledge about crop physiology be used to enhance sugarcane crop improvement? The aim of this paper is to review achievements and challenges in attempts to develop knowledge and tools to inform sugarcane breeding. It was hypothesized that genotype performance can be predicted realistically by simulating the physiological responses to environmental and management factors, using well-defined genetic trait parameters and environmental data. Traits show exploitable genetic variation and heritability. Realistic crop models with accurate trait parameter values can be used to identify important traits and their ideal values for target environments.

Materials and Methods

Results from pot and field experiments confirm strong genetic control of primary shoot emergence, canopy development and photosynthetic capacity. Model assessments reveal some capability to simulate GxE interactions at process level, but also show that improved simulation is required of environmental control of shoot emergence and the duration of the tillering phase. A more realistic simulation of dynamic source-sink interactions is also needed. Trait modelling suggest that conservative water use through stomatal sensitivity to water deficit appears not to be a desirable trait in most environments, as it is associated with a yield penalty. Several studies indicate that photosynthetic capacity is closely linked to yield and a highly desirable trait for high and low potential environments.

Results and Discussion

Breeding applications required high throughput, accurate phenotyping of large numbers of genotypes. Drone based remote sensing of crop properties holds promise. Research suggest that canopy cover can be estimated accurately from vegetation indices derived from high resolution visible and near infra-red spectra. The feasibility of phenotyping for photosynthetic capacity and drought tolerance using thermal imagery is being assessed.

Conclusions

Physiological knowledge can potentially enhance sugarcane breeding but more work is required to improve modelling capabilities and to develop reliable high throughput screening protocols.

Resource use efficiencies of potato production in the Sandveld region of the Western Cape

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Introduction

Resource use efficiencies (RUEs) are often used as indicators of sustainability in crop production. Previous studies have shown that RUEs differ substantially between and within potato production regions of South Africa. Variation between regions are explained by differing climates and soils, however, within-region differences are often harder to pinpoint. Assessment of RUEs can help explain variation and optimise practices to improve efficiency and close yield gaps. Potato production in the Sandveld occurs in an ecologically sensitive area. Soils are very sandy with low nutrient and water holding capacities, which complicates irrigation and fertiliser management. The aim of this study was to quantify water and nutrient inputs and losses in order to better understand RUE differences between farms and propose management practices to improve on-farm efficiency.

Materials and Methods

The study was conducted on nine commercial potato fields under centre-pivot irrigation. Irrigation was measured using flow meters and rain by automatic weather stations. Water loss through drainage was quantified using drainage lysimeters and leachate was analysed for nutrients. Tuber yield was determined at crop maturity and compared with model-simulated potential yields. Soil-water balance components, water-use efficiencies (WUEs) and nutrient-use efficiencies (NUEs) were calculated.

Results and Discussion

Fresh tuber yields for autumn and winter plantings were relatively lower (34.7 - 49.8 t ha^{-1}) due to less available radiation. Summer crops yielded better (51.2 - 118.2 t ha^{-1}), with small yield gaps. Rainfall ranged from 54 to 271 mm and seasonal drainage between 4 and 302 mm. For winter crops, most drainage occurred after rainfall events, while in summer drainage occurred because irrigation exceeded crop requirements. In some fields, considerable nutrient losses occurred with drainage, resulting in a range of WUEs and NUEs. WUE ranged between 65 and 122 kg mm^{-1}, while average NUEs of 198 kg fresh potato kg^{-1} N, 378 kg kg^{-1} P and 133 kg kg^{-1} K were recorded. Low water holding capacity of the sandy soils complicates water and nutrient management, as growers cannot leave substantial room for rain in the profile and thus the risk for drainage is high.

Conclusions

Substantial drainage and nutrient leaching occurred from some fields due to winter rainfall and over irrigation, resulting in a wide range of resource use efficiencies. Various management aspects should be investigated to limit unproductive losses, including irrigation scheduling to match irrigation with crop water demand, evaluation of fertiliser practices (granular versus fertigation), and use of hydrogels to improve water holding capacity of soils.

Seed-drills and their influence on uniformity of crop emergence

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Introduction

A seed-drill should be able to place seeds in an environment conducive to uniform seedling emergence. In semi-arid regions, low intensity and inconsistent rainfall events can result in non-uniform seedling emergence. Evaluation of seed-drills is necessary to supply dryland small grain producers with potential solutions to combat non-uniform seedling emergence.

Materials and Methods

Barley, canola and wheat were seeded with three different seed-drills in a semi-arid dryland production region of the southern Cape, South Africa. Seed-drills were equipped with either double disc openers, tine openers or a combination of both tines and single discs. Seedling emergence was determined by counting fully emerged seedlings approximately every four days, in five predetermined 1 m rows per plot. Data is presented as plants per m^{-2}. Weather data was collected on the trial site. Mixed model procedures using restricted maximum likelihood (REML) were followed to test for the treatment effects. The Variance Estimation and Precision (VEPAC) package of Statistica Version 13.3 (TIBCO Software Inc. 2018) were used.

Results and Discussion

Crops responded differently to seeding equipment in different climatic conditions. The commencement of the 2018 season was drier compared to the 2019 season. However, rainfall decreased towards the end of the 2019 season. In 2018, wheat seeded with the combination seed-drill outperformed the other seed-drills from 39 days after seeding ($p < 0.05$). Barley did not respond to the different seed-drills in 2018 ($p > 0.05$). Canola emergence lacked behind at the start of the growing season, but both seed-drills equipped with tines had higher seedling amounts from 39 days after seeding ($p < 0.05$). In 2019, all three crops emerged early where seeding took place with the tine seed-drill ($p < 0.05$). Nonetheless, the combination seed-drill caught up with the tine seed-drill's plants per m^{-2} approximately 20 days after seeding ($p > 0.05$). The double disc seed-drill resulted in late emergence ($p < 0.05$). The amount of wheat and canola plants per m^{-2} caught up with both other seed-drill's plant counts by the last measurement ($p > 0.05$), barley seedlings remained fewer where the double disc seed-drill was used ($p < 0.05$).

Conclusions

Seed-drills together with their associated seed placement influenced crop emergence. However, no single seed-drill can be singled out after two growing seasons. Seasonal changes, especially rainfall at the start of the growing season, will influence with emergence rate of crops significantly. Additional research about adaptions of agronomic practices and seeding equipment might increase resilience to adverse climatic conditions in semi-arid small grain production regions.

Alleviation of residual herbicide phytotoxicity on dry beans using Brassinosteroids

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Introduction

Residual herbicide in soil contributes to yield losses in many crops. Due to resistance of consumers towards transgenic plants and agra-chemicals, a rationale has been established for developing alternative manipulation techniques via natural products from wild plants. The application of Brassinosteroids (BRs) shows great potential to address these problems.

Materials and Methods

In this study with dry beans over two growing seasons (2015/16 and 2016/17) under glasshouse conditions three application methods of brassinosteroids, namely seed treatment, soil drench and foliar spray, were compared and combined with three mesotrione concentrations. The trial was conducted under natural daylight conditions, with a day length of approximately 13 hours and day/night temperatures of 28°/18°C. The experiment was laid out in a randomized complete block design and replicated eight times. The three mesotrione concentrations (1.6 µg, 0.05 and 0.0016 µg ai kg^{-1} soil) used were calculated using the average half-life of mesotrione in the soil (WWSS, 2007). Both preventative (seed treatment and soil drench) and corrective treatments (foliar application) were done with the brassinosteroids.

Results and Discussion

All the mesotrione concentrations significantly lowered growth parameters plant height and stem diameter, as well as the physiological parameters carotenoid content and photosynthesis. While both unstressed and stressed plants treated with BRs increased, growth parameters like plant height and stem diameter and photosynthesis, as well as carotenoid content. All BR applications had a significant effect on alleviating residual herbicide (Mesotrione) phytotoxicity, for example, the foliar application combined with the highest mesotrione concentration increased the carotenoid content as well as photosynthesis with an astonishing 120% and 40% respectively after 9 weeks. Of the three BR methods, foliar application, as a corrective treatment, significantly increased all morphological, physiological and yield parameters. Interestingly, both unstressed and stressed seedlings benefitted from treatment with the bio-stimulant as both corrective and preventative treatments. Observed growth differences between unstressed seedlings treated with BRs varied from significant to highly significant. The same significant differences were observed for physiological parameters including chlorophyll content and photosynthesis rate. Similar differences between treated herbicide stressed seedlings were slightly less, but still significant in most cases.

Conclusions

Yield data confirmed the beneficial effect of the bio-stimulant right up to harvest in both unstressed and stressed plants. In conclusion, brassinosteroids seems to be a useful tool for manipulating high protein legume crops in terms of resistance towards herbicide.

Management strategies to increase winter herbage production of the lucerne phase in long-rotation cropping systems

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Introduction

Lucerne (*Medicago sativa*) forms part of long-rotation cropping systems integrated with livestock in the southern Cape of South Africa. The typical lucerne phase is five to seven years, followed by five to seven years of cash crops. The integration of livestock into cropping systems allows for improved resource utilisation. Low productivity of lucerne swards in winter months has led to large fluctuations in available fodder for animals and challenging management conditions for farmers. Some farmers have considered excluding lucerne swards from crop rotation systems. The oversowing of dryland lucerne swards with annual winter growing forage crops may present opportunity to reduce large fluctuations in fodder flow programs an increase winter production of lucerne swards, for lucerne-based multiple species pasture to be considered as a viable alternative to dryland lucerne swards, total pasture herbage production must improve and specifically herbage production in winter months.

Materials and Methods

Field experiments were conducted at Tygerhoek Research Farm (Riversonderend) during the 2018 and 2019 growing seasons. The experiment had a split-plot design with four replicates. Whole plots consisted of 12 species compositions and sub-plots will have two levels of crop residue (high or low) in which lucerne was established. Each sub-plot will cover an area of 2.5 x 24 m. Species composition treatments involve oversowing either single species or mixes of species into a lucerne base that was established in April 2017. Single species treatments will include oats, forage barley, stooling rye, westerwolds ryegrass, forage radish and canola. Mixes will consist of various combinations of hybrid ryegrass, Italian ryegrass, forage barley, oats, various annual *Medicago* and clover species, vetch and forage radish. Pre-grazing herbage production and species composition were determined every six to eleven weeks depending on the season and available fodder.

Results and Discussion

There was no interaction ($p<0.05$) between main factors and therefore there is only considered to be twelve treatments with various owersown species. During the growing season (April to October), no treatment had a higher total herbage production ($p<0.05$) or higher production at any stage of the growing season ($p<0.05$) than the control. In the subsequent summer and autumn herbage production of two of the three treatments that contained ryegrass was lower than the control ($p<0.05$). Overall productivity was not improved by oversowing lucerne.

Conclusions

No lucerne-based multiple species pasture can be recommended on the basis of increased herbage production. Small grains and mixes that contain small grains showed the most potential with further research required.

The relationship between conservation tillage practices for potato production and nematode activity in the Sandveld region of South Africa

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Introduction

Tillage plays a major role in modification of soil structure as it influences the distribution of energy rich organic matter within the soil profile and thus impacts the nematode population diversity and density. The aim of this study was to investigate the effect of conservation tillage on the nematode diversity and density in the soil under potato production.

Materials and Methods

The trial was conducted in Aurora, South Africa, in the Sandveld region under a centre pivot over a four year period. The trial layout was randomised complete block. Three tillage treatments were investigated and consisted of a conventional tillage treatment with a mouldboard plough to a depth of 350 mm combined with a rip treatment 600 mm deep between planting rows, a conservation rip treatment to a depth of 600 mm between planting rows and a conservation paraplough treatment over two planting rows to a depth of 600 mm. Nematode sampling was performed four days before planting as well as ten weeks after emergence. The sampling was done up to a depth of 200 mm on each plot, ten sub-samples were randomly taken per plot, and then bulked into one sample per plot.

Results and Discussion

The only plant parasitic nematodes that were extracted were rootknot, lesion and spiral nematodes at low population densities throughout the four years with no significant impact on tuber quality and plant growth performance. The nematode samples, taken at midseason of the potato growth period, showed no significant differences between the tillage treatments when free living nematodes were considered except in year two where the rip treatment showed significant lower levels. The paraplough treatment resulted in the highest number of freeliving nematodes per 250 cm^3 of soil, which did not differ significantly from the other treatments in years 1 to 3 but was non-significantly lower than the rip treatment in in year 4 with 491 nematodes per 250 cm^3 of soil. The plantings in year 1 and 3 resulted in relatively high numbers of freeliving nematodes when compared to year 2 and 4. It is evident from the data over a period of four years that the paraplough treatment had no negative influence on freeliving nematodes when compared to the conventional tillage treatment, the plant parasitic nematodes between these two treatments showed that the paraplough treatment never had significantly higher values than the conventional and rip treatments.

Conclusions

If the low levels of plant parasitic nematodes, which were encountered over the last two seasons, can be maintained up to the planting of the next potato cycle after four years, it will reduce the nematode pressure significantly on the follow-up planting.

Influence of planting techniques and maturity group on soya bean (*Glycine max*) yield in different agro-ecologies in the North Eastern Free State

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Introduction

Successful soya bean production depends on both controllable and uncontrollable factors. It is imperative that controllable factors are optimized. These factors include the correct application of production inputs inter alia maturity group, plant population, planting date, row width, fertilization, soil tillage as well as weed, insect and disease management. This study focused on planting techniques, which included planting date, row width and plant density as well as maturity group.

Materials and Methods

In an attempt to evaluate the influence of planting techniques and maturity group on soya bean yield, a total of eight on-field experiments were conducted during the 2016/17 and 2017/18 growing seasons located in the North Eastern Free State at three experimental sites. Treatments included three cultivars (maturity group), four plant densities, two row widths and two planting dates. The three cultivars used in this experiment was SSS 4945 tuc (MG 4.5), SSS 5449 tuc (MG 5) and SSS 6560 tuc (MG 6). MG 4.5 is classified as a short MG, MG 5 as a medium MG and MG 6 as a medium-long MG. The four plant densities differed between experimental sites and ranged from 150 000 to 600 000 plants ha^{-1}. The rows width also differed between the experimental sites and ranged from 0.30 m to 0.76 m rows. An early and late planting date was planted only at one experimental site.

Results and Discussion

The influence of plant density had significantly affected grain yield for all experimental sites. At early planting dates the influence of plant density on grain yield had no definite trend, while at later planting dates an increase in plant density resulted in an increase in grain yield. Narrower row widths resulted in a significant increase in grain yield only during the 2016/17 cropping season for two of the three experimental sites. Planting date had a significant influence on grain yield with the early planting dates out yielding late planting dates for both cropping seasons. Different maturity groups had significant effects on grain yield. Planting date also had a significant effect on the three maturity groups with MG 6 recording the greatest grain yield at early planting dates and MG 4.5 and MG 5 recording significantly the greatest grain yield at late planting dates.

Conclusions

From the above results, it is clear that grain yield is significantly influenced by planting date, plant density, maturity group and row width. The process of selecting the appropriate soya bean cultivars for the North Eastern Free State is complex and requires a thorough understanding and insight in the multivariate approach with maturity group, plant density, row width and planting date.

ORAL PRESENTATIONS – WEED SCIENCE

LISTED ALPHABETICALLY

Pelargonic acid as an alternative to Paraquat for the preparation of firebreak tracer lines

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Introduction

Over the past 32 years, 75 599 ha of plantations within South Africa have been lost through fire. Fire prevention, in the form of firebreaks on landholding boundaries, are required (by law) by landowners from whose land a fire might start or spread. On forestry land, Paraquat dichloride (1,1′-dimethyl-4.4′-bipyridinium ion) has been used for the desiccation and subsequent burning of two parallel tracer lines in late summer, prior to the burning of the vegetation bordered by these tracer lines and when conditions allow (early to late autumn). Paraquat is listed as a highly hazardous pesticide within South African forestry, by the Forest Stewardship Council, with its use discontinued from 2018.

Materials and Methods

A series of 5 trials were implemented to test alternative contact/defoliation herbicides at various rates for the preparation of tracer lines in KwaZulu-Natal and Western Cape. In addition, various surfactants and nozzle types were tested to improve vegetation penetration, cover and hence efficacy. In all the trials vegetation cover was assessed prior to and 14 days after herbicide application to determine initial herbicide efficacy, and again at 3 months to determine vegetation recovery (desirable).

Results and Discussion

Of the products tested, pelargonic acid (with no surfactants) applied at 10% and using higher volumes of delivery (improved coverage) produced results most similar to that of Paraquat.

Conclusions

Combined results from these trials will be presented to illustrate key findings in terms of the practical use of pelargonic acid as a desiccant for the preparation of fire-break-tracer lines.

Weed growth and crop yield responses to tillage and mulching under different crop rotation sequences in semi-arid conditions

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Introduction

Conservation agriculture (CA) proponents assert that CA leads to improvement in long-term weed management that is observed as a reduction in weed pressure as from the third year of adoption. However, evidence of increased weed growth and weeding requirements under smallholder farmers' fields practicing low-input CA brings this assertion into question. Conservation agriculture experts propose that these reported increases in weed infestations under CA relative to conventional tillage are due to the non-simultaneous application of minimum tillage, permanent soil cover and diversified cropping systems by smallholder farmers.

Materials and Methods

Weed growth and crop yield were assessed during the third and fourth year of maize-cowpea-sorghum rotation, second and third year maize-cowpea rotation and first and second year maize mono-cropping on a clay loam soil at Matopos Research Station (annual rainfall, 573 mm) following recommended CA management practices. Each experiment had a split-plot randomized complete block design with mouldboard plough (CONV), minimum tillage (MT) with ripper tine and planting basins as main-plot factor and maize residue mulch rate (0, 2 and 4 t ha^{-1}) as a sub-plot factor, with threefold replication. All sub-plots were surface mulched and weeded by hoe at the same time. We hypothesised that under MT weed growth would be considerable with maize mono-cropping but from year three of CA, weed growth would decrease and crop yield increase relative to values from un-mulched CONV.

Results and Discussion

Minimum tillage doubled ($P < 0.001$) weed density relative to conventional tillage in 2nd year of maize mono-cropping. Under the maize-cowpea rotation, the considerable weed growth in planting basins was likely due to the large intra-row spacing and poor light competiveness of the cowpea variety. Mulch contributed to weed growth being suppressed by up to 36% ($P < 0.05$) under CA in the maize-cowpea-sorghum rotation relative to un-mulched CONV. When planted on the same date, crop yield did not differ between CA and un-mulched CONV. Maize-cowpea-sorghum rotation grain yield (3143 kg ha^{-1}) was double that of mono-cropping, probably due to improvements in soil physical and chemical conditions.

Conclusions

We found a decrease in weed growth and increase in crop yield from the 3rd year of recommended CA practices relative to conventional tillage.However, there is need for farmers to select for the inclusion of rotational crop varieties that are competitive against weeds. To optimise production and benefits from CA, full adoption of CA practices over time should be recommended to smallholder farmers.

Herbicide use within the commercial forestry sector in South Africa

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Introduction

An herbicide survey was undertaken in 2017 - 2018 within the South African forestry industry, specifically to quantify the herbicide type and quantities used. By linking the quantity of herbicides applied to timber species grown, end-product produced and vegetation management phases within and across the three climate zones, a better understanding of herbicide use can be obtained. In addition, this information will also be able to highlight areas of concern where herbicide use can be reduced.

Materials and Methods

Timber companies within the timber growing regions of South Africa were surveyed to determine total herbicide usage over one year (2017 to 2018). General background information was obtained for each plantation surveyed, with more detailed herbicide-use data obtained at the stand level.
Descriptive statistics in the form of tables and figures were used to describe the herbicide-data obtained (means, ranges, s.e.).

Results and Discussion

A total of 188 288 L (or 0.55 L ha^{-1}) herbicide a.i. (consisting of various herbicide products) was applied on the 343 872 ha surveyed. The largest quantity of herbicide a.i. applied ha^{-1} was within the WT climate zone (0.75 L ha^{-1}), followed by the CT climate zone (0.60 L ha^{-1}) and lastly the ST climate zone (0.45 L ha-1). Irrespective of climate zone, the general trend was that the pre-establishment phase received more a.i. ha^{-1}, followed with the re- and post-establishment phases (pre>re>post). Although more a.i. was applied within the pre-establishment phase across the three climate zones, this was not much more than the re-establishment phase (difference of 0.06 L a.i. across the three climate zones). Whereas, the herbicide usage in the post-establishment phase was noticeably less across the climate zones. This trend remained the same for most genera grown across the three climate zones (pre>re>post). Glyphosate-based products accounted for 97% of all the herbicide products applied during the 2017-2018 data collection period, while metazachlor and triclopyr butoxy ethyl ester accounted for 2%. Of the three vegetation management phases, the re-establishment phase received the largest quantity of herbicide applications with glyphosate-based and metazachlor products applied the most. Whereas, both the pre- and post-establishment phase received similar quantities, with glyphosate-based herbicides and triclopyr applied mostly during the post-establishment phase.

Conclusions

Fundamentally the intensity of vegetation management required to produce significant growth benefits decreased with increasing altitude (ST>WT>CT), with more herbicide a.i. required with decreasing altitude (CT<WT<ST). Future research can investigate alternative vegetation management methods, specifically focusing on the pre- and re-establishment phase, as these phases receive the most herbicides.

ORAL PRESENTATIONS – SOIL SCIENCE

LISTED ALPHABETICALLY

Can generalized erodibility models be applied for South African soils?

Presenter: MAM Abd Elbasit (mohamedahmedm@arc.agric.za)

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Introduction

Soil erodibility is highly related to the response of soil to rainfall at the field level. Soil response to rainfall at the field level is a highly dynamic process. Since the 1950s soil erodibility has been calculated quantitatively using field plots. However, the experimental nature of the soil erodibility factor makes it difficult to estimate the sediment using single published models developed under conditions different from the area where they can be applied. The study is an attempt to evaluate the impact of using different soil erodibility models on the erodibility distribution and quantification of erodibility magnitude.

Materials and Methods

The erodibility assessment has considered the entire area of South Africa. The primary soil characteristics were obtained from the national soil profile database at the Agricultural Research Council- Soil, Climate, and Water. A simplified set of models were applied to estimate soil erodibility. The geographical location of the soil profiles and soil primary information have been used to determine the soil edodibility distribution.

Results and Discussion

Based on the simplified erodibility model applied in this study, the soil erodibility values in South Africa are ranged between 0.004 and 0.58. The study has considered over 12 000 soil profile data to generate the erodibility maps. The results showed that the majority of the values are between 0.01 and 0.22 classes; this indicated that most of the South African soils are moderately erodible. However, this can only be taken as a preliminary determination of erodibile soil zones and specific sites must be verified by field and experimental studies.

Conclusions

Comparative study was done to assess the significance of models differences on soil erodibility estimation. The models showed high differences between each other recommending the necessity to have site validation before the application of any model.

A new South African Soil Classification: A review of selected downstream impacts

Presenter: KR Barichievy (kurt.barichievy@kzndard.gov.za)

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Introduction

In 2018, the new South African Soil Classification system was officially released for use in pedologic applications. This revised classification seeks to build on the two previous editions by embracing a new open-ended system and provide a more detailed classification framework for deeper soil materials. As a result of this flexibility the number of soil forms has nearly doubled. The impact of the new classification framework is far reaching, as many other scientific disciplines use soil classification as a basis for their models and as a raw input into their assessment methodologies. The objective of this study is to review of the impact of the new classification system on these models and methodologies.

Materials and Methods

For the purpose of this study, a number of models and assessment methods, that directly use Soil Form and/or Family information, were selected. These include the ACRU Hydrological Model, SCS-SA Design Flood Model, Wetland Delineation Methodology, WET-Ecoservices, KZN Bioresource Modelling System and South African Land Capability Assessment System. The impact of the new soil classification framework, on the various methods, was subsequently assessed in terms of ease of potential adoption, ease of potential translation and the continued relevancy of the model itself.

Results and Discussion

All methods and models reviewed in this study will require some degree of revision to adapt to the changes presented in the new classification system. The central soil-water module of ACRU, will require major adaption in order to quantify new runoff, infiltration and storage norms. Similar research will need to be implemented for stormflow potential, as per the SCS-SA Model. The National wetland delineation methodology will need to be amended to include the new hydromorphic forms and “Peat Topsoils”. The Bio-Resources model, which uses ecotopes for tertiary delineation and yield modelling, requires complete overhauling to assign new forms to the correct functional soil groupings. Similar to when the Taxonomic System was released in 1991, the South African Land Capability Assessment System will need to be revised to accommodate the new classification framework.

Conclusions

The impact of the new classification system on downstream users and applications should not be underestimated and wider review of future editions by such users is essential. Implementation of the new system requires an adoption window. Adoption challenges also come with opportunities to update models and methods and allow for a revitalised and improved integration of pedology with other scientific disciplines.

Adsorption potential of arsenic and selenium in soil substrates: A laboratory and pedo- geochemical modelling study

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Introduction

The hazardous environmental effects of industrialisation and mining were highlighted over the last few decades due to the increase in anthropogenic activities. Consequently, the amount of research on these environmental impacts and the rehabilitation of the impacted areas (e.g. mine tailings and the waste they produce) have increased. Numerous studies have been done on the sorption potentials of metal (loid) cations in mine tailings and soils. Insufficient attention is, however, given to the sorption potential of metal (loid) anions, posing a serious environmental problem. Arsenic (As) and Se are mobile under a larger range of naturally occurring groundwater conditions and consequently have a greater hazard rating than many other trace constituents (Sami and Druzynski, 2003). This study focused on defining the adsorption potential and behaviour of As and Se, at a specific pH, in a soil substrate.

Materials and Methods

This study used laboratory experiments and geochemical modelling replicating the geochemical environment to compile adsorption curves and to define the equilibrium constants of arsenate and selenate. Soil substrates were made by replicating the Fe-oxide and clay content of soils typically found. The substrates were contaminated with either As or Se and the pH was adjusted to 2, 5, 7 and 9 respectively. Samples were then analysed to determine the adsorption of As or Se at these levels. A numerical model was complied to replicate these experimental results by using PHREEQC (Albarede, 1996; Hansen, 2018). These numeric models together with the experimental results, were then used to compile adsorption curves and define the behaviour of these elements in soils.

Results and Discussion

It is expected that the mobility of As and Se, in oxidising conditions, will increase with an increase in pH. In this study the analytical results of the laboratory experiments were used as calibration points to correct the thermodynamic and equilibrium constants, of the elements As and Se, in the geochemical model to define the behaviour of these elements in a specific environment (Dzombak and Morel, 1990; Rahman, *et al*. 2019).

Conclusions

Data presented here is of great importance in decisions regarding irrigating with mine-extracted waters, and the rehabilitation of contaminated sites. It is of utmost importance that environmentalists acknowledge the magnitude of cation and anion metal (loid) pollution in geochemical environments.

Development of a refined land capability evaluation data layer for South Africa

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Introduction

Land capability is widely used by various industries to indicate the capability of the natural resources for various uses and is thus regarded as a form of land evaluation. From an agricultural production perspective land evaluation to determine the capability of the natural agricultural resource base plays a pivotal role in land use management and crop selection, but specifically as one of the input requirements towards the identification of land that should be protected for agricultural production purposes. Land capability is defined as the most intensive long-term use of land for the purposes of rainfed cultivation, determined by the interaction of climate, soil and terrain.

Materials and Methods

In view of the mentioned, DAFF had completed a process to refine the 2002 national land capability data layer based on in-depth researched and verified methodologies. The methodology made use of a spatial evaluation modelling approach where in a three-tier data architecture was used to provide structure to the processes followed, in order to determine the overall modelling goal. A combination of environmental-, sensitivity-, statistical-, prediction- and process modelling approaches were used to analyse agricultural phenomena by identifying explanatory climate, soil and terrain variables. Variables that were regarded as significant to the spatial distribution of the phenomenon were used relative to the importance of the variable based on published literature on the relevant issue at hand.

Results and Discussion

The newly derived spatial land capability evaluation data layer is raster based and comprises of 15 land capability evaluation values, with 1 being the lowest possible value and 15 the highest. It is thus regraded as an agricultural driven evaluation model taking into consideration the contribution of soil-, climate- and terrain capability for agricultural production purposes. The relationship of the 15 land capability evaluation values is not linear to each other but is based on a polynomial relation. Each raster cell size represents an area of 0.84 ha and is useable on a scale of 1:50 000 – 1:100 000. The land capability evaluation data layer is supported by the next level of concerning issues namely soil, climate and terrain evaluation data layers.

Conclusions

The refined land capability data layer depicts a much more refined version of the spatial distribution of the land capability in the country with the added provision of the soil-, climate and terrain capability spatial data layers for an in-depth analysis and evaluation of the capability of the land for sustainable rainfed agricultural production purposes. DAFF has formally been accepted the 15 class raster land capability data layer as the current national standard for land capability and has been appointed as the data custodian of this data layer under the Spatial Data Infrastructure Act, 54 of 2003. The presentation will focus on the applied methodology to develop the refined land capability evaluation data layer as well as a statistical analysis thereof specifically in relation to current agricultural land uses.

Mapping soil factors influencing erosion using machine learning algorithms in the T35D-E catchment in the Eastern Cape province

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Introduction

Soil erosion is probably the most common form of land degradation, leading to on and off site detrimental effects, such as an increase in river sediment load which has been shown to drastically decrease dam storage capacity. The South African Government has announced plans to build two large dams within an area with a very high erosion rate, thus necessitating soil erosion mitigation efforts. These efforts should be concentrated on the area with the largest impact, and thus a soil map showing areas with the highest susceptibility to erosion is required.

Materials and Methods

This paper describes how a soil group map for the quaternary catchments T35DE was created with digital soil mapping methods, and compares the created map to the best current soil information. Soils were described and classified at 600 locations determined with the conditioned Latin hypercube sampling method, within a 500 m buffer around the available road network. This soil database was then used with the multinomial logistic regression algorithm to create an initial soil group map with seven soil groups, based on their soil erosion properties. Additionally, a soil depth map was created using the cubist algorithm. The soil group map was then created again, but with the soil depth map added as an additional covariate.

Results and Discussion

Even though the soil depth map was a poor reflection of reality, the final soil group map showed a slight improvement in accuracy (68% vs 64%) and more detail than the initial soil group map. The final soil group map was compared to the current available spatial soil dataset, and found to contain 123 times more detail. Superimposing the gully extent of the soil group map confirmed that the Sterkspruit soils are the most susceptible to erosion and mitigation efforts should focus on the as yet ungullied Sterkspruit soils.

Conclusions

Cumulic and soils of the Sterkspruit soil form are the most susceptible to having gullies form in them, and due to the Sterkspruit soil form\'s larger area, their distribution seems to play a controlling factor in gully distribution in this area, as more than a quarter of the site’s gullies formed on Sterkspruit soil forms, although they only cover 7% of the area. Within the land type with the highest gully density, Db334, the soils of the Sterkspruit soil form are the most abundant soil group, covering 25.6% of the area. The instability of these soils increased the gully formation of the land type, with gullies spreading to the adjacent soil forms.

Wetland soil properties associated with the abundance of potential Rift Valley fever virus vectors in central South Africa

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Introduction

Rift Valley fever (RVF) is an acute vector-borne zoonotic disease that is caused by the Rift Valley Fever Virus (RVFV). RVF is endemic to African countries and the Middle East and has a significant impact on public and livestock health. Wetland soils play a transitional role in the survival of the virus, but little is known about wetland soil properties associated with the eggs of RVFV transovarial vectors. The objectives of this study were: 1) to evaluate wetland soil properties that are associated with the presence of RVF vectors, based on control and outbreak classification, and soil moisture and mosquito data; 2) to determine seasonal microbial activity; and 3) to test an existing RVF prediction model.

Materials and Methods

Thirty wetlands were selected and classified as historical RVF outbreaks and control sites based on the World Organization for Animal Health (OIE) reports. Soils were described and classified, and soil samples were collected for laboratory analysis using standard procedures. Soil water content was measured using the leveloggers, watermark and ECH2O 5TE sensors.

Results and Discussion

Soil type and texture are associated with sites where RVF outbreaks were recorded and are characterised by high clay content and are poorly drained , whereas control sites are characterised by loamy soils and well-drained soils. Salt content promotes mosquito abundance. The soil water content is correlated with mosquito abundance. Soil microbial activity was inconsistent between the two sampled seasons. The discriminant function used to classify the new sites misclassified all but one site as outbreak site.

Conclusions

The risk of RVF outbreaks can be predicted using specific soil properties. Together with mosquito surveillance and climate data they can be used to develop RVF risk maps and thus contribute to the control of outbreaks, e.g. aid targeted RVF vaccination programs.

An introduction to peat in the South African Soil Classification

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Introduction

Peat was previously not well defined in the South African Soil Classification of 1991. However, it is recognized internationally as a topsoil horizon covering 3 to 5 % of the earth's land surface. Peat accumulate in peatland ecosystems where biota is adapted to high water and low oxygen contents. Peat is well described internationally but research and inventory work only commenced in the early 1990's on South African peatlands as these systems are not widely distributed in the region. Recent advances in peatland research has necessitate the refinements of organic soils in the South African Soil Classification. Peatlands are capable of storing large quantities of soil carbon and fresh water resources. The failure to identify and assess peat properly infield will result in inappropriate land use practices on peatlands and poor management thereof.

Materials and Methods

This presentation is based on a literature review of international and recent South African peat studies as compiled in the third edition of South African Soil Classification (2018).

Results and Discussion

The first and second editions of Soil Classification recognized organic top-soils, setting the lower limit for organic carbon at 10%. The International Mire Conservation Group (Joosten and Clark, 2002) and the International Peat Society considers peat as accumulated material consisting of at least 30% (dry mass) of organic material (approximately 20% organic carbon). The third edition of Soil Classification makes provision for organic carbon in excess of 20% for peat. Fibric Peat is the least decomposed organic material and has a large amount of well-preserved fibers, a low bulk density (0.07 – 0.18 g cm^{-3}) and a high water content when saturated. Hemic Peat has an intermediate degree of decomposition expressed via an intermediate extent of decomposed fibres, bulk density and water content. Sapric Peat is the most highly decomposed of these organic materials. This peat has the smallest amount of plant fibres, highest bulk density and lowest water content on a dry-weight basis at saturation.

Conclusions

A peat horizon is introduced to account for high organic carbon top-soils in environments inundated or permanently saturated with water, together with soil forms to accommodate the regular occurrences of the horizon. Adaption to the definition of the organic topsoil horizon, and to soil forms with organic horizons, was necessary to accommodate the peat soil horizon.

Manganese (II) oxidising potential of selected soils under differing oxidation conditions: Implication for irrigation management of mine-impacted waters

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Introduction

Comparing and quantifying different soils' abilities to oxidise Mn (II) and thereby immobilise Mn (II) has not received much attention in South Africa. Understanding differing soils' Mn (II) oxidation propensities has many applications. One such application is, Mn is present in many mine impacted waters. There are widely adopted but costly processes to remove Mn from mine-impacted waters, and more affordable alternative options are required. Irrigation with Mn-rich waters on soils that are able to immobilise Mn is possibly one such alternate solution. This study quantifies and compares the Mn oxidation ability of different soils. Understanding these differences could improve prediction of the dynamics of Mn applied to soils in irrigation waters. Better understanding these Mn dynamics will assist in the revision of current Mn irrigation thresholds set out in the South African irrigation water quality guidelines.

Materials and Methods

To investigate the relationship substrate type, Mn oxidation and differing oxidising environments have on the MOP of soils, an Mn batch sorption study was performed and monitored over the period of a month and quantitative Mn recoveries measured. The following soils were used: sand, Mn oxide coated sand, andesitic and dolomitic derived soil. The soils were equilibrated with 495 mg/L Mn (II) solutions. Two experimental pathways were followed. The solutions were kept oxygen saturated by aerating and redox potentials monitored daily. Mn sorption was determined after 45 days after the soils were subjected to 1M KCl and 0.1M NH,OH-HCl in 0.01M HNO_3 extractions to quantify the extent of heterogenous Mn oxidation by the different soils. A subset of samples was subjected to oxidation for 15 days after which aeration was terminated and increasingly reducing conditions were achieved.

Results and Discussion

Soils have varying Mn (II) oxidising potentials (MOP). MOP of soils is an index indicating the Mn (II) oxidation effectiveness of different soils. Based on the results the soils were divided into 2 groups. High MOP soils; Mn oxide coated sand, dolomitic and andesitic soils, which rapidly sorbed and oxidised Mn (II), and low MOP soils; which included the sand.

Conclusions

Soils with higher Manganese (II) oxidising potentials are effective at immobilising Mn from solution, as they have high electron-accepting ability, as one would find when irrigating with Mn-rich mine waters. Soils with low Manganese (II) oxidising potentials would not be ideal to immobilise large amounts of Mn applied with mine-impacted irrigation water. This study recommends that current Mn concentrations in the irrigation guidelines be revised to take the MOP of soils to be irrigated into account.

Stabilization of soil organic carbon within silt+clay fraction in shrub- encroached rangeland shallow soil

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Introduction

The encroachment of shrubs into previously open grasslands reduces the productivity of these grasslands. Intensification of shrub-encroachment affects key functions i.e. carbon (C) cycling and stabilization resulting in reduced herbaceous cover. This reduction in herbaceous cover through livestock trampling and the introduction of shrubs leads to compaction which decreases aggregation (Podwojewski *et al*., 2014). Disturbance of soil aggregates leads to a loss of C physically stabilized in shrub encroached soils. In this study, it was hypothesized that shrub-encroachment does not affect the distribution and stabilization of soil organic carbon (SOC) within aggregates of shrub-encroached plinthic soils.

Materials and Methods

In this study, a vegetation survey was conducted whereby two encroachment sites namely, open grassland (grass dominated) and shrub-encroached grassland (shrub dominated) were selected based on tree density. The average tree density for the open and shrub-encroached grassland sites were 400 and 1300 trees per hectare, respectively. Physical fractionation of surface soil (0 - 5cm) collected from open and shrub-encroached grasslands were conducted to determine the distribution of SOC within macro-and- micro-aggregates. Soil aggregates were categorized into four fractions by a wet-sieving procedure, namely >2000 (large macro-aggregates), 212 - 2000 (small macro-aggregates), 50 - 212 (micro-aggregates) and <50µm (silt+clay).

Results and Discussion

In this study, both open and shrub-encroached grasslands were dominated by the small-large aggregates contributing to 46% and 50% of the aggregates**,** respectively. Greater proportion of the SOC was stabilized in the silt+clay fraction. In this fraction, SOC was on average 133% greater in shrub-encroached compared to open grassland. The greater SOC within the silt+clay fraction is due to greater surface area and more exchange sites for carbon adsorption and organo-mineral interactions.

Conclusions

It can be concluded that the SOC physically stabilized within the silt+clay fraction is protected in the long-term. This accentuates the importance of this fraction as the main factor driving SOC stabilization in shrub-encroached grassland.

Soil moisture monitoring using Citizen Observatory data

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Introduction

Recognition of the need for spatial soil information continues to grow as the advancement in technology increases. Where soil maps had once been seen as primarily serving agricultural and cadastral purposes, increased awareness about the importance of soil's role in environmental systems is driving new demands for better and more diverse digitized soil maps. The technology already available today makes it possible to create soil property maps with greater global coverage, higher accuracy for specific soil properties (e.g. soil moisture), and finer spatial resolution. Soil Moisture (SM) is a key variable in the climate system and a key parameter in earth surface processes. SM is defined as the volume of water content (units (vol/vol) at a particular time within a particular space in the unsaturated layer (temporal record of actual soil moisture in the top-most soil layer (0 – 10 cm) of the soil profile. In this study, SM recorded within these depths was key in understanding the thermal buffering capacity of warming and cooling the environment as well as the amount of available water for biomass production. Therefore, the variance between different soil profiles is critical is in understanding the spatial and temporal soil moisture patterns. Additionally, one of the biggest threats to agricultural land is soil compaction and SM is a principal parameter influencing soil strength, so it is a particularly helpful characteristic when assessing the likely magnitude of the soil shearing resistance and hence the inherent vulnerability of subsoil to compaction. Large datasets have been 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 EASEGrid Soil Moisture, Version 2, but the majority of them still exceeds the 10-25 km resolution. This data cannot provide appropriate information for the land users, so alternative approaches are needed to provide these data. Low-cost 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 as well as satellite data of Sentinel-1 and 2 and indices derived from them. Data of these variables were collected using soil sensors that were systematically deployed across the study area to cover the representative areas. 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 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 and remote sensed imagery of the Sentinel-1 was validated using sensor data.

Results and Discussion

The point soil moisture measurements were gathered, processed, analysed and interpreted. The sensor distribution plan was developed to generate a spatially coherent, and representative data. 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 proved to be efficient to predict soil moisture in a relatively data-rich environment. A spatial map of the interpolated soil moisture reflected the capability of the interpolation methods to obtain the parameter's variation pattern. Digital terrain variables, NDVI and Sentinel-1 data layers explained a significant amount of SM variation. The method can be applied to vegetation-covered areas for time-series of SAR and optical data were recorded. The

reliability of remotely sensed SM products was influenced by the presence of water bodies and rough topography and as such the areas with a smooth topographical surrounding and a low percentage of water bodies were favoured. Therefore, an ancillary dataset was used to derive topographic complexity and wetland fraction at the scale of a satellite footprint but this selection was used only as a starting point to future modelling.

Conclusions

With the rapid development of ground-based earth-observing techniques, we are now able to monitor environmental parameters in real-time, continuously, and with multiple sample points. However, interpolation is still needed to extend the point measurement to the spatial distribution of the corresponding parameter in an area. The satellite remote sensing showed an efficient way of acquiring area Earth-observing data. This investigation tested a statistical method suitable for the detection of soil moisture using sensor data and remote sensed imagery and also further highlighted the need for more investigations into high-resolution data sets to support greater harmonization of professional agricultural needs.

Effects of land use change on soil organic carbon concentrations and quality in the semi-arid Central South Africa

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Introduction

Soil degradation due to unprecedented pressure on food-producing ecosystems triggered the introduction of grassland restoration with an underlying goal to restore soils' productive capacity. Patterns and rates of soil carbon (C) recovery following grassland restoration have been extensively studied in Central South Africa (Preger *et al*., 2010; Kotzé *et al*., 2016); however, little attention was devoted to the integrated use of quantitative and qualitative procedures to appraise the ability of secondary grassland management to recover soil C fractions. This study evaluated effects of land use change on soil organic C (SOC) quantity and quality across three semi-arid agro-ecosystems (Harrismith, Tweespruit and Kroonstad) in Central South Africa.

Materials and Methods

Soil samples were collected from croplands, primary and secondary grasslands at the 0 - 200 mm layer in each agro-ecosystem and analyzed for various soil C fractions (SOC, permanganate oxidizable C (POXC), cold (CWEC) and hot (HWEC) water extractable C, and humic substances (extractable humic substance, C_{EX}; humic acids, C_{HA} and fulvic acids, C_{FA}). The SOC structure was characterized with ^{13}C nuclear magnetic resonance (NMR) spectroscopy with cross polarization magic angle spinning (CPMAS) technique. All analyses were done on bulk soil samples. Humification index (HI = C_{HA}/SOC), polymerization index (PI = C_{HA}/C_{FA}) and alkyl C to O-alkyl C ratio were calculated as indicators of the degree of decomposition.

Results and Discussion

Cultivation of primary grasslands decreased SOC fractions by 27 to 90%, with losses generally following the order: Harrismith > Tweespruit > Kroonstad. These losses were modulated by clay content, climate and C saturation deficits (Bach *et al*., 2010; Preger *et al*., 2010; Baer *et al*., 2015; Kotzé *et al*., 2016). The ^{13}C NMR spectra revealed a slight change in SOC structural composition when O-alkyl C declined with concomitant increase in aromatic and alkyl C due to cultivation, with differences in the range of 1 to 11%. O-alkyl C remained virtually unaltered in Harrismith, suggesting that the O-alkyl C chemical shift region was more dominated by microbially resistant lignin-derived methoxyl C than easily decomposable carbohydrates as opposed to O-alkyl C in Tweespruit and Kroonstad (Kögel-Knabner, 2002). Meanwhile, secondary grassland management restored and even increased some soil C fractions (by 3 – 129%) to represent primary grasslands, especially in Kroonstad. Indicators of the extent of decomposition were marginally affected by land use, and were <1 regardless of land use or agro-ecosystem, suggesting low SOC aromaticity and high susceptibility of these agro-ecosystems to further degradation should the farmers continue to cultivate grassland soils and/or convert secondary grasslands back to arable cropping (Kotzé *et al*., 2016).

Conclusions

This study demonstrates the potential of secondary grassland management to rehabilitate degraded cultivated soils with implications for restoration of agro-ecosystem functions and services.

Susceptibility of urban soils from the Cape Town and Stellenbosch areas to degradation by laundry greywater

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Introduction

Fresh water scarcity due to recent drought in the Western Cape has led local municipalities to encourage the use of domestic greywater for garden irrigation. However, there is little information on the effect of greywater irrigation on soil quality in the Western Cape. Laundry greywater is one of the largest and easiest streams of domestic greywater to capture and apply. The aim of this study was to investigate the impact of liquid and powdered laundry detergent derived greywater on the extent of soil degradation of the five main soil groups from Cape Town and Stellenbosch urban regions.

Materials and Methods

Urban topsoils were collected from across five major soil types [aeolian sands, alluvial deposits, shale-derived soils, granite-derived soils and chromic soils (high-lying red and yellow soils)] occurring in Stellenbosch and Cape Town urban areas identified using ARC-ISCW urban soil maps. Samples were characterised for physical and chemical properties. A soil column infiltration experiment was used to determine the effect of 20 mm laundry greywater application on saturated soil hydraulic conductivity (K_{sat}) and humus removal in comparison to same volume of tap water (TW).

Results and Discussion

Powdered laundry detergent (PLD) greywater had significant negative effects on soil properties compared to liquid laundry detergent (LLD) greywater, due to PLD's high pH (9.95) and 30-fold greater Na content. PLD application significantly enhanced humus removal from all soils compared to TW or LLD. Sandy soils were the most susceptible to humus losses due to PLD (7.5% C lost), while chromic soils were most resistant (1.5% C lost). Application of PLD significantly decreased the K_{sat} of all soil groups (47-82% reduction) compared to application of TW, while application of LLD only significantly reduced K_{sat} of aeolian sands, alluvium and shale soil groups (24 - 54% reduction) compared to TW. Granite-derived soils were most susceptible to K_{sat} reduction (81% reduction) due to PD greywater application, while chromic soils were the least (47% reduction).

Conclusions

It was concluded that PLD greywater should not be used to irrigate soils regardless of soil type, while LLD greywater should be used cautiously, especially on granite-derived soils.

Analysis of soil enzymes and microbial diversity for effective crop production under agroforestry environment in Limpopo and Mpumalanga Province

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Introduction

Diversification and intensification through inclusion of crops in agroforestry-based cropping systems represents a key technology in the drive towards the sustainable intensification of agriculture in South Africa. Functional diversity can be measured to determine the biological status of soil microbial populations, since it relates to the actual or potential activities of organisms that contribute to ecosystem dynamics (Habig, 2019).The objective of this study was to determine the soil microbial community possible effects impeding agroforestry in South Africa.

Materials and Methods

Soil samples were randomly collected from six trial sites in Limpopo and Mpumalanga, namely: Ratombo-Levubu, Safcol Graskop, Safcol Block J4, Safcol Block J25, Serala Georges Valley and MTO plantations at depth of 20 cm. Soil samples were diluted in sterile distilled water and inoculated into Biolog EcoPlatesTM containing 31 carbon sources and a control well, in triplicate. The plates were incubated at 28°C. Respiration of carbon sources was measured twice daily over a period of 5 - 10 days at 590 nm. The functional diversity of the soil microbial populations was determined using the amount and equitability of carbon substrates metabolized as indicators of richness and evenness, respectively. The data were statistically analysed by cluster analyses. Biodiversity was determined using the Shannon-Weaver diversity index and Evenness Index, indicating species richness and abundance, respectively.

Results and Discussion

After data collection and analysis, the results indicated from the Principal Component Analysis (PCA), that microbial communities in the Safcol Graskop site clustered separately from all the other sampling sites, while no clear clustering could be distinguished between the remaining sites. These results depict the carbon source utilization of the soil microbial populations present, clearly indicating differences in Carbon substrate utilization profiles between the different sampling sites, also implying differences in microbial functioning between the different sampling sites. The biological soil health seems to be more favourable at the Georges Valley and Ratombo sites due to the high microbial diversity and activity, compared to all other sites. Consequently, the latter sites might hinder crop production directly through lower mineralisation rates, or indirectly through the presence of a low microbial diversity.

Conclusions

In conclusion, it is recommended that trends in CSUP and enzymatic activity be monitored over an extended period of time in order to attain a complete reflection on the impact of different crops practices on microbial diversity and activity as soil health indicator.

Vital soils for sustainable intensification of agriculture: A chronosequence approach to organic agricultural research

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Introduction

Research is increasingly directed to agricultural practices that reduce environmental burdens while maintaining productivity. Organic agriculture encompasses a variety of management practices with long histories of application, especially in Europe, offering insights into practices with potentially wider application.

Materials and Methods

The project Vital Soils for Sustainable Intensification of Agriculture investigates the dynamic changes in soil biology and function after conversion from conventional to organic production. A network of 37 operational organic farms has been selected in the Netherlands, on either sandy or clay soils. Each represents a known period of time since conversion and is paired with a nearby conventional field with comparable history and soil. These pairs of farms constitute a novel chronosequence of organic agricultural management spanning a period of 60 years of organic production. Soil was sampled from all the farms, with subsequent chemical, physical and biological analysis as well as functional assays.

Results and Discussion

The chronosequence displays differences in soil microbial community diversity and nutrient cycling, and interactions between biotic and abiotic conditions and management. The investigation of operational farms is extended by observations under more controlled conditions at the Vredepeel long-term experimental farm (13-year organic/conventional comparisons) as well as targeted laboratory experiments to support mechanistic interpretation of soil biological processes.

Conclusions

The presentation provides an overview of the project and its current outcomes. These offer new insights into the soil biological effects of alternative agricultural management, and the potential implications for soil function.

On-farm measurement of water and nutrient use efficiencies of potato-based rotation systems in North West Province

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Introduction

High water use efficiency (WUE) and nutrient use efficiency (NUE) has a direct impact on yield and profitability and is essential for ecological sustainability of production. Little is known, however, on the WUE and NUE of potato (*Solanum tuberosum* L.) rotations in different production regions of South Africa. This study was conducted to quantify existing WUE and NUE of potato farms in the North West and to evaluate nutrient carry-over effects to the subsequent crop in rotation. It is therefore the first study of its kind in South Africa.

Materials and Methods

Five potato fields were monitored during the 2017/18 summer season, and one field monitored during the 2018/19 season. Follow-up crops of paprika (*Capsicum annuum* L.), groundnuts (*Arachis hypogaea* L.) and onions (*Allium cepa* L.) were planted and monitored during the 2018/19 season in three of the fields. Surveys and field measurements were conducted regarding fertilizer type and application rate for both potato and follow-up crops. Flow meters and pressure transducers were used to monitor irrigation. Drainage lysimeters were installed to monitor drainage and nutrient leaching. Soil and plant samples were taken for nutrient analysis. Final yields of potato and the follow-up crops were determined at harvest. Yields were used to calculate WUE and NUE.

Results and Discussion

Results revealed that all potato fields received relatively large quantities of macro- nutrients, with average rates of 300 kg N ha^{-1}, 220 kg P ha^{-1}, 386 kg K ha^{-1}, 580 kg Ca ha^{-1}, 252 kg Mg ha^{-1} and 99 kg S ha^{-1}. Average nutrient inputs applied to follow-up crops were quite similar to potato input rates. Irrigation applied to potato fields varied greatly and ranged from 590 – 1011 mm (average 866 mm) per season, while that of the follow-up crops was between 805 – 1526 mm (average of 1155 mm) per season. Fresh tuber yields ranged from 60 – 93 t ha^{-1} (average 83 t ha^{-1}), and WUE ranged between 53 – 124 kg mm^{-1}. An average paprika dry fruit yield of 5.5 t ha^{-1}, groundnut dry grain yield of 3.4 t ha^{-1} and onion fresh bulb yield of 75 t ha^{-1} were obtained. Drainage of 415 mm was measured in one potato field and leaching of 29 kg N ha^{-1} N, 20 kg K ha^{-1}, 484 kg Ca ha^{-1}, 179 kg Mg ha^{-1} and 129 kg S ha^{-1} was recorded. The other fields had a chalky layer between 0.80 and 1.00 m depth, which probably restricted drainage. Partial factor productivity of N, P and K was quite similar for all potato fields, with average values of 288, 379 and 229 kg tuber kg^{-1} of applied nutrient, respectively.

Conclusions

High levels of water and nutrients applied to potato and the follow-up crops were not necessarily proportional to crop yields for some fields, which led to a large variability in WUE and NUE among fields. There are clearly opportunities for growers to improve WUE and NUE in potato and the follow-up crops in the North West Province.

Soil spectral characteristics and their predictive value in relation to spatial and temporal variability in wheat yield and soil quality within a long-term field trial

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Introduction

Spatial variations within short distances in the field continue to be a limiting factor in obtaining reliable and accurate results in experimental trials. The field of agriculture is facing an escalating demand for databases from a regional to a worldwide scale that will help agriculturists understand the impact of these variations. To make such data available is expensive and involves tedious and labor-intensive approaches. Rapid and cost-effective tools to measure soil properties and crop yields are required. Soil spectroscopy has been reported to be fast, non-destructive, cost-effective, environmental-friendly analytical technique.

Materials and Methods

The study aims at evaluating the use of soil spectroscopy in predicting common selected soil properties (CEC, SOC, pH, Ca, bulk density) and wheat yield, as well as exploring its potential in explaining the spatial variations in the field. The experiment was conducted as a long-term ongoing trial at the Langgewens research farm, Western Cape Department of Agriculture. The trial was laid out in an incomplete block design structure, across a 12 ha area made up of 3 cropping systems with varying degrees of crop diversity and 4 replicates allocated in 120 plots. Soil properties were analyzed using laboratory methods. Soil samples were scanned to acquire the near-infrared (NIR) spectral signatures using the Fourier transform NIR spectrometer. NIR spectral signatures were pre-processed following two procedures; de-noising and data transformation before performing multivariate data analysis.

Results and Discussion

The partial least squares regression (PLSR) method was used to develop models to establish the relationship that the NIR spectra have with wheat yield and soil properties. Prediction results were fairly accurate and falling on the acceptable ranges. For the selected models, most correlation coefficients (R^2) ranged between 0.80 and 0.60 with ratio of performance to deviation (RPDs) between 2.38 to 1.6. Temporal spatial variations were also assessed in wheat yield and changes in 5 cm soil spectral characteristics in the field trial area after four years (2015 to 2019). In overall, a significant difference was obtained between the average spectral absorbance of the two years ($P<0.05$), an increase in absorbance for the year 2019 was observed. Bulk density was observed to have significantly decreased across the field ($P<0.05$). A decrease in soil organic carbon ($P<0.05$) was observed as well as in soil organic carbon stocks.

Conclusions

The results obtained in this study show that spectral characteristics in the NIR region may be a good indicator of not only soil properties but also plant responses to the changes in soil properties across the field.

Accumulation and distribution of soil organic carbon in Oxisols, Tshivhase Estate, Limpopo province.

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Introduction

Land use change from undisturbed forest to tea plantation may lead to accumulation or loss of soil organic carbon (SOC). The factors controlling vertical distribution of SOC under long-term establishment of tea plantation remain poorly understood, especially in Oxisols. Long-term tea plantation has been reported to lead to soil degradation in different forms including chemical, physical and biological degradation. (Alekseeva *et al*., 2011). Degradation of soil through acidification has been reported to decrease tea yield quality by 15%. It was hypothesized that tea plantation did not influence SOC in Oxisols across different topographic positions.

Materials and Methods

Different topographical positions of the Tshivhase Tea Estate and undisturbed forest i.e., upslope, mid-slope and downslope were sampled, with three 1 m profiles in each land use varying according to the topographical positions. We quantified the vertical distribution of SOC on Oxisols under tea plantation compared to adjacent undisturbed forest soils at different topographic positions, and determined controlling edaphic factors.

Results and Discussion

SOC was greater in tea plantation compared to undisturbed forest soils and declined with depth across all topographic positions. SOC was positively correlated with heavy metals; manganese ($r = 0.62 - 0.83$; $P<0.05$) and copper ($r = 0.45 - 0.69$), effective cation exchange capacity (ECEC) ($r = 0.72$) and mean weight diameter (MWD) ($r = 0.72 - 0.73$), while in the subsoil SOC was positively correlated with copper ($r = 0.89 - 0.92$) and zinc ($r = 0.86$), ECEC ($r = 0.56 - 0.69$) and MWD ($r = 0.48$). These relationships suggest that SOC in Oxisols is chemically stabilized via complexation with polyvalent cations and heavy metals, and physically stabilized by soil aggregates.

Conclusions

In conclusion, tea plantation increased SOC in Oxisols across the varying topographic positions. In both land uses, SOC decreases with depth across the topographic positions. An improved understanding of edaphic factors controlling SOC in Oxisols is important in sustainable tea plantation management.

Disaggregation of Land Types map: Why bother and how much could it cost?

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Introduction

The Land types map was published at 1:250 000 scale and presents soil information aggregated into a Land Type polygon. Each polygon is accompanied by a topo-sequence diagram describing allocating unique or multiple soil types to a portion of the catena. Most of these topo-sequence diagrams were produced as a true section of 1:50 000 topo-cadastral maps and as such with various degree of accuracy may be re-scaled back (disaggregated) to 1:50 000 scale roughly corresponding to 30 m grid resolution. In principle, the diagrams formulate one-dimensional distribution rules, which may be formalized. This may allow for rule-based disaggregation through knowledge formalization.

Materials and Methods

This work is purely theoretical and is based on review of literature, and analysis of Global Soil Grids, DSMART disaggregation and semi-automated disaggregation undertaken by several soil scientists. The main line of thought is based on the process and outcomes of the SA-EU dialogue conducted in 2018.

Results and Discussion

The results obtained through experimental work of various researchers carried out by different South Africa surveyors show relatively poor accuracy of predictions (around 60% at best) by virtually all currently available disaggregation methods. The changes in soil classification and limited data collection in the country is aggravating the problem, since the identification of a soil class is often the main and sometimes - the only data that is being collected by surveyors conducting detailed work. The increasing detail of classification reduces the probability of correct class identification and overall accuracy of disaggregated map. The pathways to improve accuracy of Land Types disaggregation are discussed.

Conclusions

A soil map of South Africa at 30m resolution may be produced through disaggregation of legacy Land Types map using either rule-based mapping and / or machine learning algorithms relying on supplementary information from detailed surveys conducted throughout the country.

Effect of zeolite as a soil amendment on the performance of cabbage (*Brassica oleracea* Var. *capitata L*)

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Introduction

Poor soil fertility and irrigation water shortage are challenges to the production of cabbage. Farmers find different ways to address these challenges. Zeolite is a soil amendment, which can be used to increase the water retention ability of the soil and enhance more effective fertilizer consumption of crops (Xiubin and Zhanbin, 2001). However, information on zeolite use for crop production in South Africa is scarce. The objective of the study was to assess the effects of zeolite on the growth, yield and nutritional quality of cabbage, soil chemistry, as well as the water retention ability of zeolite in sandy soil.

Materials and Methods

A greenhouse pot experiment was carried out at ARC Infruitec-Nietvoorbij, Stellenbosch (33.914476° S and 18.861322° E) on cabbage grown in sandy soil. The experiment consisted of four treatments, replicated six times, and laid out in a randomized complete block design. Zeolite was applied in the ratios 0:10, 1:9, 2:8, 3:7 zeolite to sandy soil. Irrigation water was maintained above 50% field capacity. Standard soil chemical analysis was carried out prior to planting and again at harvest. Number of leaves, plant height, leaf length and width, and leaf area were measured from three weeks after planting. Yield was measured at harvest.

Results and Discussion

An increase in zeolite application resulted in an improved pH and total K of the soil. Despite a decrease in P with higher application rates of zeolite, the P was still within normal range for crop production (Horneck *et al*. 2011). Nitrate-N remained unchanged whereas ammonium-N increased at 10% and 20% zeolite application rate. Zeolite had no significant effect on plant height, leaf area, head circumference, diameter and fresh mass ($p>0.05$) of cabbage. However, dry matter content of cabbage head increased with increase in zeolite application. The amount of applied irrigation water decreased with increased zeolite, showing the water retention ability of the soil conditioner. In general, no treatment performed better than the other in terms of nutritional composition. However, zinc and boron were higher in the 0% zeolite treatment. The nutritional values obtained for cabbage head in this study were comparable with those of traditional or wild vegetables.

Conclusions

Due to the ability of zeolite to raise soil pH to near neutral range, the use of zeolite should be further explored as a potential liming material. Zeolite contributed to improving soil water holding capacity of pot-grown cabbage while 30% zeolite application improved dry matter contents. ·Zeolite amendment did not improve growth, yield or the nutritional value of cabbage.

Potential of conservation agriculture to sequester carbon in cultivated maize and wheat fields

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Introduction

Carbon (C) sequestration results in positive consequences for soil quality, and also positively impacts on climate change by removing carbon dioxide from the atmosphere. Conservation agriculture (CA) is widely advocated as an alternative farming practice that can increase soil organic carbon (SOC). As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), South Africa has pledged to reduce its greenhouse gas emissions by 34% by 2020 (EDF, 2015). In this study, we aim to quantify the potential of CA to sequester C, thereby contributing towards climate change mitigation efforts.

Materials and Methods

To evaluate the change of SOC as a result of CA, we used published data on SOC content in conventional ploughed soils vs CA treatments, and calculated the manipulation effect (Guo and Gifford, 2002). To estimate the area under maize and wheat cultivation and naturally occurring SOC levels, we used databases such as the National Soils Database (ARC-ISCW, 2008). Values were overlaid and extracted per agro-ecological zone to account for climatic gradient. Using default values for bulk density and C losses under cultivation we could quantify the potential loss of C under conventional tillage, and subsequently, the amount of C sequestrated under CA systems.

Results and Discussion

Preliminary results show that CA has the potential to increase SOC by 17% during an initial period of approximately 7 years, should production move away from conventional tillage. Maize and wheat fields could potentially sequester 0.8 t C ha^{-1} yr^{-1}, resulting in a total of 7040 Gg C sequestered in a period of 8 years.

Conclusions

Implementing CA farming practices could raise C stocks of South African soils and present a viable mitigation option that would enable the agricultural sector to meet its reduction targets. These preliminary but evidence-based estimates could be improved by more representative research, including studies in various agro-ecosystems and under different cropping systems.

Identifying sources of suspended and deposited sediment at a sub-catchment level of the Caledon river basin

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Introduction

Accelerated soil erosion is a global concern that has threatened our natural water systems and freshwater reservoirs through sediment deposition. Therefore, reliable quantitative information on ne-grained sediment sources are required to help target remedial actions to mitigate the impacts of excessive sediment build up into the river channel and water reservoirs. Sediment fingerprinting approaches have been used to provide catchment-scale sediment source information, but there is paucity of information about the underlying dynamics behind its application in SA and conditions thereof. The current research attempted to locate sources of deposited and mobilised sediment at the sub-catchment level of the Caledon river basin (Free State province) using the sediment-fingerprinting approach.

Materials and Methods

Fieldwork involved the collection of representative samples of both source material and the suspended sediments at a sub-catchment level of the Caledon river basin. Source samples were collected from six land use/land cover (LULC) classes: channel banks/gullies, cultivated/cropland, bush/shrub-land, grass/pasture, plantation, and settlement. Suspended samples were collected at deposition sites and at the outlet of the sub-catchment. Quantitative geochemical fingerprinting techniques and a mixing model were employed to estimate the relative contributions of sediment from the six sources to the suspended sediment loads. The provenance of source types was discussed in terms of the mean contributions and potential seasonal, inter-and intra-storm variations in the relative contributions of surface erosion from distinct LULC classes and of channel erosion to the suspended sediment load.

Results and Discussion

On this basis, the sub-catchment wide average median sediment source contribution was found to be 35±1% (grass/pasture), 3±1% (cultivated/cropland), 32±1% (channel banks/gullies), 17±1% (settlements), 8±1% (plantation), 5±1% (bush/shrub-land) sources. Results showed unambiguously that during base flow, grass/pasture contributed large quantities of sediment, while channel banks/gullies were the dominant sediment source during high flow. Contributions from the lower main gully decreased before stabilising, while those from the upper main gully increased before decreasing, and those from other sources all increased before stabilising. This indicates that the connectivity of sediment source areas within the sub-catchment changes between the base and high flow conditions.

Conclusions

It was observed that, although grazing occurs over only a small portion of the total sub-catchment area, grass/pasture and channel/gullies are an important source of sediment in this fluvial sub-catchment system. Efforts to reduce fluxes of fine sediment should focus on controlled grazing and channel banks within heavily grazed reaches of the stream.

Infrequent tillage could be used to reduce nutrient stratification in conservation agriculture systems

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Introduction

Prolonged tillage practices with a mouldboard plough are detrimental to soil quality and crop productivity. Many farmers are therefore adopting conservation agriculture practices, with minimal soil disturbance, which have led to improved soil quality and crop productivity but are associated with nutrient stratification. Researchers have contrasting views on the impact of prolonged no-tillage practices on soil quality and nutrient stratification. Some researchers claim that single cultivation of a no-tillage camp can reduce soil quality. This research aimed to assess the effects of long-term no-tillage as well as infrequent tillage in a no-tillage regime, on soil nutrient characteristics and stratification of carbon, phosphorus and potassium.

Materials and Methods

The research was conducted on a long-term trial site at Langgewens Farm in the Western Cape. Seven tillage treatments (mouldboard plough at 200 mm depth; tine-tillage at 150 mm; shallow tine-tillage (ST) at 75 mm; no-tillage (NT); ST every second year with NT in between (ST-NT); ST every third year with NT in between (ST-NT-NT); and ST every fourth year with NT in between (ST-NT-NT-NT)), were investigated. The trial site had 56 plots, each measuring 50 x 6 m. Six soil cores (Ø 45 mm) were randomly collected per plot in April 2018 at depths of 0 - 50, 50 – 100, 100 – 150 and 150 – 300 mm depths for soil nutrient analysis.

Results and Discussion

The quantity of Ca, Mg, P, and soil characteristics pH, acidity and CEC in a no-tillage regime were not significantly different from those in the ST-NT-NT-NT treatment. The mouldboard treatment did not cause soil carbon stratification, but the no-tillage treatment did. The mouldboard plough caused soil inversion, hence the soil carbon was evenly distributed in the top 300 mm. The no-tillage treatment did not mix the soil, resulting in nutrients on the top surface remaining there for a long time. Soil carbon stratification in a no-tillage system was reduced by the introduction of a shallow tine-tillage treatment. Both the no-tillage and ST-NT-NT-NT treatments led to similar distribution and stratification of phosphorous. The distribution of potassium was not affected by tillage treatments. It is hypothesised that the stony, sandy loam soils of Swartland do allow the movement of nutrients, including phosphorus. There was no significant difference in wheat yield for the no-tillage (1160 kg/ha) and ST-NT-NT-NT (1179 kg/ha) treatments (after wind damage). Potential yield for the two treatments was 4257 and 4444 kg/ha respectively.

Conclusions

The infrequent tillage treatment ST-NT-NT-NT did not affect wheat yield and may be used to prevent soil carbon stratification. However, the success of the infrequent tillage may not be universally applicable and will likely depend on soil type.

Relating the South African soil classification system with the World Reference Base

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Introduction

Soil classification aims to organize knowledge; give maximum knowledge with least cognitive effort; map the environment; reveal and understand relationships among individuals and classes; serve as the basis for research and experimentation; and to establish groups or subdivisions. Various national soil classification systems exist, mainly due to regional soil differences. Conceptually it would be possible to relate national soil classification systems with the two internationally recognised systems: The World Reference Base for soil resources (WRB; IUSS Working Group WRB, 2015) and Soil Taxonomy (Soil Survey Staff, 2014). Such a relation will enable pedologists to make accurate WRB classifications, without necessarily being conversed in the WRB and would provide guiding principles in the development of the national classification systems. The South African taxonomic system classifies soil into 74 soil forms at the highest level, each of which is classified at the second level into soil families, unique for each soil form. This research reports on a desktop study to relate each soil family to a WRB reference soil group, with its relevant principal and secondary qualifiers.

Materials and Methods

Soil profile description and analytical data from the land type survey of South Africa (Land Type Survey Staff, 2004) were used in the evaluation of the relations and correlations between the SAT and WRB diagnostics. Subdivisions of master horizons were counted separately during the calculation of statistics. Horizons that had only partial data were included, while those that have all data fields empty were excluded from the analysis. Obviously extraneous values were deleted. Effective base saturation (EBS) was calculated as Sum of basic cation x 100 / (Sum of basic cations + Exchangeable Al). An inherent shortcoming of using the land type database is that the land type survey was done using the 1977 (Macvicar *et al*., 1977) classification, while the discussion here focuses on the 1991 (Soil Classification Working Group, 1991) classification. This was considered a minor drawback, since the majority of the horizon diagnostics remained fairly similar between the 1977 and 1991 versions, while the biggest change was at the soil form and soil family level.

Results and Discussion

Some of the diagnostics (e.g. podzol B and prismacutanic B) relates very well to the WRB diagnostics and can therefore be easily classified. Others (e.g. organic O, the yellow brown apedal B, red apedal B, neocutanic B) does not relate directly to WRB diagnostics and can therefore not easily be classified.

Hydropedological response in a Savannah hillslope under different precipitation regimes

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Introduction

Soil water is the link between precipitation and ecological systems. It is therefore critical to understand exactly how soil water regimes are affected by changes in the precipitation. This is especially true for the variable water regimes of Savannah ecosystems. Therefore, understanding the effects of precipitation on soil water was the central goal of this paper.

Materials and Methods

The hydropedological behaviour of a catena in the Stevenson Hamilton Research Supersite in the Kruger National Park was configured in the Catchment Monitoring Framework (CMF). The model was parameterised using measured hydraulic properties of the soils, and calibrated and validated using measured soil matric potentials and derived actual evapotranspiration (aET) data. The model was then used to simulate hydropedological response under five different precipitation scenarios, ranging from 30% drier than the normal to 30% wetter than normal rainfall. The scenarios also included rainfall years with fewer, but larger rain events.

Results and Discussion

In general, the model performed well with R-values ranging between 0.66 and 0.87 and between 0.58 and 0.69 for correlations with daily soil matric potential and daily aET respectively. Scenario analysis indicates non-linearity in the response of hydropedological parameters against changes in precipitation. Soil matric potential, the duration and volume of return flow from the seepline, overland flow and percolation from the riparian zone will decrease between 26% and 85% under a drying climate. An increase of between 13% and 700% is expected in some of these processes under wetter climatic conditions.

Conclusions

This paper presents realistic predictions of the potential impacts of precipitation changes on hydropedological processes in an important area in the Kruger National Park. These predictions will enable decision makers to be prepared for the anticipated in near surface hydrological processes.

What is new in the new classification system?

Presenter: GM Van Zijl (george.vanzijl@nwu.ac.za)

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Introduction

The Soil Classification Working Group (SCWG) published a new classification system: Soil Classification: a natural and anthropogenic system for South Africa in 2018. This classification system has recently been ratified by the board of the SSSSA. This presentation will deal with the changes from the 1991: Soil Classification: A taxonomic system for South Africa to the new system.

Materials and Methods

The major change to the 2018 edition is that the man altered soils now have their own classification system, and are not all accommodated under the Witbank soil form. Furthermore, the rigid structure of the past has been changed to an open ended system, whereby any soil encountered in the field could be classified. However, the method of determining soil forms by sequence of horizons have stayed. Most of the diagnostic soil horizons have remained, although the diagnostic criteria have been altered. The new system is comprised of 6 topsoil horizons and 28 subsoil horizons, making up 135 soil forms, while the 1991 edition was comprised of 5 topsoil and 25 subsoil horizons, contributing to 73 soil forms.

Results and Discussion

It is intended that the new soil classification system will allow for more information to be transferred when using a soil form name, as more information has been included into the soil name. The structure is also more versatile, and will prevent soil observations "being rubbed into" soil classifications. There is also a method given on how anyone could suggest new soil forms for consideration by the SCWG.

Conclusions

The new soil classification system keeps the principles laid down in the two editions published previously, but allows for much greater freedom and precision in naming soils in the natural condition. As such, more precise information could be transmitted by using soil form names between users.

Saving urban infrastructure from water damage: Digital soil mapping combines with hydrological modelling to determine remedial actions

Presenter: GM van Zijl (george.vanzijl@nwu.ac.za)

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Introduction

Urban developments are often negatively influenced by the hydrology of the area, which decreases property value and drives up maintenance costs. Using hydropedology correct remedial measures can now be prescribed, by determining the source and quantity of water influencing infrastructure. However, soil mapping methods falter in urban settings, due to the infrastructure already built. This project shows how digital soil mapping methods used old satellite images to create a soil map of Cosmo City a suburb within the City of Joburg experiencing severe water damage. The soil map was then used to model water flow, from which remedial actions could be prescribed.

Materials and Methods

A soil map was created by combining soil observations a DEM and satellite images from 2004, before construction within Cosmo City began in a machine learning digital soil mapping method. The resultant hydropedological soil map was used as basis for hydrological mapping with SWAT and Hydrus to determine the source and quantity of water creating the infrastructural damage.

Results and Discussion

The hydropedological soil map achieved a 80% validation point accuracy, which is sufficiently accurate for the mapping. The map indicated that large areas of the developments are built within interflow zones and will experience water damage to infrastructure. The hydrus model indicated that a subsurface drain must have the capacity to remove 300*l/s* to prevent the structural damage at Kampala Crescent, a point highly influenced by hydrology. Furthermore, the SWAT model showed that the higher surface sealing under urbanization lead to an increase in water runoff, a decrease in infiltration and a decrease in percolation.

Conclusions

Digital soil mapping, together with hydrological modelling proved to be a powerful combination of tools to determine adequate maintenance measures for hydrologically damaged infrastructure. Using pre-construction dated satellite images allowed for a soil map to be created even though infrastructure has been established.

Making fertilizer recommendation based on soil sorption capacity and soil P test efficiency: Comparison of Phosphate Buffering Capacity, single-point sorption test and incubation methods

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Introduction

When making fertilizer recommendations the P sorption capacity of the soil needs to be incorporated. Phosphate sorption can be described most commonly by the Freundlich isotherm. A quick and simple incubation method simulating field conditions would be a more practical approach. Such an estimate of sorption can then be used to adjust the amount of P fertilizer required. The objective of this study is to compare a multiple point estimate of sorption with a single-point estimate, and a simple incubation method that was developed in this study.

Materials and Methods

Ten soils were selected based on expected P sorption capabilities. Soils were sampled at a depth of 0 – 300 mm. Estimates of sorption were derived by fitting the Tempkin, Freundlich and Langmuir equations. Phosphorus buffering capacity (PBC) was determined from the sorption curve as described used by Burkitt *et al* (2002). The Freundlich equation was selected in estimating single-point sorption indices, samples with equilibrated with 1000 mg P kg^{-1}. An incubation trial was conducted, Samples were incubated with five rates of P (0, 50, 100, 150 and 200 mg P kg^{-1}), in the form of KH_2PO_4 for 6 months. Soil samples were taken at 7 days, 30 days and 6 months and extractable Bray II, Mehlcih III and Olsen P was determined.

Results and Discussion

By using the untransformed variation of the Freundlich equation and using the two distinct manually selected values for b the best results were obtained. The single point estimate of PBC correlated significantly with PBC. However, this predicted estimate of sorption is not reliable. A strong linear relationship existed between applied P and percentage extractable P using the incubation method. It was found that the percentage extractable P at rates (100 – 150 mg kg^{-1}) correlated highly significantly with the percentage extractable P. Bray II extractable P only significantly decreased after 1 month.

Conclusions

The single-point estimate of sorption could not be used as a reliable estimate of sorption. Through incubating a soil sample with 100 - 150 mg P kg^{-1} an accurate estimate of percentage extractable P could be determined. Therefore, it is possible to get an estimate of the amount of applied P that will be plant available with a single-application incubation method allowing for 24 – 72 h of equilibration.

POSTER PRESENTATIONS – HORTICULTURAL SCIENCE

LISTED ALPHABETICALLY

1) Susceptibility of avocado fruit to *Scirtothrips aurantii* (Faure) (Thysanoptera: Thripidae) and wind scarring damage in Limpopo and KwaZulu-Natal Provinces of South Africa

Presenter: G.T. Bara (baragtt@gmail.com)

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Introduction

In South Africa,avocado is an important fruit, grown primarily for export and contributing ZAR 1.75 billion to the gross domestic product of the country. As an export driven industry, optimising exportable avocado fruit volume is a primary concern. Wind induced abrasion and thrips through their feeding on avocado fruit result in corky tissue development (scarring) and making the fruit unsuitable for export.

Materials and Methods

This study was carried out at three areas each of the KwaZulu-Natal and Limpopo Provinces, 27800 fruits from 'Hass', 'Pinkerton', 'Fuerte' and 'Rinton' were randomly sampled from in field assessments from the two provinces. Each fruit was examined for thrips and wind scarring damage.The pack house study was done during the August – September 2018 fruit packing period. Ten crates of freshly picked, unsorted avocado fruit were randomly selected. A total of 100 fruit were sampled per cultivar. The percentage fruit damage and damage severity was evaluated for each cultivar and expressed as % export grade, % local grade, % reject to quantify damage and assess susceptibility of the cultivars to wind and thrips damage. Scoring data was analysed using non-parametric Kruskal-Wallis rank sum test and pairwise comparisons done using Wilcoxon rank sum test.

Results and Discussion

Wind damage across all the cultivars investigated accounted for 25.33 % downgrading (loss factor %) in Pietermaritzburg (KwaZulu-Natal) which is significantly different to the 3.92 % recorded for Tzaneen (Limpopo). More fruits suffered from wind induced abrasion in KZN (55.06 %) as compared to Limpopo's 8.27 %. When pooled, thrips damage was highest in 'Pinkerton' and the least was recorded in 'Fuerte'. All the cultivars differed significantly from each other. In Limpopo Province, 'Fuerte' was the least thrips scarred avocado cultivar, followed by 'Hass' and then 'Pinkerton'. In KwaZulu-Natal, Rinton had the least thrips scarring. 'Fuerte' scar damage was significantly different to 'Rinton', but was not significantly different to 'Hass'. The highest damage score was recorded for 'Pinkerton'. Site differences were clearly illustrated at Westfalia, Tzaneen when blocks of 'Hass" and "Carmen®-Hass'- were compared. Thrips damage at Macnoon farm, where blocks were close to macadamia were significantly different to a block of 'Hass' which was about 10 km away.

Conclusions

The industry losses 1.49 % revenue annually due to *S. aurantii* downgrading (3.86 % loss factor), translating to ZAR 34.90 million. 'Pinkerton' potentially losses 3.296 % per ton of fruit harvested, followed by 'Hass' (1.878 %), 'Rinton' (0.526 %) and 'Fuerte' (0.035%). Growers are advised to consider site, locality and the presence/absence of macadamia's in the area when selecting cultivars to grow. In wind prone areas', growers can take cultural management measures to minimise wind damage.

2) Interspecific hybrids to optimize variation in new Protea and Leucospermum hybrids for the floriculture industry

Presenter: LM Blomerus (Blomerusl@arc.agric.za)

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Introduction

Three genera of Proteaceae forms the foundation of the South African floriculture industry: *Protea*, *Leucospermum* and *Leucadendron*. These genera are popular around the world, not only amongst florists excited about these niche cut flower products from South Africa, but also amongst producers as commercial flowers. The cultivation of *Protea* was initiated in 1950's, with the first exports form these plantations in 1960's. The domestication of such a native genus usually follow a six phase process characterise by control over the genetic quality of the material, from flowers being used from the wild with no control over the genetic quality of the plant material to biotechnology interventions and the control of single genes. The breeding project of the Agricultural Research Council (ARC) focuses on the exploration of interspecific hybridisation to a level where new hybrids are genetically isolated from the original species.

Materials and Methods

Pollinations for production of interspecific genetic combinations are carefully executed using standard hand pollination protocols, inflorescences are covered and seeds are allowed to mature on the female parental plant.

Results and Discussion

The ARC has already registered several genetically complex cultivars with Plant Breeder Rights, e.g. *Leucadendron* cv 'Lwando' (*L. salignum/eucalyptifolium x L. laureolum*), Leucospermum cv 'Anouk' (*L. cordifolium/patersonii x L. tottum/glabrum*) Protea cv 'Sugar Baby' (*P. repens x P. mundii/lacticolor*). New recombinations hybrids are annually attempted with success, e.g. *P. magnifica/burchellii x P.magnifica/compacta // lorifolia/neriifolia* and Ls*.cordifolium / patersonii x Ls.tottum / formosum.*

Conclusions

It is possible to generate multiple complex hybrids successful through multifaceted controlled interspecific hybrids to produce cultivars that can continuously supply the floricultural industry with new and exciting character combinations to address niche markets.

3) Response of eggplant (*Solanum melogena* L.) to split application of organic and inorganic fertilizers on clay loamy soil

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Introduction

Eggplant is an economic vegetable of nutritional and dietary importance. Little is known about response of the crop to farmyard manure (FYM) and inorganic fertilizers applied in split form on marginal clay loamy soil. Hence, growth, development and nutrient uptake concentration of eggplant as influenced by FYM and NPK 20:3:7 applied at different growth stages on clay loamy soil in North West province, of South Africa was investigated.

Materials and Methods

The field study was conducted during 2017/18 and 2018/19 summer planting seasons at the Research Farm of North West University, South Africa. The study was a 2 x 5 factorial arranged in a split-plot, fitted into randomised complete block design replicated three times. The main plot effect was four soil amendments comprising compost, chicken manure, cattle manure, NPK and unamended plot served as the control. The sub-plot effect was 2 and 3 split application at pre-transplanting, pre-anthensis and anthesis. Data were collected on growth, yield attributes and N uptake. Data were analysed with ANOVA and means separated with LSD at $p \leq 0.05$.

Results and Discussion

Different FYM and NPK fertilizer had significant ($p \leq 0.05$) effect on performance of eggplant whereas split application of the amendment did not affect the crop performance significantly ($p \geq 0.05$). Height, number of leaves, leaf area and branches of eggplant improved significantly on plots supplied poultry manure in two splits relative to the control at all stages in the field study. However, in the greenhouse study eggplant performed better in compost treated pots relative to control. The number of flower produced in NPK treated pots was statistically comparable to compost amended pots. Organic inputs add organic matter to soil and contribute maintenance of soil physical properties. The importance of this as organic fertilizers are good alternative to solving not only soil fertility constraints to eggplant production but also as a respite from environmental pollution emanating from fossil fertilizers. Applying organic or inorganic fertilizers in two splits increased growth and biomass yield of eggplant on clay loamy soil better. This is probably because the time of application coincide with phenological phase when nutrient uptake was efficiently utilized for metabolic processes. The superior results obtained in clay loamy soil supplied poultry manure in two splits could be linked to sufficient mineral nutrient present in this manure over other fertilizer types.

Conclusions

Farmyard manure application improved growth, flower production and nutrient uptake of eggplant better than the unfertilized treatment. The effect of farmyard manure is comparable to NPK fertilizer improving eggplant performance clay loamy soil.

4) A review of postharvest technologies for perishable and semi-perishable produce in developing countries

Presenter: Z Dlamini (zibuyiled@gmail.com)

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Introduction

Research claims that 50% of food wastage is due to postharvest losses (WWF 2017). Food wastage presents a threat to food security and is likely to affect poor communities in developing countries more severely as it translates to a monetary loss of USD 310 billion per year (World bank 2017). Further, global population is projected to increase to 10, 5 billion by 2050 thereby adding to food security concerns (Alexandratos and Bruinsma 2012). An integral part of ensuring food security for the growing global population is to address postharvest losses (Aulakh and Regmi 2013). There is a need to examine the possible causes of postharvest losses in rural communities in developing countries. The study seeks to review a plethora of postharvest methods and technologies used in rural Africa and make recommendations.

Materials and Methods

A meta-analysis of literature focused on postharvest storage technologies used by rural farmers and their shortfalls was conducted. The review draws from studies based on cereals, root and tuber staple crops in developing countries. Different post-harvest processes were examined namely processing, transportation, handling and storage to understand how crops are susceptible to damage, pest infestations and rot. This study was based on both gray literature and peer reviewed journal articles.

Results and Discussion

Approximately 80.4% of the postharvest loss takes place during storage phase (Affognon *et al*. 2015). Traditional methods of storage allow for postharvest quality loss (George 2011). Silos made of mud, wood and straw are among the storage methods utilized in most developing countries (Affognon *et al.* 2015; Nagnur 2006). Mud silos store maize better in dry climates but tend to attract moisture to their walls. Small farmers keep them dry by cooking near them (Goodier 2013). Metal silos, which were first introduced in Kenya, are effective in protecting cereals rot because they allow less aerobic bacterial growth (George 2011). Hermetic cocoon, hermetic bags and polypropylene storage bags are among other storage methods used. Burying sweet potato in sand pits is considered a storage method in West Africa. The root crop can be stored for up to four months in Savanna areas and seven months in the drier areas. An average of 62% of sweet potatoes were consumed, 27% were replanted and 21% were damaged and infected by disease (Abidin *et al.* 2016).

Conclusions

Although rural communities had indigenous strategies to help prevent spoilage, innovations introduced by researchers and NGO's were more effective. Airtight technologies namely metal silos and hermetic bags ensured fresher grain for longer periods. Investigation of microclimate conditions namely temperature and humidity, within traditional storages should be implemented. Analysis should include measurements of carbon dioxide to oxygen ratio to determine whether it has an influence on rate of the food quality loss. Initiatives should be introduced where communities and experts could develop strategies to improve the status quo.

5) Determining the potential of selected herb essential oil production in the Mnquma Local Municipality, Eastern Cape

Presenter: RJ du Preez (rosedup@arc.agric.za)

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Introduction

A feasibility study to determine the potential for essential oil production on four farms in the Butterworth (Mnquma Local Municipality) area of the Eastern Cape was carried out. In essential oil production, the end product quality is of critical importance for successful marketing and profitability and this is strongly influenced by the intrinsic characteristics of the planting stock, soil and climatic conditions and cultural practices. The study assessed the suitability of climate, soil, water, available infrastructure and yield and quality of the oils produced for commercial essential oil production of selected herbs.

Materials and Methods

Trial sites were planted at Waterdale, Teko, Ngqana and Columba farms and normal cultivation practices were implemented. An initial feasibility study was carried out and climatic data, soil and water samples were collected at each site to determine which crops would be best suited for the area. The crops selected for evaluation were rose geranium, rosemary, melissa and thyme. The crops were harvested at accepted maturity. Three replicates were harvested to determine oil yield. No statistical analysis was carried out, as this was a preliminary evaluation to determine suitability of each farm for commercial production. Essential oil was extracted using steam distillation. Yield and quality for each crop were determined.

Results and Discussion

At the four sites, rose geranium essential oil yield varied between 0.15 and 0.26%, which is higher than the accepted yield for commercial production of 0.11%. Oil yield for rosemary ranged between 0.5% and 0.8% with the accepted norm for commercial production being 0.5%. The accepted yield for thyme is 0.3% and yields between 0.16 and 0.3% were obtained. Oil yields of melissa varied between 0.02 and 0.03% with the accepted yield for commercial production being 0.01%. An acceptable oil quality was obtained from all the harvests for rose geranium and rosemary. The oil from the first thyme harvest was acceptable but a poor quality was obtained from the subsequent harvests. Melissa had a variable quality irrespective of harvest time.

Conclusions

The trials conducted clearly show the suitability of the Mnquma region for production of quality rose geranium and rosemary oils. Scaling up to commercial production would be viable, however, a number of issues, apart from the agricultural aspect, would need to be addressed to ensure sustainable commercial production. A scaling up plan was developed for each farm and expansion to commercial production would have a significant economic impact on the area and will complement other initiatives in the Eastern Cape Province to develop a significant essential oil industry.

6) Genetic analysis in Bambara Groundnut [*Vigna subterrenea* L. Verdc.] germplasm using agronomic traits

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Introduction

Bambara groundnut is one of the neglected and underutilized legumes on the African continent (Ntundu *et al*., 2006). It is a major source of protein and is grown commonly by resource poor farmers at subsistence level. In South Africa, the crop is used for food and the enhancement of soil fertility. Information on genetic variability among available local germplasm of Bambara groundnut will increase the efficiency of the improvement programme in South Africa.

Materials and Methods

Field experiments were conducted at the ARC Vegetable and Ornamental Plant at Roodeplaat in 2018-2019 cropping season to estimate the level of phenotypic variability among 24 Bambara groundnut germplasm accessions. The experiment was laid out in a randomized complete block design with three replications. Most important agronomic traits were recorded for each accession such as canopy diameter, plant height, leaf length, leaf width, leaf area, petiole length, days to maturity, hundred seed weight and grain yield.

Results and Discussion

Analysis of variance for the phenotypic traits revealed that differences among the germplasm were highly significant for all traits. This indicated that quantitative agronomic traits differed among the accessions studied. The results of the principal component analysis showed that the first seven principal components contributed 83% of the variability among the accessions evaluated. Leaf area index, pods mass and dry weights are highly associated with the first principal component, while estimated leaf area, actual leaf area, number of pods and fresh weight of Bambara groundnut contributed more to the second principal component. The genetic distances of the germplasm varied from 0.86 to 1.79.

Conclusions

The quantitative traits provided a useful measure of genetic variability among the tested germplasm and will enable the identification of candidate parents for breeding to increase production and productivity, which will contribute towards food and nutritional security. These phenotypic markers can therefore serve as useful tools that can be exploited for use in future breeding programme for the traits.

7) Seasonal rejuvenation of stock plants affect rooting of Honeybush cuttings

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Introduction

Honeybush (*Cyclopia* spp.), a leguminous plant endemic to the Eastern and Western Cape, enjoys increasing popularity amongst health conscious consumers as the herbal infused tea produced from its leaves and twigs has a pleasant honey-like taste, while also being low in tannins (Joubert *et al*., 2011), rich in antioxidants (Spriggs *et al*., 2006) and stimulates the appetite (Watt *et al*., 1962). As Honeybush is relatively slow growing, being adapted to sandy, low phosphorous and acidic soils typical of the Fynbos Biome, alternative production methods to harvesting from the wild is required to ensure that sufficient volume and quality is produced to meet current and future market demanded. At present, honeybush is cultivated by using seedlings. However, to ensure consistently high yield (Gleeson, 2004) and produce more uniform populations of a known high tea quality (Erasmus, 2002) the use of superior, clonal propagated material is of the utmost importance. Major factors identified that is likely to affect regeneration of plants from cuttings are: stock plant management, woodiness of stems selected as stock plants, treatment of cuttings postharvest as well as manipulations of the environment promoting the rooting of cutting material.

Materials and Methods

Clonal plant material of *C. genistoides* was collected from the farm Toekoms near Bredasdorp, Western Cape, South Africa. Stock plants were cutback at four different times during the growth season, namely January, April, July and October 2015, respectively and allowed to regrow for 12 months. A second experiment was done in 2016 were the stock plants were cut back in same four seasons as above. Cuttings were subsequently made from regrowth obtained from stock plants 6 and 9 months after the respective cutbacks were made. Cuttings were prepared by removing the bottom half of leaves, where after the cuttings where soaked in Mancozeb (dithiocarbamate) and the basal 10 mm dipped in $2g.L^{-1}$ IBA powder (Seradix 2). Cuttings were then transferred to polystyrene trays (128 plugs, 90mm deep), filled a mixture of polystyrene beads sand and peat (1:1:1) with a pH of 4 - 5.5. Cuttings were placed in a protective tunnel on a misting bed supplied with bottom heating (18 - 25°C), and misting for 5 - 10 seconds every 10 minutes, for a three month period. A completely randomised block design, with four blocks and eight, terminal semi-softwood cutting replications per treatment was used. After 3 months following transfer to the trays, cuttings were evaluated for rooting success by determining the percentage rooting, primary and secondary root number, also including mean root length and root dry mass accumulation.

Results and Discussion

The time of cutback on stock plants during the season did not impact significantly ($p=0.105$) on rooting percentage, when cuttings were harvested a year later. Cuttings that resulted from the April cutback treatment produced the highest rooting percentage (57.81%), Cuttings made from the April cutback treatment also counted a significantly higher number of primary roots per cutting (3.98) than those produced by the January (1.89) or July (1.12) cutback treatment. The average primary root length of cuttings taken from the July (12.62 mm) and October cutback treatment (14.02 mm) was significantly higher than those obtained from the cutback treatments of either January (5.68 mm) or April (7.42 mm). When stock plants were cut back and allowed to regrow for 6 and 9 months, the time allowed for regrowth generally affected rooting parameters. The highest rooting percentage at 68% was obtained in stock plants that were cut back in April and allowed to regrow for 6 months. However, when regrow was extended for another 3 months, the rooting percentage in the April cutback treatment was significantly decreased by 18% to 50% rooting success. Similarly, stock plants cutback in January showed higher rooting percentages at 48% when 6 month's regrowth was used rather extending the regrowth to 9 months, when rooting % was reduced to 34%. However, when six and nine months' regrowth from stock plants cutback in July (12.5%, 59%) and October (52%, 38%) was compared, a higher rooting percentage was reported when regrowth was allowed to continue for 9 months, compared to that where regrowth continue for only 6 months. A difference of 55% in rooting of cuttings was recorded where stock plants that were cutback in July resulted in 13% compared to the much higher 68% rooting when material with six or nine months was used as stock plants, respectively. Results indicate that 9-month regrowth is required to ensure sufficient rooting, when regrowth occurs during in cooler months. Cuttings from regrowth that initiated in early autumn continued through winter and into spring produced the highest rooting percentage. Plants cut back in April and that was allowed to regrow over a 6 months period, had highest number of primary roots (5). Cuttings made from nine month's regrowth following a July cutback (17.4 mm) or a six (14.0 mm) and nine (13.9 mm) month's regrowth from an October cutback, recorded a significantly higher primary root length per cutting, respectively.

Conclusions

A rooting percentage for Honeybush in excess of 60 % is considered the threshold level to achieve, to be economically viable. When stock plants that are harvested and regrowth was allowed for a 12-month period, generally poor rooting was achieved. However, cuttings made from regrowth that grew through autumn winter and into spring had the gave the highest rooting results. This finding should be explored with respect to what the optimum physiological condition of stock plants should be to ensure strong rooting performance. Further research focussing on reducing transplant shock under field conditions would be key to reduce transport losses and promote successful field establishment.

8) The effect of two pollination methods on improving the efficiency of fruit set of litchi cultivars in a breeding programme

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Introduction

Controlled closed pollination is one of the important methods of conventional breeding and usually involves hand pollination techniques to cross two parents, both demonstrating desired traits (Bally *et al*. 2009). Hand pollination is the manual application of the desired pollen from one parent to the individual stigmas of the flowers of the other parent by using a paintbrush, thereby excluding undesired pollen. The litchi panicle and litchi flowers are not suitable for easy hand pollinations, as the flowers are extremely small. In this study, the paintbrush pollination method, which is used widely for pollination in other species was compared with the hand-blower method to determine if there were any differences in final fruit set.

Materials and Methods

This study was carried out over two seasons at the ARC-TSC (Nelspruit). 'Mauritius' was used as the male parent while KAI ('Kaimana') and FZS ('Fay Zee Siu') were used as female parents. Two pollination methods were used: hand pollination using a small rounded tip painting brush and a blower pollination method using a custom made bottle blower.

Results and Discussion

The main effect of pollination method on fruit set and on seed germination indicated highly significant ($p<.0001$) differences between the blower method, the brush method and the control (open pollination). The use of hand-operated blowers resulted in the highest fruit set (65.70%) of the two methods applied and this method did not significantly differ from results obtained for open pollination (65.75%). Thus open pollinator was to significantly different from the open pollination.

Conclusions

The blower method was confirmed to be the most effective method compared with the brush method over seasons and cross combinations and should therefore be implemented as a breeding tool with regard to the efficient production of large numbers of controlled pollinated hybrids needed in a litchi breeding programme.

9) The effect of site, irrigation and soil on the fruits yield of African horned cucumber (*Cucumis metuliferus* L.).

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Introduction

Water, soil and climate are among the most important factors influencing agricultural practices. There is a need for farmers to determine the optimum climatic conditions and amount of water required to irrigate a specific crop for optimum yield. The aim of the study was to determine a suitable growing regime of *C. metuliferus* L. between the greenhouse, shade net and pots-open area conditions so that a comparative analysis can be done.

Materials and Methods

Different cultivation sites, 1 (greenhouse), 2 (shade net), 3 (pots-open area), soils and irrigation levels were evaluated to determine their influence on the fruit yield of the African horned cucumber (*Cucumis metuliferus* L.). The irrigation levels were well watered (100 % field water capacity), mild watered (75 %) and stress watered (35 %). A 9 × 13.5 factorial pot experiment was laid in a completely split plot randomized block designed at the Florida campus, University of South Africa (Johannesburg). Uniform and healthy African horned cucumber seedlings were transplanted into 30 cm planting pots (loam soil (1) and loam sand-2) for 2 consecutive seasons. Irrigation were imposed until all transplanted seedlings were established. Fruit parameter data (number, weight, length) were collected after harvest. A three-way analyzed analysis of variance (ANOVA) was used. All statistical analysis was done using the Statistica v. 10, StatSoft (USA) software.

Results and Discussion

Results showed that soil significantly ($P \leq 0.001$) affected the fruit yield of African horned cucumber. Plants grown on loam soil in the pots-open area had the highest yield of fruits irrespective of irrigation rate compared to those from other sites. Results also showed that irrigation significantly ($P \leq 0.001$) affected fruit yield of African horned cucumber. For instance, fruits harvested from plants irrigated with 100% and 75% water levels produced more fresh and dry biomass than those irrigated with 35 % water level. In addition, fruits harvested from plants grown in pot-open area and the greenhouse and 100% irrigated had higher fruit length than shade net grown, 35% irrigated plants.

Conclusions

This study advocates that the best combination for optimum yield of African horned cucumber (*C. metuliferus* L.) fruits is pots-open area, 75% irrigation level and loam soils.

10) Response of morphometries and body total protein of *Steirnenema feltiae* biocontrol agent to NEMAFRIC-BL Phytonematicide

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Introduction

After the withdrawal of certain highly effective synthetic nematicides from the agrochemical markets, competing alternative management strategies were introduced for suppression of population densities of pests. In plant-parasitic nematodes, biocontrol agents such as *Steirnenema* species competed with botanicals as potential alternative management products, with limited information on their interactive effects. The objective of this study was to investigate the chemical responses of *S. feltiae* to increasing.

Materials and Methods

Over 500 000 commercial infective juveniles (IJ) of *S. feltiae* were activated in chlorine-free tap water. Approximately 220 IJ were exposed to Nemafric-BL phytonematicide solutions at 0, 2, 4, 8, 16, 32 and 64%, which was replicated 10 times. Post-72 h exposure, specimens were mounted on slides, with selected morphometric data collected. Total proteins were collected from the remaining specimens. Prior to subjection of data to the Curve-fitting Allelochemical Response Dose (CARD) model, concentration data were expressed as exponential series and log-transformed to meet the requirements of normality.

Results and Discussion

Nemafric-BL phytonematicide significantly ($P \leq 0.05$) affected the morphometries of various structures, including the body length and the cuticle thickness, along with the total proteins in *S. feltiae* IJ. Generally, body length versus phytonematicide concentration exhibited positive quadratic relations, suggesting tolerance attributes up to 5.6% phytonematicide concentration, thereafter resulting in the decline of body length. In contrast, cuticle thickness and total proteins versus phytonematicide concentration each exhibited negative quadratic relations. The observed morphological and total protein changes in *S. feltiae* IJ at various phytonematicide concentration, all constitute notable structural damage. However, *S. feltiae* IJ consistently remain tolerant to the product at the non-phytotoxic concentration (1-3%) where the product is used for managing plant-parasitic nematodes (Mashela *et al*., 2017).

Conclusions

At concentration used for managing plant-parasitic nematodes, the cucurbitacin-containing phytonematicides could have effects that negligently stimulate or inhibit the morphometries and total proteins of *S. feltiae* IJ. Overall, findings in the current study showed that the cucurbitacin-containing phytonematicides are structurally damaging in nematodes.

11) Investigations on Various Agro-wastes found in Vhembe District as Substrates for Cultivation of Oyster mushrooms (*Pleurotus ostreatus* (Jacq.:Fr) P. Kumm and *Pleurotus pulmonarius* (Fr.) Quèl)

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Introduction

Oyster mushrooms are primary saprophytes and can grow on uncomposted lignocellulose waste materials unlike species of *Agaricus,* which require composted substrates. Due to *Pleurotus* ability to use various lignocellulose materials, the abundance of various agro-wastes found in local areas that can be utilised directly without any further treatment provides a great opportunity for growing *Pleurotus* species. Therefore, the present study aims to investigate the effect of maize stalks (MS), macadamia husks (MH) and nutshell (MnS), and banana pseudo-stem (BP) on the cultivation of oyster mushroom (*Pleurotus ostreatus* and *Pleurotus pulmonarius*).

Materials and Methods

The study was conducted in a laboratory at the University of Venda's school of Agriculture, which is situated in Thohoyandou Limpopo Province at room temperature. The experiment was laid out as Randomized Complete Block (RCB) design with five replications and five observational bags per treatment. Treatments were (MS), (MH), (MnS) and (BP); *Pleurotus ostreatus* (*P. ostreatus*) and *Pleurotus pulmonarius* (*P. pulmonarius*) were used as planting materials. Substrates of about 500 g was packed into plastic tubing and soaked overnight into solution of calcium hydroxide (150 g) and calcium carbonate (50 g) mixed with tap water filled into a black bin. Measurements recorded on the yield such as number of bags contaminated (NBC), days to flushing (DF) were taken after cultivation and fruiting bodies (FB), stipe length (SL), pileus diameter (PD), fresh weight (FW), number of flushes (F) and period between the flushes (PBF) and biological efficiency (BE) were recorded after flushing. Data was subjected to ANOVA using SPSS (26 version) and means was compared using LSD test at $p< 0.05$.

Results and Discussion

The use of various substrates had significantly affected the yield and BE of both oyster mushrooms (*Pleurotus ostreatus* and *Pleurotus pulmonarius*). Although substrates were significant on the yield of oyster mushrooms, they were not significant difference to all attributes on both *P. ostreatus* and *P. pulmonarius*. However, MnS was more vulnerable to green mould (*Trichoderma* species) as compared to other substrates and as a results, there were no fruit bodies formed. MS of 109.75 g and 47.60 g had a best performance on the yield on *P. ostreatus and P. pulmonarius* respectively. The result of this study is in agreement with Mondal *et al*. 2010 who obtained lower biological yield of 26.39 g per flush and the high biological yield of 164.4 g per flush. The maximum BE was recorded from MS at 22.00% and 9.60% followed by BP (14.00%) and MH (8.75%) on *P. ostreatus* and *P. pulmonarius* respectively. However, this study is supported by Tesfaw *et al*. 2015 who reported BE that ranges from 10.22% to 24.67% within flush 1 to 4.

Conclusions

It can be concluded that maize stalk (MS) is very promising for the cultivation of *P. ostreatus* and *P. pulmonarius*. However, MnS showed poor performance and it also was highly susceptible to green mould (*Trichoderma* species) during period of substrates colonisation and flushing. In case MS is not accessible, BP and MH can be potentially used as substrates in the cultivation of *P. ostreatus* and *P. pulmonarius* respectively.

12) Evaluation of Plant Population, Growth and Yield of Hydroponics tomatoes (*Lycopersicon esculentum* Mill) grown under 50% shade net

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Introduction

Tomatoes (*Lycopersicon esculentum Mill*.) belongs to the family Solanaceae. The need to produce better yield and quality led to innovative ways to manipulate the environment in order to meet the demand. One such innovation is controlled-environmental agriculture (CEA) such as hydroponics, which is envisaged to maximise production in areas where climate or soil type is not conducive to vegetable production.

Materials and Methods

The experiment on F2 Galaxy tomato (indeterminate growth) was conducted at Madzivhandila College of Agriculture with Latitude $22^0$59' 12.8'' and Longitude $30^0$32' 55.3", in a 50% black hydroponic shade net structure of 30 x 17m. The seed trays were filled with growth medium Hygromix®, and covered with vermiculite after seeding. Foliar fertilizer Multifeed® was applied at least twice per week at 1 g/L water. The plants were transplanted from mid October 2018. 4-5 weeks after sowing, seedlings were transplanted into 15L planting bags filled with sawdust subjected to one, two, three and four plant populations per bag in a randomized Completely Randomized Design. Observations were conducted fortnightly starting from four weeks after transplanting (4 WAT) in a Completely Randomized Design. The parameters observed were, plant height, number of leaves, number of flowers, number of fruits and fruit weight.

Results and Discussion

Significant difference in plant height was obtained when one plant was transplanted in the planting bag compared to when two, three and four plants were transplanted in one planting bag from 4 to 14 weeks after transplanting (WAT). The number of leaves per plant increased significantly from 4 WAT to 14 WAT from 12 to 23 leaves with one plant population. Number of fruits per plant increased from 8-14 WAT and more fruits were observed in one plant population than two, three and four plant populations per planting bag. There was significant difference of fruit weight from 12 to 14 WAT on one plant population as compared to two, three and four plant populations per planting bag.

Conclusions

It can be concluded that plant height, number of leaves, number of fruits and fruit weight is influenced by plant population in hydroponic tomato production.

13) Pineapple mealybug (*Dysmicoccus brevipes*) infestation on suckers (used for planting material) of the queen pineapple plant

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Introduction

Mealybugs infest all parts of the pineapple plant, below and above ground, but are mainly found on the lower portion of the stem as well as the basal leaves. It may spread upwards to feed in floral cavities near the peduncle, as well as on crown leaves. The pineapple mealybug (*Dysmicoccus brevipes* Cockerell) is a major pest of pineapples in southern Africa due to its ability to transmit mealybug wilt virus which is a serious disease of pineapples and responsible for severe crop losses. Queen pineapples are replanted using suckers harvested from the plant that have yielded the previous crop (mother plant). Up to 23 suckers of various sizes develop from axillary buds in the leaf axils of the leaves on the aerial part of the mother plant stem. This forms a huge bush of plant material when suckers is ready to be planted 6 – 8 months after fruit harvest. Mealybug infestation can easily be transmitted to a new planting by planting infested material. Knowing the distribution of the mealybug infestation in this complex of plant material is therefore essential for effective control.

Materials and Methods

A pineapple field (100 m long) with planting material ready to be harvested and consisting of 14 ridges (ridge = 1.7 m wide) were divided into 5 m blocks to give a grid of 280 blocks (14 ridges x 5 m x 20). Two plants with suckers were sampled from each 5 m block (one from ridges 1 - 7 and one from ridges 8 - 14). Samples were chosen to give an even representation of the field. Forty plants in total were sampled. Plants were divided in plants with and without mealybug wilt symptoms. Leaves and suckers were then stripped from the mother plant, starting from the roots end and numbered according to their position on the stem. Mealybug infestation were determined on the mother plant stem, as well as on the leaves and their matching suckers.

Results and Discussion

Mealybugs not only occurred on plants with mealybug wilt symptoms, but also on plants without symptoms. Mealybug infestation can occur on leaves and suckers from the base to the top of the stem when a plant is heavily infested with more mealybugs occurring on the suckers than on the leaves. In light infestations, infestation will be more on suckers from the centre to the top of the stem than on the leaves. Infestation can also occur on the mother plant stem in between the aerial roots at the bottom of the stem.

Conclusions

In applying any type of mealybug control on pineapples fields after fruit harvest, the location of the mealybug infestation must be taken in consideration. If using any other means of control than systemic chemical control, penetration of the agent to reach the mealybug infestation will be very important.

14) Effects of irrigation regimes on nutritional composition and phytochemical profiles of *Moringa oleifera*

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Introduction

Moringa oleifera is a multipurpose tree and is widely grown in the tropics and sub-tropics. The aim of this study was to investigate the variability in nutritive values and phytochemical profiles of *Moringa oleifera* as influenced by irrigation regimes.

Materials and Methods

Leaf samples were collected from four-month-old Moringa trees subjected to four different water supply regimes [20, 40, 60% allowable depletion levels (ADL), and a rain-fed treatment] under field conditions at the Agricultural Research Council, in a semi-arid area of South Africa. The leaf samples were lyophilized and used for nutritional and phytochemical analyses.

Results and Discussion

The results indicated that varying water supply regimes had a significant effect on mineral elements. The accumulation of phosphorus, for example, was higher at 20% ADL, followed by 60% ADL compared with other water supply treatments. Similarly, leaves from Moringa trees subjected to 20% ADL had significantly higher levels of total phenolics and flavonoids. Significant variation in β-carotene content was also found with the recorded in leaves from the different treatments.

Conclusions

Overall, the application of varying water supply regimes altered the nutritional and phytochemical profiles of the harvested leaves. Thus, desired phytochemical, nutritional and pharmacological properties of Moringa trees might be orientated by manipulating water supply. The findings indicated that cultivation of Moringa under varying water supply regimes could affect the production quality of the raw material obtainable from Moringa and their subsequent products.

15) Stimulatory effects of plant growth regulators on kiwifruit (*Actinidia* spp.) stem cuttings at low, medium and high concentration levels, with special reference to Indole-3-butyric acid

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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 incidents of seed-borne diseases and prolonged juvenile phase where gender cannot be segregated for inter-planting purposes. Most of these challenges could be overcome through vegetative (asexual) 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 hypothesis that the concentrations of PGRs used were outside the stimulation phase for callus formation in the genus *Actinidia*. The objective of the study was 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. argute* and *A. chinensis* were harvested from cultivated kiwifruit plants after fruiting. The bases of the SC were treated with Indole-3-butyric acid (IBA) concentrations for 10 seconds (2500, 5000, 7500 and 10000 ppm) in liquid form and raised in a pasteurized sand and Hygromix (3:1 v/v). Pots with cuttings were kept on benches in a greenhouse for a period of 4 months before the assessment for formation of roots. Both *A. argute* and *A. chinensis* cutting experiments were laid in a randomized complete block design (RCBD), with 5 replicates (n = 25). 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

For survival of stem cuttings, in *A. argute* and *A. chinensis* no significant ($p \leq 0.05$) differences were observed between the control and the IBA concentrations in all parameters measured. Highest survival percentage of SC (85%) was achieved in *A. argute* at the highest IBA concentration of 10000 ppm, whereas in *A. chinensis* maximum survival of stem cutting (40%) was obtained at the application of higher IBA concentration of 7500 ppm. Survived *A. argute* 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. argute* SC. In *A. chinensis*, 5000 – 10000 ppm IBA treatments resulted in callus development, but without the development of adventitious roots. At lower IBA concentrations (2500 ppm) *A. argute* did not root, similarly to observations in other *Actinidia* species (Ercisli *et al., 2002;* Ono *et al., 2000).*

Conclusions

Semi-hardwood cuttings of *A. argute* responded to all IBA treatments. The treatment with highest concentration (10000 ppm) showed better rooting response with respect to the quality and the number of the roots. However, *A. chinensis* did not respond to any treatment level except for callus formation at IBA application of 7500 and 10000 ppm.

16) Effect of intercropping patterns on the growth parameters of cabbage intercropped with onion

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Introduction

The most important thing to achieve in intercropping is to arrange spacing of different kinds of crops in a pattern that will permit each to receive maximum light, water, and nutrients to avoid competition. This study was conducted to determine the effect of intercropping patterns on the growth parameters of cabbage intercropped with onion.

Materials and Methods

Field experiments were carried out to investigate the effect of inter-cropping patterns on the growth parameters of cabbage (*cv.*Drumhead) inter-cropped with onion (*cv.* Texas Grano), with cabbage planted as the main crop and onion as an inter crop during winter. The experiments were laid out in two trial sites (Greylingstad (S_1) and Driefontein (S_2) in Mpumalanga province, in a randomized complete block design with four replications. The inter-cropping patterns 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. Cabbage plant height was measured during vegetative growth stage and head weight at harvest.

Results and Discussion

Results revealed that there was a variation in terms of growth parameters in both sites. The 1:1 inter-cropping pattern gave the highest values of growth parameters in both trial sites (S_1 & S_2), but there was no significant difference in growth parameters between 1:1 pattern and cabbage planted in pure stand in S_1. The average cabbage head weight of 3.6 kg and average cabbage plant height of 41 cm was recorded in 1:1 pattern in both sites. The 2:1 inter-cropping pattern recorded lowest values but there was no significant difference in growth parameters between 2:1 pattern and cabbage grown in pure stand in both sites.

Conclusions

Alternating one row of cabbage with one row of onion is a promising pattern for cabbage-onion intercropping combination as it recorded the highest values of growth parameters.

17) Screening *Kishmish Vatkana* seedlings with molecular markers linked to powdery mildew resistance gene, REN1

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Introduction

Powdery mildew of grapes caused by *Erysiphe necator* is one of the major fungal diseases affecting crop production. Breeding of grapevine with resistance to powdery mildew seems to be the most promising way to control the disease. *REN1* is the powdery mildew resistance gene that was identified in Kishmish Vatkana and localised on linkage group 13 (Hoffman *et al*., 2008). This gene is heterozygous in Kishmish Vatkana. The objective of this study was to develop a homozygous *REN1* donor for breeding through self-pollinating Kishmish Vatkana. A homozygous donor of *REN* will ensure the transfer of this useful gene to all offspring derived from this line.

Materials and Methods

Kishmish Vatkana plants were self-pollinated at ARC-Infruitec-Nietvoorbij and embryo rescue techniques was used to develop *in vitro*plants. DNA was extracted from fresh seedling leaves. PCR analysis was performed using SSR markers linked to *REN1* and genotype data capturing was done to identify offspring homozygous for *REN1*.

Results and Discussion

Thirty-six individuals from the self-pollinated Kishmish Vatkana population survived and were genotyped. Marker VMC9H4-2 AND VMCNG4E10-1 were used to determine if the genotypes were homozygous for *REN1* since these markers are most tightly linked to *REN1*and co-segregate. The allele size of 217bp for the UDV124 marker associated with *REN1* was identified but all plants were heterozygous for this marker. An error in parentage was assumed for four individuals as allele sizes for each marker did not support self-pollination of Kishmish Vatkana. The marker, UDV-020, produced multiple alleles and these allele sizes were difficult to score. Ten individuals were found to be homozygous, carrying the dominant alleles for three markers VMC9H4-2, VMCNG4E10-1 and VVIP10. Five individuals were found to be homozygous but carrying the recessive gene for markers UDV124, VMC9H4-2, VMCNG4E10-1 and VVIP10.

Conclusions

The individuals that were identified in our study which are homozygous for the dominant gene *REN1* are intended for use as parents in future breeding programmes.

POSTER PRESENTATIONS - CROP SCIENCE

LISTED ALPHABETICALLY

18) Smat-Lysimter for assessment of irrigated barley water use

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Introduction

The water scarcity problem need immediate solutions on either the exploration of non-conventional water sources or/and efficient utilization of available water resources. According to the Department of Water and Rural development, over 70% of water resources in the country are used by the agricultural sector and under the water shortage, the major reduction should be made on agricultural water. The improvement of water use efficiency at field level requires an accurate evaluation of the on-farm water balance. Lysimeters, general, are a fundamental tool to understand plant water uptake and specifically the actual evapotranspiration at specific areas. The aim of this study is to measure and analyse the actual water use of irrigated Barley crops grown under semiarid conditions using a smart lysimeter.

Materials and Methods

Two SFL-600 smart lysimeters were installed at the Barley field during the winter growing season to monitor various water constituents, including evapotranspiration, soil moisture, soil water potential, and drainage. The lysimeters were consisted of an inner 30 cm diameter and 60 cm height cylinder used for undisturbed soil cut and outer cylinder with 45 com diameter and 75 cm height. Each lysimeter has a sensitive load cell at the bottom. The inner cylinder equipped with three moisture sensors and three water potential sensors at 5, 30 and 55 cm depths. The weight of the lysimeters was recorded every 1-minute while the sensors reading recorded every 10-minutes. The lysimeters were installed for two months during the growing season.

Results and Discussion

The Barley field actual evapotranspiration (ETa) was calculated based on the changes of the lysimeters weight during the non-irrigating period. The water balance in the lysimeter was changing positively with irrigation and negatively with water uptake. The ETa was validated using changes in soil moisture and water potential at the three depths. The ETa was compared to the reference evapotranspiration calculated using FAO 56 method.

Conclusions

The field smart lysimeter can provide essential information about plant water use and water productivity at the field level. The lysimeter data showed good agreement with soil moisture sensor pattern at the topsoil layer while showed clear discrepancies at the bottom of the lysimeter.

19) Effect of seeding rate on the production of maize cultivars with varying maturity groups at Cedara

Presenter: AJ Arathoon (James.Arathoon@kzndard.gov.za)

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Introduction

Higher seeding rates are recommended for ultra-quick and quick-maturing maize (*Zea mays* L.) cultivars compared to medium-maturing cultivars, because of their less dense growth habit. For the high-potential dryland production areas of KwaZulu-Natal, 40 000 - 45 000 seeds ha^{-1} are recommended for medium-maturing cultivars, while 45 000 - 70 000 seeds ha^{-1} are recommended for quicker-maturing cultivars. However, high seeding rates could result in more lodging and greater competition between the plants, especially during dry periods.

Materials and Methods

Research trials were conducted on the Cedara Research Station (Bioclimate: Mistbelt), KwaZulu-Natal, during the 2015/16, 2016/17 and 2017/18 growing-seasons to determine the effect of four seeding rates (40 000, 60 000, 80 000 and 100 000 seeds ha^{-1}) on the production of eight cultivars with maturity groups ranging from ultra-fast to medium. A randomized complete block design with three replicates was used. The inter-row spacing was 0.75 m and the crops were fertilized for 10 ton ha^{-1} yields under no-till conditions. Weeds, pests and diseases were controlled throughout the growing-seasons.

Results and Discussion

The 2015/16 and 2016/17 growing-seasons experienced drier and warmer conditions than the long-term means. Above-average rainfall was received in the 2017/18 growing-season, but low rainfall in January and hail damage in February resulted in a mean yield of 9.21 t ha^{-1}compared to 7.32 t ha^{-1} and 10.47 t ha^{-1} in the 2015/16 and 2016/17 growing-seasons, respectively. Overall, the percentage of lodged plants increased significantly from 18.6% to 40.3% with increasing seeding rate up to 80 000 seeds ha^{-1}. The number of cobs $plant^{-1}$, grain mass $plant^{-1}$ and 100-kernel mass decreased significantly as seeding rate increased. In each season, yields increased significantly from 40 000 seeds ha^{-1} (mean = 8.21 t ha^{-1}) to 60 000 seeds ha^{-1} (mean = 9.26 t ha^{-1}), but no significant interactions were measured for yield between the cultivars and seeding rates. However, overall, significant interactions were measured between the seasons and seeding rates, and between the cultivars and seeding rates. In the 2017/18 season a significantly higher yield was produced at 80 000 seeds ha^{-1} (9.76 t ha^{-1}) compared to the lower seeding rates. All the cultivars yielded optimally at 60 000 seeds ha^{-1}, except for PAN 4A-111, a quick-maturing cultivar, and DKC 71-44B, a medium-quick maturing cultivar, which yielded optimally at 40 000 seeds ha^{-1} and 80 000 seeds ha^{-1}, respectively.

Conclusions

Since yields did not increase significantly above 60 000 seeds ha^{-1}, this seeding rate is recommended for all the maturity groups in the high-potential dryland Mistbelt areas of KwaZulu-Natal. However, cultivars with good resistance to lodging should be planted.

20) Selected bio-fertilizers influence on wheat yield under various phosphate levels as part of a nutrient management system

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Introduction

The advancement in plant nutrition and mineral fertilizers during the 19th century was one of the dominating factors that laid the foundation for the rapid increase in the human population (Erisman, 2011). Currently agricultural management strategies still rely on heavy fertilizer use and the result is a sharp decline in mineral resources to feed this demand (St. Clair & Lynch, 2010). Studies have shown that bio fertilizers can be used in combination with mineral fertilizers to increase fertilizer use efficiency, thus the aim of the study was to evaluate the infield effect of bio fertilizers on wheat yield in an integrated phosphate nutrient management system.

Materials and Methods

The field trial evaluated the effect of different phosphate on PGPR efficiency to stimulate wheat growth. The experimental design was RCBD in a factorial arrangement, replicated three times. Each replicate consisted of a 2 m x 2 m block, with either of the two bio-fertilizer treatments (isolates T19 & T29) at five phosphate increments (0%, 25%, 50%, 75% & 100%). An untreated control was included. Phosphate level 100% was set at 50kg/P/ha and nitrogen levels were kept constant for all treatments at a recommended 180 kg N/ha. Each treatment was prepared just before planting by treating seed (wheat cultivar - Duzi®) at factory recommendations. Data collection consisted of growth rate and yield at 12% grain moisture which was subjected to combined analysis of variance using GLM procedures of SAS 9.4 Statistical Analysis System, North Carolina, U.S.A) at P =0.05 to partition variation accounted for by treatment, phosphorus level and treatment by phosphorus interaction effect.

Results and Discussion

No significant increase in growth rate was observed, but a reduction in yield was observed below a 50% phosphate level when the treatments were compared to the control. The treatment T19 and T29 significantly reduced the yield by 9.39% and 13.38% at a P 0% and P 25% respectively. As the level of phosphate increased, yield significantly increased for treatment T19 and T29 compared to the control by 7.83% and 16.22% and 4.08% and 9.31% for phosphate level 75% and 100% respectively. The results also show a significant relationship (r^2 = 0.635) between phosphate level and the ability of the bio fertilizers to increase wheat yield.

Conclusions

Bio-fertilizers in this study significantly increased wheat yield under normal field production conditions and can be a crucial factor in a nutrient management system to increase wheat yield while lowering mineral fertilizer use.

21) Soil mineral in response to top dressed rate on canola under conservation agriculture in the Western Cape

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Introduction

Soil nitrogen (N) test values is a useful and important management tool to determine top dress N fertiliser requirement. In order to ensure the successful implementation of soil N test values, accurate predictions of the response of soil test N value to applied N fertiliser is essential. The aim of this study was to determine the relationship between top-dressed N fertiliser application rate and the resultant increase in soil mineral N test value.

Materials and Methods

Canola was planted at five different locations differing in soil properties and climatic conditions in the grain producing areas of the Western Cape over four production seasons (2016 to 2019). The trial was laid out as a randomised block and replicated four times. The N treatments comprised of planting with 25 kg N ha^{-1} and top dress rates of 0, 25, 50, 75, 105, 135 and 165 kg N ha^{-1} respectively. A control treatment was included that did not receive any N fertiliser. Soil samples were taken at planting, pre-top dress, post-top dress and at harvest to a depth of 300 mm. NO_3^--N and NH_4^+-N were determined colorimetrically on a SEAL AutoAnalyzer 3. N was calculated as the sum of NO_3^--N and NH_4^+-N.

Results and Discussion

Regression analysis showed a decrease in response of soil mineral N to top dress N rate from 2016 to 2018 at Langgewens, Porterville, Darling, Tygerhoek and Riversdale. At Langgewens the R^2 value ranged from 0.72 to 0.93, Porterville from 0.81 to 0.84, Darling from 0.0004 to 0.82, Tygerhoek from 0.52 to 0.87 and Riversdale from 0.61 to 0.90

Conclusions

Although the 2019 data is not yet available, the projections of soil mineral N in response to topdressed N rate shows to be a reliable soil response indicator. The relation between soil N response to fertiliser N top-dress rate will be finalised after completion of the 2019 data capturing year.

22) Identifying the best soybean cultivars for the different climatic regions

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Introduction

The national soybean cultivar trials started in 1978/79 to support local soybean producers to identify adapted cultivars for the different climatic regions. The trials facilitate cultivar comparisons for agronomic/economic performance and should be well adapted for the particular soil and climate conditions. A number of cultivar trials are done annually at different localities called multi environmental yield trials (MET's). MET's are costly and thus the best cultivar choice for a specific environment are of utmost importance.

Materials and Methods

Commercially available Roundup ready cultivars were evaluated in three climatic regions (cool, moderate and warm). Thirty-two and 35 cultivars in 21 trials were evaluated during the 2016/17 and 2017/18 seasons, while 28 cultivars were evaluated in the cool regions, 32 cultivars in the moderate as well as warm areas in 22 field trials (2018/19). The cultivars were evaluated for yield and some agronomical characteristics. A Randomised Latinised row/column design with three replicates was used as statistical layout. Each trial plot consisted of four, 5 m rows. Four metres were harvested from each of the middle two rows. The regression line technique, calculated for each cultivar over localities, are based on the least square method with mean locality yield as the independent and cultivar yield as the dependable variable. From this analysis yield, probability can be calculated for different yield potentials (Thiebaut *et al*., 2015). Only the cultivars included in all 3 seasons are included in this analysis.

Results and Discussion

Cultivars with an above average yield potential (≥50%), yield (≥2 t ha^{-1} dryland; ≥4 t ha^{-1} irrigation) and a high stability (D-parameter ≤0.13) over 3 seasons have been identified. All-rounder cultivars are PAN1521R and DM5302RSF (cool) as well as PAN1521R and P64T39R for the moderate area. Cultivars suitable for the higher yield potential areas are P61T38R (moderate), LS6161R and SSS6560 (tuc) (warm). For the lower yield, potential areas NS6448R (cool), PAN1532R and P61T38R (moderate) as well as DM6.8iRR (warm) are recommended (De Beer & Bronkhorst, 2019). The mean yield of the best four cultivars (cool) (3723 kg ha^{-1}) was 1167 kg ha^{-1} higher than the mean yield of the poorest four cultivars (2556 kg ha^{-1}). This relates to R5 835 ha^{-1} at a commodity price of R5 000 t^{-1}.

Conclusions

The best cultivar selection for a specific climatic region can have a significant financial impact for the producer.

23) The effect of commercial bio-products used as foliar applications to control stem rust of wheat under glasshouse conditions

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Introduction

Stem rust is a devastating fungal disease of wheat, in some seasons resulting in up to 35% yield losses in South Africa. Control measures currently include genetic and chemical approaches, but the frequent emergence of virulent pathotypes and environmental risks of fungicides, have evoked interest in biological control. The need for alternative control measures against stem rust is also underscored by the recent discovery of a new Ug99 race, 2SA42, bringing to five the number of Ug99 variants present in South Africa (Terefe *et al*. 2019). The aim of this study was to determine whether currently available biocontrol organisms and other local products could be used to manage stem rust on wheat.

Materials and Methods

Seven local bio-products were used in this study at the recommended application rate and a 2X rate. The products comprised three biocontrol agents containing strains of *Trichoderma* spp. (Bio-Tricho, Bio-Impilo and Eco-77) and four chemical products containing salicylic acid + sodium bicarbonate (Bio-Build), monopotassium phosphate + ascorbic acid (Bio-Protector), plant organic acids (Kanguard 940) and copper oxychloride (Copper). Checks included two positive controls and the trial was repeated three times with eight replicates per treatment. A RCBD and percentage rust infected leaf area was determined according to the modified Cobb-scale. Given heterogeneous variances in time, a weighted combined ANOVA was performed (John and Quenouille, 1977) using the General Linear Models Procedure (PROC GLM) of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Fisher's LSD at the 5% level was calculated to compare treatment means (Ott and Longnecker, 2010).

Results and Discussion

The positive control plants developed between 5 and 7% of stem rust, respectively. Fungicide treatments before and after rust infection, provided the best control with rust severity reaching <1% and 2%, respectively. The three *Trichoderma* biocontrol agents at recommended rate performed best, with rust severities between 3.7 and 4.4%. The poorest performance was by Kanguard 940, which provided no significant control (P>0.05). The systemic fungicide out-performed all other treatments, with a preventative treatment providing the best control. The *Trichoderma*-based product, Bio-Impilo (recommended rate), showed good potential, reducing infection significantly compared to both positive controls. *Trichoderma* spp. employ various modes of action to suppress plant pathogens, including antibiosis, parasitism, induced host-plant resistance, increased nutrient uptake and/or competition (Harman, 2006).

Conclusions

The notion of exploring *Trichoderma* as biocontrol agent against wheat stem rust is supported by the positive findings of El-Sharkawy *et al.* (2018). Field trials incorporating *Trichoderma* as both rhizosphere and foliar applications are warranted.

24) Effect of bio-slurry effluent on seedling growth of Swiss chard (*Beta vulgaris L.*)

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Introduction

Seedling characteristics are the principal determinants of quality and yield in vegetables production. There is a compelling evidence that use quality seedlings (transplants) from good quality growing medium with proper fertilizer application determine quality and quantity of the produce in vegetables production. Seed germination and growth depend greatly on temperature and the effect vary among crops and varieties

Materials and Methods

To evaluate the effect of bio-slurry effluent on seedling growth of Swiss chard, glasshouse experiments were conducted at Dohne Agriculture Development Institute, in summer 2017 and winter 2018. Two cultivars of Swiss chard namely Star 1801 and Fordhook giant were planted in 200 cavity trays using a hygromix commercial growing medium incorporated with fertilizer treatments at different rates of bio-slurry namely, no incorporation (control), 50%Bioslurry, 100%Bioslurry, 200%Bioslurry and the recommended rate of 2:3:4 (30) NPK fertilizers. In the glasshouse the experiment was arranged in a randomized complete block design (RCBD) replicated three times. At four weeks after germination ten (10) seedlings per treatment were destructively sampled randomly to determine the plant growth parameters namely: i) Seedling height, shoot and root height were measured using a 30 centimetre ruler; ii) Seedling mass; iii) Fresh shoot and fresh root mass as well as their dry mass were measured using (Adam CBW-3KG) scale in grams. The dry mass was obtained by drying the samples in an oven at 65°C for 48 hours; iv) Nutrient content of leaves was determined using the Kjeldahl method at Dohne Analytical laboratory.

Results and Discussion

Results showed that the season and cultivar has significantly affected the seedling height, fresh shoot mass, dry shoot mass and dry root mass with the highest obtained from Fordhook giant cultivar. Fertilizer application rates had significantly affected morphological and biological yield parameters measured with bio-slurry application rates performed better compared to the recommended fertilizer application rates. Similarly, the bio-slurry application rates have significantly affected the interaction between season, cultivar and fertilization on morphological and biological yield parameters compared to chemical fertilizer recommended application rate.

Conclusions

Fordhook giant seedlings planted in summer at double optimal (200%) bio-slurry application rate enhanced the vegetative growth and quality of the Swiss chard seedlings.

25) Detection and visualization of Arbuscular Mycorrhizal Fungi in wheat

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Introduction

Arbuscular mycorrhizal fungi (AMF) form symbiotic associations with more than 80% of land plants. They provide a range of benefits to host plants, and particularly emerging seedlings in exchange for organic carbon from the host. In order to make conclusions on differences in yield or plant biomass during trials, one must first validate the presence of mycorrhizal fungi in the plant root system. In this study, we aim to visually confirm the AMF roots infection status of rainfed winter wheat after inoculation in the Western Cape. Visualizing the presence of mycorrhizal fungi in the roots of plants is challenging without the use of root staining and microscopy techniques to detect the root-AMF symbiosis. This trial is part of a broader study regarding the effects of AMF on wheat in the Western Cape.

Materials and Methods

Three trial sites were planted with wheat in 2019, i.e. near Moorreesburg and Piketberg in the Swartland region, and near Caledon in the Southern Cape region of the Western Cape. The trials consisted of three treatments of an inoculum containing 4 different AMF species (*Glomus intraradices, G. mosseae, G. aggregatum*, and *G. etunicatum*) at different dosages; one industry standard, and a control treatment that received no inoculation. Root samples were gathered at 90 and 130 days after emergence and stained using a modified protocol from *Wu et al.* (2012), after which they were randomly selected and observed for root infection under a light microscope.

Results and Discussion

Root samples from all three trial sites were stained and did not demonstrate clear infection in the root cells around 90 days after emergence. This might still be too early to determine if the plants were in fact infected. In addition, environmental factors such as hot, dry weather and soils and the late onset of the 2019 rain season may have affected the infection rate and growth of AMF, which could also explain the lack of infection. Samples gathered from all three sites at physiological maturity stage (130 days after emergence) should have more positive results due to the fungi having more time to grow and multiply.

Conclusions

Staining and observation of root samples should be done as late as possible in the wheat plant life cycle to allow the roots to be properly infected. Being able to visually determine if AMF infection has occurred in a crop can be valuable information for producers looking into the health of their soil and plants as well as researchers working with AMF.

25) Influence of cold stress on the yield and quality of malting barley (*Hordeum vulgare L.*)

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Introduction

With the exception of the past two years, the production of barley has grown extensively across the world. Barley is the fourth most important cereal crop in the world. Several products are made from barley which include bread, crackers, pasta as well as baby food. Another product for which barley is most commonly known is beer. Throughout the production cycle of barley, the crop is exposed to adverse environmental conditions especially during grain filling. The main objective of this study was to determine the effect of cold damage to quantitative and qualitative parameters of malt barley on the milky, early soft dough and late soft dough grain filling stages.

Materials and Methods

A glasshouse pot trial was conducted at the University of the Free State under controlled conditions. The trial was laid out as a complete randomized block design consisting of three grain filling stages *viz*. milky stage, early soft dough stage and late soft dough stage and five temperatures *viz*. control at ≥6, 4, 2, 0 and -2°C were applied over a three-hour period and replicated 4 times (each replicate consisted of 10 pots). Planting (cultivar Overture) was done in 3? pots during June 2018 in a loamy sand soil. Three plants per pot were kept following thinning to represent a plant population of 120 – 130 plants m^{-2}. Agronomic practices applied were adopted from the SAB/AB-InBev producer guide. One day before temperature treatments were administered, the plants were exposed to a minimum/maximum day temperature of 6/26°C. The following morning plants were placed in convection cold and freezing chambers at 6°C and target temperatures were reached within two hours and kept at the target temperature for one hour before returned to the glasshouse. All quantitative and qualitative parameters were collected and analysed at physiological maturity.

Results and Discussion

Neither grain filling stage nor temperature had any significant effect on all parameters evaluated, with the exception of hectolitre mass. Hectolitre mass was 0.5% lower at the milky stage compared to the apparently less sensitive late soft dough grain filling stage. The hectolitre mass was also significantly lower at 0°C (1.74%) and -2°C (2.0%) than that of the control plants at (6°C). Although only hectolitre mass was significantly affected this is of importance to the barley industry since kernel plumpness/hectolitre mass is used as part of the grading criteria.

Conclusions

Although there was a significant difference with regard to one parameter only (hectolitre mass), it is not possible to come to a full conclusion as more trails are conducted.

26) Screening of commercial maize cultivars for resistance to *M. phaseolina* stalk rot

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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 aim of this study was therefore to evaluate 30 cultivars at adult plant stage for resistance to charcoal rot.

Materials and Methods

Thirty cultivars (obtained from the ARC-GC national cultivar trial list) were planted at Potchefstroom (North-West province, South Africa, -26.736755, 27.06658) in a field trial mid-November of 2018/19. Two rows of each cultivar (7 m with 1 m spacing between rows) were planted. The trial was planted in a randomized order with three replicates. No irrigation was applied for the duration of the trial. The first row of each cultivar was inoculated with *M. phaseolina* infected toothpicks (MIT) and the second row with clean, sterilized toothpicks (control) at flowering stage at the 3rd internode. Destructive sampling of the maize stalks was done at soft dough stage and disease ratings captured according to the disease scale (score of 1 -9) of Shekar and Kumar (2012). A score of 1 indicate a healthy stalk or slightly discoloured stalk at the site of inoculation and a score of 9, premature death of the plant.

Results and Discussion

Both cultivar and treatment as main factors had a significant effect on charcoal rot infection. MIT inoculated plants had a mean disease score of 3.41 and the controls had a mean disease score of 1.63. The cultivar with the highest mean average disease score was PAN4A-156 (3.88) and the lowest mean average disease score was recorded for PAN5R-785BR (1.67). The significant interaction (P=0.05) between cultivar and treatment showed higher disease scores for the MIT inoculated plants compared to the control disease scores. PAN4A-156 (MIT) had the highest mean average score of 5.13 and the lowest mean average score (MIT) was for cultivar PAN5R-785BR (2.06). The same outcome was observed with the control plants, with PAN4A-156 having the highest mean average score (2.53) and cultivar PAN5R-785BR having the lowest mean average score (1.27).

Conclusions

M. phaseolina resistance information generated in 30 commercial cultivars, 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 production areas.

27) Evaluation of bio-slurry application rates on maize seedling emergence and establishment

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Introduction

Fast seedling emergence and establishment are important prerequisites for successful maize production. Some organic fertilizers negatively affect seedling emergence and establishment, while others promote it. There is limited information on how cattle bio-slurry affect this. The study aimed to evaluate the effect of bio-slurry application rates on maize seedling emergence and establishment.

Materials and Methods

A single factor experiment, with three replications, laid out as a completely randomised design was conducted under controlled conditions for 30 days to evaluate seven bio-slurry application rates (1 - 11 t ha^{-1}, with equal increments of 2 t ha^{-1} and 0 t ha^{-1} as control). Data for the calculation of mean emergence time (MET), emergence vigour index (EVI) and percentage emergence (PE) was collected daily from four to 19 days after planting (DAP). Root length, shoot length, dry root weight and dry shoot weight were collected at 5 day intervals. Dry root weight and dry shoot weight were used for the calculation of dry root to shoot ratio. Selection criteria used to assess the optimum bio-slurry application rate was done by looking at primary factors (quickness to emerge, seedling emergence vigour) and secondary factors (root: shoot ratio, dry root and shoot weight). Analysis of variance was done on results using JMP 14^{th} edition.

Results and Discussion

Bio-slurry application resulted in quick seedling emergence, improved seedling vigour, increased shoot length, root length, dry shoot weight and dry root weight. The 11 and 9 t ha^{-1} application rates provided the best results, with the control treatment giving the poorest results. This could be attributed to the ability of bio-slurry to form a soft protective layer on the surface of the growing medium. This helped in insulating temperature and conserving moisture.

Conclusions

The optimum bio-slurry application rate for maize seedling emergence and establishment is 9 t ha^{-1}.

28) Effects of residue and seed-drill type on barley populations and biomass production

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Introduction

Conservation agriculture practises are critical for sustainable crop production in the Western Cape. Conservation Agriculture principles include minimum tillage, crop rotation and a permanent organic mulch – principles that promote soil health and moisture conservation. Conservation agriculture does, however, not come without challenges. Some of these challenges include planting into crop residue. The aim of this study was to investigate the effects of different crop residues and disc drill residue management on barley production.

Materials and Methods

A field trial was conducted at Tygerhoek Research Farm near Riviersonderend. Barley was planted into one and two years' medic residues, as well as wheat and canola residue. The experiment was laid out as a randomized block design and the treatment factors are the different donor crop residue and the different seed drills. Each treatment was replicated four times. Plant population was determined 21 days after emergence and biomass was determined 30 days after emergence

Results and Discussion

There was no significant effect of the different types of residue on barley plant populations ($p > 0.05$). The effect of the different disc drills on the plant populations was significant ($p < 0.05$). The double disc drill resulted in better establishment. There was an effect ($p < 0.05$) of the different types of residue on biomass. Barley planted into wheat residue had the lowest biomass, while barley planted into 2-year medic residue, as well as canola residue had a higher biomass. The double disc drill resulted in a higher ($p < 0.05$) biomass compared to the single disc drill plots.

Conclusions

Higher biomass production can be ascribed to the fact that the double disc drill opens up the seed furrow more than the single disc, thus allowing the seedling to emerge with less physical obstructions. The significant impact residue type has on the biomass could possibly be ascribed to a nitrogen negative period in the soil, due to the residue type or possibly an allelopathic effect from the previous crop residue. A higher residue load was also beneficial, which can be achieved by reducing the grazing intensity. The results were however obtained in a dry year and concrete findings can only be made after two year's field trails.

29) The long-term effect of crop rotation and tillage practices on biological soil health indicators

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Introduction

Agricultural management practices have far-reaching consequences for microbial ecology and soil health. This is especially significant in arid and semi-arid areas such as those found in South Africa. Traditionally, farmers mainly utilised conventional tillage and mono-cropping in the winter wheat production areas of the country. Gradually, sustainable conservation agriculture approaches are being adopted. This study presents the long-term effects of different agricultural practices by integrating nematode functional guilds with soil microbial diversity and activity data. The objectives were to quantify the temporal impact of cropping sequences and degrees of soil disturbance on (i) nematode trophic levels, (ii) microbial diversity indices and (ii) enzymatic activity in crop production systems in the Western Cape, South Africa.

Materials and Methods

During a four-year cropping cycle, the effects of a wheat-medic rotation and wheat mono-cropping as well as contrasting degrees of soil disturbance (conventional vs zero tillage) were compared. Nematode functional guilds were determined and assigned to a coloniser-persister scale. Microbial species richness and abundance were measured using the Shannon-Weaver and Evenness diversity indices, respectively. Microbial function over time was determined by enzymatic assays (B-glucosidase, phosphatase, urease).

Results and Discussion

Crop rotation and zero tillage increased nematode trophic linkages, microbial richness and evenness. Plant-feeding nematodes declined over time in conventionally tilled soils. Enzymatic activity related to the carbon, nitrogen and phosphorus cycles increased over time under zero tillage and were independently influenced by cropping sequence. Quantitative analyses of integrated biological indicators under various management practices is important to ensure healthier soil and sustainable crop production.

Conclusions

Crop rotation and zero tillage increased nematode trophic linkages, microbial richness and evenness. Plant feeding nematodes declined over time in conventionally tilled soils. Enzymatic activity related to the carbon, nitrogen and phosphorus cycles increased over time under zero tillage and were independently influenced by cropping sequence. Quantitative analyses of integrated biological indicators under various practices is important to ensure healthier soil and sustainable crop production.

30) Canola production with various tillage systems in the sandy soils of the Swartland

Presenter: J Laubscher (19058101@sun.ac.za)

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Introduction

Although most of the canola producers in the sandy areas of the Swartland use no-tillage knifepoint seeders, soil is still either scarified or disc-ploughed once every one to four years. Conventional tillage practices reduce the organic content of the sandy soil and cause the breakdown of the soil structure. In this study, the effects of different planters and rip-action of deep sandy soil on canola production and soil physical quality were investigated. The aim is to determine to what extent ripping of the soil and two different seeders influence above ground biomass, plant population and bulk density.

Materials and Methods

Soil bulk density was measured at soil depths of 0 to 150, 150 to 300 and at 300 to 450 mm before and after planting, as well as mid- and end-season. Plant population was determined at one, three and six weeks after emergence. Above ground biomass was determined at 30, 60 and 90 days after emergence and at physiological maturity.

Results and Discussion

There was no difference ($P>0.05$) in biomass production between the two seeders, but there was a difference between the rip-actions ($P<0.05$). The non-ripped plots produced more ($P<0.05$) above ground biomass than the ripped plots. Regardless of the seeder, plant population was always among the highest ($P<0.05$) when soils were not ripped. Conversely, plant population was mostly lower ($P<0.05$) when soils were ripped. The higher biomass and plant population recorded in the non-ripped soils could be as a result of too porous soils for canola seed germination in the ripped plots, and that there was better soil-seed contact in the plots that were not ripped. Soil bulk density of the 0 to 150 mm was consistently lower ($P<0.05$) in the plots that were ripped compared to the non-ripped plots throughout the season. The 150 to 300 and 300 to 450 mm samples showed no differences ($P>0.05$) between the ripped and the non-ripped plots.

Conclusions

Ripping the soil have led to less above ground biomass and a reduced plant population. Concerning soil bulk density, ripping only had an effect on the 0 to 150 mm soil layer. Less above ground biomass and a reduced plant population as a result of ripping, could lead to a lower canola yield at the end of the season. No differences were found between the two seeders with regards to above ground biomass, plant population and bulk density.

31) Canola response to lime form, placement and tillage action

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Introduction

Minimum-tillage practices are generally more beneficial than conventional tillage, but present a challenge in the form of soil acidity amelioration. Where minimum tillage is followed, lime is only surface applied. Over time, soil acidity stratification is observed, with the subsoil being more acidic than the topsoil due to the lack of movement of lime into the subsoil. This study aims to evaluate possible solutions for addressing soil acidity in minimum-tillage systems.

Materials and Methods

A canola field trial was conducted in the southern Cape region. Treatments entailed a combination of one of three different liming materials and one of four types of soil tillage. The liming materials consisted of two Class A limes (88% and 96% calcium carbonate equivalent) and a micro-fine lime granulated with molasses. Tillage treatments consisted of minimum-tillage planter only, chisel plough, disc plough and deep ripper. The inclusion of deeper soil tillage in the trial is to evaluate the effectiveness of a one-time soil disturbance to incorporate lime in order to address subsoil acidity. Soil samples were taken at depths of 0-5, 5-15 and 15-30 cm before planting, halfway through the growth season and after harvest. Every 30 days after emergence, biomass and leaf area index (LAI) were determined. After harvest, seeds were analysed to determine protein content, thousand kernel mass and oil content.

Results and Discussion

The placement of granulated lime in the furrows during planting led to both high biomass yield as well as high LAI. Disc-tilling of lime into the subsoil yielded higher biomass and LAI than the chisel or deep plough treatments. This can possibly be ascribed to the chisel plough not effectively moving the applied lime into the subsoil and the deep ripper severely loosening the soil resulting in poor seed-soil contact and therefore weak establishment of crops.

Conclusions

Long-term observation of the neutralising effect of granulated lime in the soil needs to be done in order to make meaningful conclusions about the effectiveness of this product over the span of a few years.

32) The effect of planting date on time to flower of canola (*Brassica napus*)

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Introduction

The primary objective of canola production is to plant at an appropriate time to avoid moisture and heat stress during flowering and the important seed-filling period, as both heat stress and high temperatures are detrimental to oil accumulation (Robertson *et al.*, 2004). Farmers in the Western Cape normally plant their canola after the first effective winter rainfall (15 to 20 mm for a single rainfall event) to optimize the yield potential of the canola crop. Nanda *et al*. (1996) concluded that there was a response to photoperiod only between emergence and visible flower buds. In their field study no response to photo period was found with a photoperiod between 10.2 hour and 11.3 hour. In the controlled environment study, B. napus did not respond to a photoperiod shorter than 12 h. The question therefore was raised if this is also true for Western Cape conditions?

Materials and Methods

Temperature and days to flowering data of 10 growing seasons from the cultivar evaluation programme at Tygerhoek near Riviersondend was included in this study. The regression over years was used to determine the effect of planting date and GDD (growth degree days) on days to flower. The various canola cultivars were divided according to the period (days) from planting till flowering, i.e. early and medium developmental groupings. GDD were determine by adding up the average daily temperature from planting to 50% flowering stage.

Results and Discussion

The GDD for the early developmental group varied between 1110 and 1504 GDD. The medium group varied between 1182 and 1582 GDD to 50% flowering. The GDD increase from 15 April to 25 and 27 April for the medium ($r^2 = 0.82$) and early group ($r^2 = 0.79$), respectively. It declined from there to 13 May planting date, indicating that there is another factor influencing days to flower. The correlation between planting date and day of flowering was significant ($r^2 = 0.67$ and $r^2 = 0.65$).

Conclusions

The days to flower increase to a photoperiod of 10 hours 58-59 minutes on 26/27 April. GDD was influenced by number of days to flower. The time to flower after 26/27 April planting date was influenced by another factor, other than photo period.

33) Evaluation of morphological variation of nightshade (*Solanum Section, Solanum*.) accessions

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Introduction

Nightshade (*Solanum S*ect, *Solanum*) is a highly nutritious indigenous leafy vegetable with capacity to improve household food and nutritional security in South Africa and other African countries. The nightshade plant is an erect, branched annual or biannual herbaceous plants. The objectives of the study were to characterize the phenotypic traits of the nightshade accessions using morphological descriptors and to assess the genetic components of the traits with the specific aim of identifying superior lines for future breeding programs.

Materials and Methods

The experiment was carried out in a randomized complete block design with three replications. In this study, 6 genotypes were evaluated and 12 morphological characters were measured.

Results and Discussion

The accessions were significantly variable in all traits. High variability among accessions was found in days to fruit forming, number of leaves, days to 50% flowering, and plant height. Principal component analysis showed that the five PCs with eigenvalues ≥ 1 explained 92.53% had the highest variability in the accessions. The number of leaves, leaf fresh mass, number of branches, leaf dry mass, days to 50% flowering, days to fruit forming and leaf width accounted high variability in PC1, whereas plant height, leaf fresh mass, stem diameter and leaf dry matter also accounted the highest variability in PC2. Cluster analysis grouped the accessions based on UPGMA. Analysis of variance showed that there are significant differences ($p<0.05$) among the genotypes recorded for all traits. In this study, the phenotypic coefficient variance (PCV) values were relatively higher than genotypic coefficient (GCV) variance for all traits; however, GCV values were close to PCV values for number of branches, stem diameter, days to 50% flowering, days to fruit forming, leaf length and leaf width. High heritability coupled with high genetic advance percentage of means was obtained for number of leaves, leaf fresh mass(g), number of branches, stem diameter, leaf dry mass(g), stem dry mass(g), number of days to flowering, number of days to fruit formation, leaf length, and leaf width, and improving of these traits could be done through selection.

Conclusions

This study revealed high genetic variability for both qualitative and quantitative traits measured, counted and recorded among the nightshade accessions for crop improvement. The heritability of measured traits was revealed and the study suggested accessions that differed widely to be used as parents for future breeding programmes. Nshade9 was the most superior accession that can be used for further breeding programmes.

34) Evaluation of the agronomic performance of unimproved finger millet germplasm

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Introduction

Finger millet (*Eleusine coracana*) offers multiple uses for human food, fodder and nutrition. It is highly tolerant to drought and can grow under low input conditions (Onyango, 2016). Despite its important benefits, there is no commercial production of finger millet in South Africa at present and the agronomic performance of our current local unimproved germplasm has not been determined adequately. Identification of high yielding genotypes will help in adoption of the crop by local farmers and hence the production. This study examined variation in selected agronomic and yield components among 15 unimproved traditional finger millet varieties.

Materials and Methods

A pot experiment was conducted in a shade house at Thohoyandou (220 58' S, 300 26' E; 596 m a.s.l.) in Limpopo Province (South Africa) during the 2018 cropping season. The seed of each of fifteen diverse unimproved varieties of finger millet (including one check variety), which were obtained from local smallholder farmers, was planted in plastic pots (35 cm x 30 cm diameter) that were filled with field top soil (classified as Rhodic Ferralsols). The pots were laid out in a randomized complete block design with two replications. Data sets on agronomic and yield components variables including plant height (PHT) (cm), dry fodder weight per plant (DFWP) (g), number of fingers per ear (NFE), number of ears per plant (NEP) and grain weight per plant (GWP) were subjected to analysis of variance (using STATISTIX 10.0).

Results and Discussion

The results showed highly significant ($P<0.01$) differences in PHT and DFWP among genotypes. There were significant differences ($P<0.05$) among the genotypes in terms of the NFE, NEP and GWP. The genotype 'FM-G9' produced the tallest (103.3 cm) while genotype 'FM-G13' produced the highest NFE (15) and GWP (9.9 g). Genotype 'FM-G8' which produced the highest DFW (292 g), indicated good potential for utilization in livestock feeding subject to further testing on a field basis in multiple locations and seasons. Future studies could also use a participatory approach (McElhinny *et al*., 2007) in order to enhance subsequent adoption of the crop by growers in the area. The significant variation in agronomic attributes was useful from a genetic improvement standpoint particularly for initial selection of promising varieties.

Conclusions

The study showed variation in agronomic performance among finger millet genotypes. It is recommended to evaluate the germplasm further in order to validate their agronomic performance particularly under field conditions.

35) Influence of nitrogen application on yield and quality of patty pan (*Cucurbita pepo L.*) varieties

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Introduction

Patty pans (*Cucurbita pepo* L.) is an easy to grow vegetable crop, and is mostly consumed in salads and soups. Nitrogen (N) is one of the essential elements that play an important role during plant growth and development. It has a great impact on crop yield; therefore, it is important to apply optimum amounts to enhance crop production. Nitrogen deficiency can result in yellowing of leaves, low yields, retarded plant growth as well as poor crop quality. High N application can affect the nutritional value of a crop in relation to human health. The main objective of this study was to determine the effect of nitrogen application on yield and quality parameters of two patty pans cultivars; Pinwheel (yellow) and Star 8080 (green), produced under open field.

Materials and Methods

The research study was conducted in the Agricultural Research Council Research station in Roodeplaat, South Africa. Limestone Ammonium Nitrate (LAN (28)) was used as a source of nitrogen. The plants were subjected to six different concentration levels of N (0, 70, 140, 210, 280 and 350 kg ha^{-1}). Treatments were replicated four times in a randomized complete block design. Data were collected on the plant growth parameters such as plant height, leaf area index, leaf number, stem diameter, leaf fresh mass, leaf dry mass and leaf chlorophyll content**,** marketable (fruits from 4 to 6 cm regarded as first grade and from 7 to 10 cm regarded as second grade) and unmarketable (greater than 10 cm) yields and on post-harvest storage.

Results and Discussion

Plants that were applied with 120 to 350 kg ha^{-1} of nitrogen had increased marketable yield with high number of fruits produced per plot and increased fruit mass (kg/plot). Optimum yields were obtained with 280 kg ha^{-1} application of N. Increased stem diameter, root dry mass and leaf fresh mass (kg $plant^{-1}$) were obtained with 210 - 280 kg ha^{-1} of N application. The application of N had no effect in post-harvest storage, chlorophyll content, fruit quality attributes (fruit flesh colour (L* a* b*), EC (mS/cm), TSS (%Brix) and pH) and plant morphological parameters (root fresh and leaf dry mass (kg $plant^{-1}$). There was reduction in yield with N application of 0 - 140 kg ha^{-1}. Marketable yield and fruit flesh colour were significantly higher for Pinwheel cultivar than star 8080. Furthermore, Star 8080 resulted in higher unmarketable fruits as compared to pinwheel. Interaction between cultivar and nitrogen did not show significant difference on fruit yield, plant and chlorophyll parameters.

Conclusions

The application of N at 280 kg ha^{-1} may be recommended for production of patty pans under open field as it resulted in higher marketable yield.

36) Enhancing vegetative propagation of African ginger during dormancy period

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Introduction

African ginger (*Siphonochilus aethiopicus*) is one of the most important and most popular of all traditional medicinal plants of southern Africa. The plant is propagated by rhizomes in spring. However, the reproducing part (rhizome) is also the economically used part of the ginger plant, which restricts the availability of ginger rhizomes needed for processing and product development. Therefore, there is a need to explore new propagation techniques that reduce propagation material. The study focused on the effect of planting time (May, July and August) and rhizome piece size on sprouting and growth of African ginger.

Materials and Methods

Matured dormant rhizomes weighing 40 – 50 g were obtained from the medicinal plants genebank at ARC VOP, during autumn immediately after senescence. Rhizomes were planted at different planting dates (May, July & August). The rhizomes were washed and cut into sections. The different cutting treatments included twelve pieces, eight pieces, four pieces, two pieces, rhizome buds and full rhizome. A clean, sharp knife was used to cut the rhizomes into pieces. Rhizome pieces were planted in 10 L pots containing potting soil at a 5 cm planting depth and were arranged in a completely randomized design in a glasshouse. In the glasshouse, maximum air temperature fluctuated between 25° to 27° and daily minimum between 10° to 15°. Maximum soil temperature was 20° and minimum was 25°. The pots were irrigated daily up to field capacity. Plants were monitored at regular intervals and the number of sprouts per rhizome piece were recorded.

Results and Discussion

African ginger pieces planted during May did not produce any sprouts for up to 80 days after planting (DAP). However, rhizomes pieces planted in July sprouted 20 DAP and produced higher number of sprouts than those planted during May. Rhizome pieces planted during August took 5 days to sprout and resulted in 50 % increase in sprouting as compared to the May and July planting time. This study indicates that dormant African ginger rhizomes grown in a controlled environment during winter will still be restricted to sprouting due to the postharvest dormant phase of rhizomes. Therefore, further study should be conducted to break the postharvest dormant of African ginger rhizomes in order to ensure sustainable supply of propagation material.

Conclusions

African ginger rhizomes grown in a controlled environment during winter will be restricted to growth due to the dormant phase of rhizomes, regardless of the controlled environment. Seasonal climatic condition is a key factor in stimulating African ginger sprouts.

37) Preliminary results on adaptability of maize cultivars under dryland conditions in the Free State province

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Introduction

Maize (*Zea mays* L.) is grown as a staple crop in the whole of Africa and more than 300 million people depend on it as their main food source. Drought is one of the major factors of reduced crop yields than any other abiotic stresses, especially under dryland maize production. Adaptation to the current climate changes requires the use of maize cultivars with tolerance to drought and resistance to emerging pests and diseases. WEMA (Water Efficient Maize for Africa) drought tolerant maize cultivars were bred to be used in Africa as a means to help cope with constrained conditions. This study was therefore conducted to assess the extent of variation in tolerance to constrained production conditions and identify WEMA cultivars that contributed to better performances under such conditions in the Free State Province.

Materials and Methods

The trials were planted at 4 different sites in the Province under dryland conditions using a randomised block design. Seven WEMA maize cultivars (WE 6206, WE 6207, WE 6208, WE 6209, WE 6210) were planted at a density of ±16 000/ha and replicated four times. Two commercial cultivars (SNK61 (OPV) and PAN 993Bt) were used as control to compare against the WEMA cultivars. Each plot comprises of 8 rows that are 12 m long, inter-row space is 0.42 m and intra row space is 1.5 m.

Results and Discussion

Preliminary results for the 2016/17 season showed no significant differences between the commercial and WEMA cultivars regarding yield and cobs per plant. However, WEMA 6206 and 6208 did beter than the other WEMA and commercial cultivars. Although all the cultivars showed a higher yield overall, the same tendency were found for the two cultivars in the 2017/18 season.

Conclusions

The cultivars showed no significance differences between them for the two seasons, although yield mass as such differed between the different growing seasons. Soil types and weather data can make a difference in yield. Next years' growing season will provide a better picture of the differences between the cultivars. More data is required to make final recommendation.

38) Influence of different NPK and rock dust fertiliser levels on growth and nutrient content of *Moringa oleifera* seedlings

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Introduction

Moringa oleifera is a drought tolerant and fast-growing tree that can be propagated by sowing seeds or plant cuttings. However, for commercial purpose, reducing or withholding fertilisers tends to slow the overall growth of seedlings and consequently reduced biomass and yields. Therefore, the aim of this study was to determine the effect of rock dust (RD) and nitrogen, phosphorus and potassium (NPK) fertiliser levels on *M. oleifera* for optimum plant growth, total biomass, leaf yields and nutrient quality.

Materials and Methods

The study was conducted under tunnel conditions at Welgevallen Experimental Farm, Stellenbosch University. Six levels of RD and NPK fertilisers were used as topdressing treatments and were arranged in a randomised complete block design with six replications. Treatment (T) protocols were as follows: T1 − control; T2 – 100 % NPK (5 g 2:3:2 (22) fertiliser mixture per plant); T3 – 75 % NPK (3.75 g) and 25 % RD (1.25 g); T4 – 50 % NPK (2.5 g) and 50 % RD (2.5 g); T5 – 25 % NPK (1.25 g) and 75 % RD (3.75 g); T6 – 100 % (5 g) RD. Plants parameters were measured at 87 days after planting. Dried leaf powder was sent to Central Analytical Facilities for nutrient analysis.

Results and Discussion

NPK fertiliser and RD level did not influence plant height, stem diameter, leaf area index, leaf number, dry root mass and dry leaf yield. Only dry shoot mass was significantly different from control across the treatments. Rock dust applied at 5 g (100%) level had higher shoot mass than the control treatment, but was not significantly better than any of the other treatments. No significant differences were found between NPK and RD treatments on Ca, Fe, Mg, P, Zn, Mn and Na nutrients elements of *M. oleifer* leaves. Only Potassium (K) differed across the treatments, with treatments at 1.25 g NPK + 3.5 g RD and 5 g RD being significantly higher than the control.

Conclusions

Findings of this study suggested that in terms of growth and nutrient composition, *M oleifera* was not influenced by various levels of NPK and RD, apart from 5 g RD on dry shoot mass and P nutrient which were higher than the control. In conclusion, RD alone or with reduced amount of NPK could be used as sources of plant nutrition for attaining sustainable farming and improved biomass of *M. oleifera.*

39) The effect of soil pH and NPK fertilizer rates on the growth of warty gourd (*Lagenaria siceraria*)

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Introduction

Warty gourd (*Lagenaria siceraria*) is an important indigenous vegetable known in Southern Africa by most people. The leaves and the fruits of the plant are consumed as a vegetable and the plant leaves have medicinal benefit and is used as a headache remedy. The aim of the study was to determine the effect of soil pH and NPK on the growth of Warty gourd.

Materials and Methods

The treatments were: two soil types (acidic with pH 4.6 and alkaline with pH 7.6, which was measured in distilled water), five fertilizer rates 3:2:1 (25) at 0 kg/ha (0 g/pot); 30 kg/ha (0.93 g/pot); 60 kg/ha (1.89 g/pot); 90 kg/ha (3.73 g/pot); 120 kg/ha (4.66 g/pot). The fertilizer rates were all applied at planting in a 7 kg soil pot in the greenhouse. The soil was analysed for pH. The experiment was fitted in a complete randomized design (CRD) and the experiment was replicated 3 times. The growth parameters studied were plant height, number of leaves, stem diameter, chlorophyll content, number of fruits, number of branches, number of flowers, fresh mass and oven dry mass. The trial was planted in February 2019 and terminated in April 2019. Data was statistically analysed using the SAS program.

Results and Discussion

The results show that the crop performed well on acidic soil compared to alkaline soil. The response of the crop on the acidic soil was significantly different and the crop had a positive response on the increase of NPK rate at 120 kg/ha (4.66 g per pot) The interaction between NPK and soil pH was not significantly different. There was a significant increase on the response on the different rates of NPK applied on the crop on plant height, number of leaves, chlorophyll content, number of flowers and stem diameter.

Conclusions

The increase in NPK rate at 120 kg/ha (4.66 g) led to a significant increase in plant height, number of leaves, stem diameter, chlorophyll content, number of flowers, fresh mass and oven dry mass. Acidic soil had a significant difference on the response of the crop, which led to a significant increase on the number of leaves, plant height, stem diameter and fresh mass.

40) Effect of phosphorus application rates on the growth and nodulation of cowpea (*Vigna unguiculata L Walp*)

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Introduction

Cowpea (*Vigna unguiculata* L Walp.) is a leguminous crop grown for its leaves and seeds. It is a nutritionally important crop especially in small-scale or subsistence farmers in the semi-arid and sub-humid tropics of Africa, India and Asia. Phosphorus (P) is a major limiting nutrient in most soils in South Africa affecting plant growth. Low soil P levels and plant available P often results in poor plant growth, reduction of leaves and roots mass. The aim of the study was to assess different phosphorus fertilizer application rates on the growth and nodulation of indigenous cowpea.

Materials and Methods

The trial was conducted at North-West University Mafikeng in pots to determine the effect of phosphorus application rates on the growth and nodulation of a cowpea landrace Mae a tsilwane. The trial was planted in the first week February 2017 and terminated in the last week of April 2017. The design of the pot experiment was a Compete Randomized Design (CRD) consists of four P levels namely control with no P application, 30, 60 and 90 kg ha^{-1} (Single superphosphate) with each treatment containing three replicates. Top soil of the Coega form was used in this study, and soil analysis was done by ARC-Rustenburg. According to the analysis the soil had over 300 ppm of K, and 1 ppm of P. No inoculation or application of K was done. The data was statistically analyzed using SAS version 9.4.

Results and Discussion

P fertilizer significantly increased the number of leaves, plant height, and number of nodules compered to pots without P application. With 90 kg P ha^{-1} applied there was an increase in number of leaves and nodulation. Thus 90 kg P ha^{-1} can be recommended for the enhancement of cowpea nodulation and vegetative growth. From this study the application of phosphorus at 60 kg P ha^{-1} led to an increased in most plant parameters. The study also showed an increase in number of leaves (vegetative growth) and nodulation at 90 kg P ha^{-1}. It was also revealed that application rate at 30 kg P ha^{-1} had no significant difference in the number of leaves, number of branches, plant height and nodule weight.

Conclusions

P fertilizer significantly increased vegetative growth and nodulation. It can be concluded that 60 kg P ha^{-1} can be recommended for the enhancement of cowpea nodulation and vegetative growth. A further study will be made to look at the effects of inoculants on nodulation, and another study is needed to look at seed production.

41) Seed flow and diversity assessment of plant genetic resources conserved in two selected community seed banks in South Africa

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Introduction

In many areas, farmers are facing challenges with regard to the availability of diverse and good quality seeds that respond to the local agro- and socio-economic conditions. Although there has been no country wide assessment made of agricultural biodiversity loss, a number of field studies indicate that farmers are losing locally adapted varieties along with the associated traditional knowledge and skills in selection, storage and use. Therefore, setting up the community seed banks (CSBs), which are local institutions used to conserve and maintain locally adapted seeds, is imperative against genetic erosion and ultimately the disappearance of local varieties. The study, therefore, aimed at assessing the seed flow and the diversity of the plant genetic resources conserved in selected CSBs in South Africa.

Materials and Methods

A survey exercise was conducted in 2016 using a structured questionnaire to the farmers that are currently part of the established Gumbu and Sterkspruit community seed banks in Limpopo and Eastern Cape Provinces, respectively. In order to understand the seed flow and the diversity of the conserved plant genetic resources in both the CSBs. A total of 22 and 11 farmers, respectively from Gumbu CSB and Sterkspruit CSB, were interviewed and the data was analyzed using SPSS 20.0.

Results and Discussion

The results indicated that 100% of the farmers in Gumbu CSB were women and 95.5% of these farmers aged above 37 years whereas 4.5% were aged below 36 years. In Sterkspruit CSB, both men (63.6%) and women (36.4%) farmers were involved in these study and they were all aged above 37 years. The findings also indicated that both Gumbu CSB and Sterkspruit CSB farmers continue to rely overwhelmingly on local seed sources with an important role played by local shops for the majority of the interviewed farmers. It was revealed that Sterkspruit CSB farmers use less crop diversity and fewer seed sources than Gumbu CSB farmers and thus appear less seed secure than Gumbu CSB farmers. The number of crop varieties used by Sterkspruit CSB farmers ranged from a minimum of 1 to a maximum of 21, with an average of 8, which was half the average used by Gumbu CSB farmers (16).

Conclusions

Maximizing the seeds diversity in both the CSBs could assist in overcoming the challenges of genetic erosion of the seed varieties that have acclimatized to the local climatic conditions.

42) Examining the viability of alternative crops as a mitigation measure for elephant crop raiding

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Introduction

Elephant crop raiding causes food insecurity to subsistence farmers in the Eastern Okavango Panhandles of Botswana. Unpalatable live crops can thus be used to deter elephants from raiding crops (Gross *et al*. 2017). Chilli (*Capsicum frutescens L*.) is a common elephant deterrent crop but it is used in the processed form rather than being planted as part of the cropping systems. Also, safflower *(Carthamus tinctorius L*.) is a deterrent to some wildlife. However, its effect against elephants has never been examined. The study compared safflowerand chilli for their elephant deterrence potential and effectiveness as buffer crops against elephant raiding. We also hypothesize that groundnut (*Arachis hypogaea L.)* and cowpea (*Vigna unguiculata L. Walp)* can also be used as alternate crops for mitigating elephant raids because of their hidden fruits.

Materials and Methods

The experiment was laid out as randomized complete block design with four replications on major elephant corridors in the Okavango area in December 2018**.** There were fourteen treatments comprising maize, sorghum, cowpea, groundnuts, chilli and safflower as sole crops and maize, sorghum, groundnuts and cowpea, and crops buffered with, chillies and safflower. The IUCN data collection protocol Hoare (1999) was used for crop raiding assessment. To determine crop resilience to elephant damage, we compared frequency of elephant visitation to the plots, crop stand at harvest, crop losses, and grain yield.

Results and Discussion

Elephants visited sorghum and maize plots more than other crops and were least sighted on chilli. No elephant deterrent effect was observed in safflower. The percentage of plants damaged differed significantly ($P < 0.0001$) with the lowest damage observed in chilli and the highest in maize. Non-buffered maize and sorghum plants had the highest damage incidences. Cowpea and groundnut suffered less damage than the cereals. Safflower-buffered crops suffered more damage than chilli-buffered crops**.** Chilli-buffered crops had significantly higher yields compared to safflower buffered and non-buffered counterparts. Safflower buffered crops appeared to attract elephants and led to lower yields of legumes.

Conclusions

This study showed that chili deterred elephants from damaging crops when incorporated into the cropping systems compared to safflower. We therefore recommend that more farmers should grow chilli rather than safflower in combination with both groundnut, cowpea cereals maize and sorghum to reduce elephant raiding and crop damage. Cowpea and groundnut were better at resisting elephant raid than cereals. Revenue from these legumes could enable farmers to diversify their income and improve their socio-economic and food security.

43) Effects of sheep kraal manure application and intercropping with maize (*Zea mays*) on growth and yield of a vegetable Amaranthus accession in the Eastern Cape Province of South Africa

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Introduction

The effects of climate change have intensified water scarcity, which is a major threat to food and nutritional security in Africa due to prolonged dry seasons. This encourages consideration of adaptation mechanisms which include, promotion and inclusion of nutritious food crops with low water and few agricultural input requirements such as indigenous leafy vegetables like amaranth (*Amaranthus sp.*), African nightshade (*Solanum scabru* and *S. villosum*), jute mallow (*Corchorus olitorius*) etc. These vegetables are, in most cases, not cultivated but gathered from the wild in the Eastern Cape Province and consumed by households. There is lack of information on the effects of sheep kraal manure application on the growth performance of *Amaranthu* intercropped with maize, when cultivated. A study on the effects of sheep kraal manure application rates and intercropping with maize on the growth and yield of *Amaranthus* in the central region of the Eastern Cape was therefore conducted.

Materials and Methods

A field experiment, arranged as a split plot in a randomized complete block design (RCBD) with four replications, was conducted at Somgxada Farm near University of Fort Hare in Alice Town. Main-plots comprised of sole *Amaranthus*, maize-*Amaranthus* intercropping and sole maize. Sub-plots comprised of five sheep kraal manure rates (0, 1.3, 2.5, 5.0 and 10 tonnes per hectare {tons/ha}) and inorganic NPK fertilizer {2:3:4 (30) + 0.5% Zn} applied at a rate of 100 kilograms per hectare (kg/ha) as a positive control.

Results and Discussion

Plant height, number of leaves, stem girth and dry matter yield of *Amaranthus* increased significantly when manure rates ≥ 2.5 tons/ha were applied and compared well with plants fertilized with inorganic NPK fertilizer at 30 and 60 days after transplanting (DAT) in both sole and intercropping systems. Intercropped plants had fewer leaves, less dry shoot yield when compared to sole-cropped plants and did not respond to manure rates at 60 DAT. Generally, results of the study suggest that application of manure at the rates of 2.5 tons/ha or higher could improve growth and yield of both sole and intercropped *Amaranthus* in a similar way as the recommended inorganic NPK fertilizer at 30 DAT.

Conclusions

Manure at the rates of 2.5 t/ha or higher could improve growth and yield of both sole and intercropped *Amaranthus* in a similar way as the recommended NPK fertilizer at 30 DAT. Although *Amaranthus* yield was not affected by presence of maize at 60 DAT, maize grain yield in intercropped plants dropped significantly when compared to sole-cropped plants.

44) Effect of bio-fertilizers on growth of cereal and legume crops raised in metal-contaminated soil from a coal mine site

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Introduction

The New Largo village of the Mpumalanga Province of South Africa is an old coal mine site that is not fenced-off to prevent human activities. As a result, locals excavate coal, grow crops and rear livestock and were it not rehabilitated, the toxic effect of heavy metals could affect the growth of plants and harm humans and livestock. For example, the uptake of higher concentrations of heavy metals results in fewer leaves, abscission of older leaves, stunted leaves, leaf rolling, necrosis, chlorosis, senescence, and wilting but also reduced uptake of nutrients and water (Rabelo *et al*., 2018). Bio fertilizers on the other hand enhances the growth of plants grown in metal-contaminated soils through improved solubilisation and uptake of mineral nutrients. We however are yet to see literature on whether South African produced bio fertilizers are effective in increasing the growth of plants established in metal-contaminated soils. This study evaluated whether the growth of sorghum, maize, soybean, cowpea and Bambara groundnut would be increased by the application of mainly South Africa-produced bio fertilizers.

Materials and Methods

Soil collected from New Largo was analysed for chemical properties, as well as potted for planting of the selected plant species (maize, sorghum, cowpea and soybean). Bio fertilizers: Kelpak, *Bacillus subtilis,* Mycoroot, Vermicompost leachate, and Runyu were supplied as drench. Plants were irrigated there times in a week and grown to the flowering stage. From each plant, roots and shoots were collected, oven-dried and weighed. Data was subjected to analysis of variance using a STATISTICA version 10 software.

Results and Discussion

A comparison between the test species revealed that maize exhibited the highest root, shoot and whole-plant dry weight but least root: shoot ratio while Bambara groundnut revealed the least. The application of Kelpak to maize established in metal-contaminated soil markedly increased growth parameters while that supplied with Runyu revealed the lowest. By contrast, the growth of sorghum was increased by the application of Runyu while reduced by the supply of mycoroot. The application of the test biofertilizers showed least growth parameter compared to control plants. The root, shoot and whole-plant dry weights of cowpea were improved when grown with mycoroot compared to vermicompost, which showed the least. Lastly, growth-related parameters of soybean were markedly increased when supplied with *Bacilus subtilis* relative to the application of vermicompost. The varied response with regards to growth-related parameters of the selected cereals and legumes was to be expected and has been reported in literature (Mounde & Boh, 2015; Ojuederie & Babalola, 2017; Verma *et al*., 2019).

Conclusions

With the exception of Bambara groundnut, the application of the selected biofertilizers enhanced the growth (root, shoot and whole-plant dry weights) of maize, sorghum, cowpea, and soybean that were established in metal-contaminated soil.

45) Evaluation of different cowpea genotypes using grain yield and canning quality traits

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Introduction

Cowpea (*Vigna unguiculat* (L.) *Walp*) is an important annual leguminous crop in semi-arid and tropics(FAO, 2016).Most of cowpea grain production in South Africa is mainly used for domestic consumption, as seed planting and little or none gets to be used in industrial processing, thus, there is a need to expand utilization of cowpea through industrial processing (Henshaw,2000).

Materials and Methods

The field experiment was conducted in two locations in Limpopo Province, namely Syferkuil Agricultural Experimental farm and Ga-Molepo village during 2017/2018 growing season and canning took place at ARC-Grain Crops Potchefstroom. The experiment comprised of 100 cowpea genotypes laid out in a Randomized Complete Block Designs (RCBD). The grain yield, yield components and canning quality traits were analysed using Genstat software.

Results and Discussion

About 62 genotypes were suitable for canning, 38 were not due to their seed coat texture, and water uptake was less than 80% resulting in too soft (mushy) seeds. Grain yield for RV115 ,99k-494-6, ITOOK1263, RV111, RV353 and 53 other genotypes recorded high positive association with number of branches, pods per plant, and number of seeds per pod, unshelled weight and shelled weight for Syferkuil than at Ga-Molepo.

Conclusions

Genotypes recognized with desirable traits can be recommended for direct production by growers and/or used in breeding programme to develop new cultivars with high yield in South Africa and are therefore recommended for canning quality.

46) Effect of cabbage and spinach waste on growth of tomato (*Solanum lycopersium*)

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Introduction

Tomato (*Solanum lycopersium*) is an important vegetable crop grown throughout the world. Cultivation of the crop requires adequate supply of nutrients. Composting of vegetable wastes is reported to influence plant growth (Sharma *et al*., 2011). In this study, the effect of two vegetable wastes (cabbage and spinach) on the growth parameters of two tomato cultivars was tested under glasshouse conditions.

Materials and Methods

A factorial experiment with two tomato cultivars (Roma and Heinz 1307), and three nutritional sources (cabbage, spinach and poultry) applied at five levels each was carried out under glasshouse conditions. Poultry manure served as the control. The experiment was laid out using a randomized complete block design with six replications.

Results and Discussion

At 90 days after transplanting, the results showed significant tomato cultivar response to the treatments. The plant height, stem diameter and number of leaves of Roma VF were higher compared to Heinz 1307. The type of nutritional source and the level applied also affected the growth of tomato. Plants treated with cabbage compost had bigger stem diameter (9.36 cm), higher number of leaves (16.19) compared to those treated with spinach compost (8.28 cm and 12.56 respectively). Significant treatment and cultivar interaction effect was also noted on the growth of tomato including days to flowering. Roma VF treated with spinach compost had taller plants with bigger stem diameter and more number of leaves compared to Heinz 1307 with the same treatment. Similarly, cultivar response to the type and level of nutrients applied also was significant. The plant height, stem diameter and number of leaves of Roma VF treated with cabbage compost were different compared to Heinz 1307 with spinach compost. Spinach compost applied at 1:4 enhanced plant height, stem diameter and number of leaves of Heinz 1307 compared to other levels. Results obtained in this study are in agreement with reports by Sharma *et al*. (2011).

Conclusions

Using compost of vegetable (cabbage and spinach) waste as a nutrient source to grow tomato has significant impact on growth of tomato under glasshouse conditions.

47) Effect of intercropping with a forage legume on maize forage yield and quality

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Introduction

Intercropping is the planting of two crops simultaneously on the same piece of land for food and feed purposes. Maize as a forage crop, can supply large amounts of energy-rich forage for animal feed and it has low protein content, which is a very important ingredient of dairy cow ration. The protein supplements are necessary when the forage quality is low although it results in high feed costs for smallholder farmers. Alternative leguminous crops like cowpea *(Vigna unguiculata*) has a high level of proteins and is well- known amongst farmers. It can be intercropped with maize to improve its protein content for forage purposes. Therefore, the study sought to evaluate the forage production potential of maize and cowpea intercropping in terms of maize forage quality and total dry matter production.

Materials and Methods

Maize (*Zea mays*) and cowpea (*Vigna unguiculata*) monocultures and their mixtures at three different cropping patterns (alternate –row, within–row and mixed intercrop) were evaluated at the Kokstad Research Station during the 2017 and 2018 growing seasons. The intercrop composition was based on the replacement design (Snaydon, 1991) in which one maize plant was replaced by three cowpea plants. The trial was laid in a complete randomised block design with four replicates. Weeds, pests and diseases were controlled throughout the growing-seasons.

Results and Discussion

Sole maize had significantly higher forage yield than intercropping in 2017 while it was insignificantly different to intercropping in 2018. The sole cowpea had significantly lower forage yield in both years. Intercropping had significantly higher crude protein than sole crops and the season had no effect, however a significant interaction between treatment and season was observed. Maize forage quality in terms of crude protein was improved by intercropping; it could be because of nitrogen availability for maize in intercropping compared with its sole crops. The results concur with Eskandari *et al*. (2009), and Javanmard *et al*, (2009) who reported significantly higher crude protein (CP) content of maize-cowpea intercropping and maize intercropped with different legumes.

Conclusions

Intercropping resulted in increased maize forage quality due to availability of more nitrogen supply for maize caused by complementary interaction between the intercrops therefore intercropping with leguminous crops such as cowpea could be a viable option to improve the maize protein content for forage purposes for smallholder farmers.

48) Distribution of Ramularia leaf spot (*Ramularia collo-cygni*) on barley in South Africa

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Introduction

Ramularia leaf spot (RLS) caused by the fungus *Ramularia collo-cygni* (*Rcc*) is a seed-borne disease of barley that usually occurs late in the season. It is one of the major barley diseases worldwide, with a potential yield loss of up to 35% on susceptible varieties. Symptoms are usually observed on leaves as small dark brown rectangular spots surrounded by yellowish haloes, which may coalesce to form large necrotic areas. RLS was identified for the first time in South Africa (SA) in 2015, but the current status of this disease is uncertain. The aim of this study was to determine the distribution of *Ramularia collo-cygni* in barley growing regions in South Africa.

Materials and Methods

Surveys were conducted in different barley growing regions, including Western Cape, Northern Cape, North West and Limpopo during the 2018/19 season. Barley fields were randomly selected and checked for the presence of RLS. Leaf samples that showed RLS symptoms were collected for molecular analysis. Two different methods were used to detect the presence of *Rcc* in barley tissues. The first test was based on Loop-mediated isothermal amplification (LAMP). The LAMP approach has very high level of specificity and uses two sets of primers, that were designed based on the *Rcc* translation elongation factor gene sequence. The second method which was developed by CenGen team, SA used a gel-based marker and it's known to have higher sensitivity than LAMP method.

Results and Discussion

RLS infections were indicated by the presence of small rectangular brown spot surrounded by yellowish areas. From the 52 barley fields that were surveyed, only 21 showed RLS-type symptoms. Most of the symptomatic samples were collected from the Western Cape (95%) and remaining 5% from North West province. Trace levels of RLS-type spots were observed in most of the localities, except at four barley fields (Swellendam, Sandkraal, Bredasdorp and Roodebloem) where the severity was ±10%. *Rcc* DNA was found in 28% of the 18 samples tested. Localities where the occurrence of *Rcc* was confirmed included Napier, Riviersonderend, Roodebloem, Swellendam and Bredasdorp.

Conclusions

The study confirmed the occurrence of RLS in farmers' fields in the Western Cape. Even though only trace levels were observed, RLS has a potential to increase and cause economic loses under favourable conditions. It is therefore important to develop control measures and mitigate the potential negative impact of this disease on barley production in SA.

49) Effects of *Bacillus Subtilis* (bd233) on germination of Bambara groundnut subjected to different temperature regimes

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Introduction

Bambara groundnut is one of the important underutilized indigenous African crops grown primarily for human consumption and contributes to alleviation of malnutrition and poverty in rural communities. However, at the farm level yields decline due to rising temperatures as a consequence of climate change. Plant growth promoting rhizobacteria (PGPR) have been reported to mitigate heat stress effects on crop and improve yields. Therefore, this study's aim was to evaluate the effects of *Bacillus subtilis* (BD233) strain on germination of Bambara groundnuts landraces under elevated temperatures.

Materials and Methods

Three Bambara groundnut landraces (red, cream and brown) were inoculated with 1ml *Bacillus subtilis* (strain BD233) and incubated at three different temperature levels (24°C, 27°C and 35°C) for germination test for 14 days. The plumule length was measured daily for using a vernier caliper (Model DC-515). The bacterial strain (BD233) was grown in lysogeny broth at 37°C overnight and the culture was adjusted to 0.5 McFarland Standards with sterile distilled water. Statistical analyses were carried out using the STATISTICA (StaSoft Inc., Tulsa, OK, USA) package. Data was subjected to one-way analysis of variance (ANOVA) and the means were separated using the Fisher LSD.

Results and Discussion

Generally, BD233 strain and temperature significantly improved germination and plumule length of Bambara groundnut landraces. At 35°C, inoculation of brown Bambara groundnut landrace with *Bacillus sutilis* (BD233 strain) increased germination percentage (66.67%) and plumule length (4.95cm). The lowest germination percentage and the lowest plumule length were observed when Bambara groundnut landraces were not inoculated with strain BD233 at different temperatures.

Conclusions

This study therefore, suggests that the inoculation of Bambara groundnut with *Bacillus sutilis* (strain BD233) has a potential to minimize the effect of high temperatures and could thus, be recommended for yield improvement of this crop in the global warming.

50) Evaluation of maize (*Zea mays L.*) cultivars planted at different sites of the Vhembe district

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K	Ralivhesa	LDARD - Tshitale Service Center

Introduction

Maize is the most important grain crop grown in South Africa for human and livestock consumption. Smallholder farmers in Vhembe District of the Limpopo Province grow maize for grain production and for green mealie production. It is of importance for these farmers to know and able to select cultivars that will meet their expectations. The objective of the study was to evaluate different maize cultivars for grain yield and for green mealie production. Cultivars were offered by Monsanto Company and were unknown to our area.

Materials and Methods

Maize trials were planted at four areas *viz*. Dzindi irrigation scheme, Tshivhilwi village, Tshiombo irrigation scheme, and Mashamba village during the 2018-planting season on the 22 March 2018, 05 June 2018, 25 July 2018, and 11 September 2018 respectively. The seven cultivars included: DKC 80-30R, DKC 78-35R, DKC 73-76R, DKC 78-83R, DKC 78-79BR, DKC 73-74BRGEN, and DKC 80-40BR. The following data was collected: grain yield, hundred seed weight, plant height, number of cobs per plant, cob length, and number of lines per cob, cob weight, and plant weight.

Results and Discussion

The results revealed that the highest grain yield from all sites was produced by DKC 80-40BR (4.28 t/ha) and DKC 73-74BRGEN (3.02 t/ha) while DKC 78-35R performed best at Tshiombo irrigation scheme (5.58 t/ha) and at Mashamba (5.10 t/ha). The lowest grain yield was observed with DKC 80-30R (1.61 t/ha) and DKC 73-76R (1.29 t/ha). DKC 80-40BR won the hearts of farmers by producing two big cobs of more or less same size but failed the green mealie test, while the lower producing DKC 73-74BRGEN passed the tests due to its large and tasty cobs.

Conclusions

The results are not conclusive since observations are from one growing season. More work still requires attention for one to reach the conclusion.

51) A survey on farmers' production constraints, perceptions and preferences of cowpeas in Buhera District, Zimbabwe

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Introduction

Farmers are faced with a lot of challenges in cowpea production especially in low rainfall areas. Through surveys and interviews a lot of valuable scientific information is gathered from farmers and this can be very helpful in strengthening extension and advisory services. The objectives of the study were to determine farmers' perceptions on major constraints limiting cowpea production and identifying preferences regarding cultivars and traits.

Materials and Methods

A survey was carried out to assess the farmers' production constraints and traits and types of varieties of cowpeas that they prefer. The formal survey involved individual interviews with 100 farmers from the district and from various wards. At ward level, farmer selection for the survey was random but based on knowledge and experience of growing cowpeas. The semi-structured questionnaire had these components: cowpea production constraints and farmers' trait preferences of cowpea varieties.

Results and Discussion

Women farmers dominated the survey as they were 52% of the surveyed population and men were at 48% of the total population. Cowpea production is usually dominated by women (Sirinathsinghji, 2015). Farmers cited shortage, unavailability and cost of fertilizer, access to quality seed and labour as the major constraints in cowpea production. On abiotic factors, farmers interviewed ranked heat, drought and poor soils as major hindrances. Other constraints to cowpea farming were insect pests, diseases, drought, weeds and harvesting difficulties.

Conclusions

The study concluded that there is a need to plant drought tolerant cultivars as well as those that are resistant to problematic pests such as aphids in production as well as weevils in storage. There is also a need to avail quality and improved seeds on time especially in rain fed agriculture systems.

52) Evaluating the potential constraints of climate and soil: a case study of agroforestry sites in Limpopo and Mpumalanga provinces, South Africa

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Introduction

Agroforestry is a land use system that involve the use of woody perennial, agricultural crops and animals in combination to achieve beneficial ecological and economical interactions for food, fibre and livestock production. It is reported that wrong choice of forestry plants might have detrimental effects on crop production in agroforestry environments. Under these incompatibility conditions it is of paramount importance to find suitable alternatives to overcome reduction of crop production in the agroforestry environment. Information on suitable genotypes, soil, water and temperature is unavailable under the agroforestry systems. The objective of this study was to identify and describe various climatic variables and soil conditions in selected agroforestry sites, South Africa.

Materials and Methods

Coordinates were taken at Ratombo, Serala, MTO and SAFCOL plantations, and sent to Agriculture Research Council –Institute for Soil, Climate and Water (ARC-ISCW) for analysis. Regression analysis and spatial modelling were utilized taking into account topographic indices such as altitude, aspect, slope and distance to the sea during the development of the surface. Soil samples were collected at identified plantations and analysed for nematodes population to determine the initial population.

Results and Discussion

After data collection and analysis, the results indicated that between September to December 2019, monthly average rainfall, temperature, is probable at 50 – 250 mm and 18 – 25^{o}C, respectively. Rainwater was further analysed for 33rd percentile, median and 67th percentile which all showed excessive rainfall of over 800 – 1000 mm, respectively. Soil depth and drainage are suitable for agroforestry production, even in future 67th percentile years ahead. Soil depth is between 900 – 1200 mm, lastly soil drainage exhibited to be well excessive for agroforestry production. Nematodes population (*Pratylenchus penetrans*) in identified sampled areas were dominant above 100 eggs and juveniles per 250 g in agroforestry production. Findings suggested that rainwater, temperature and soil is not a constraint in identified agroforestry areas for the establishment of agrosilviculture. Annual rainfall resulted well above the agriculture and forestry threshold. However, the *P. penetrans* population of 25 eggs and juveniles per 250 g in sampled areas were found potential threatening to susceptible genotypes in agrosilviculture. Therefore, nematodes resistant genotypes will have to be promoted to enhance sufficient production under agroforestry environment.

Conclusions

It is recommended that the establishment and expansion of agroforestry be executed in line with the DAFF Agroforestry 2017 Implementation strategy. However, there is a need to select and use nematode resistant genotypes in the identified nematodes occurrence study areas.

53) Preliminary characterization of Tepary bean plant introductions

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Introduction

Tepary Bean (*Phaseolus acutifolius*) is a short life cycle legume originating from the semi-arid environment of North Western Mexico and South Western United States. It is cultivated in many African countries including Botswana, Kenya, Malawi, South Africa and Zimbabwe. Its productivity in South Africa is generally low compared to other legumes partly because farmers grow unimproved varieties, which are often produced for subsistence purposes on poor soils in mixed cropping systems with limited production inputs. New germplasm for utilization locally which was acquired from Mexico has not been characterized in order for it to be exploited in a breeding program.

Materials and Methods

Genetic materials there were 42 genotypes of plant introductions plus one check, which were planted in 15 L pots filled with field soil, at 4.0 cm deep 2 seeds were planted per pot in the green house. The germplasm originated from Mexico. It includes a range of seed colour types including black, brown, speckled and cream. The experiment was laid out in a 6 × 7 lattice design replicated two times. Data was collected at maturity and included: plant height, number of pods per plant, pod length, number of seeds per pod and number of seeds per plant, which are the quantitative data. Qualitative data included: flower colour and seed coat colour. Plant height was measured from the base of the plant to the tip of the main stem using a ruler, number of pods per plant, number of seeds per pod (3 pods per plant) and number of seeds per plant were counted. Pod length (3 pods per plant) was measured using a ruler.

Results and Discussion

There were significant differences among genotypes for the majority of the traits. Plant height ranged from 17.9 cm to 80.0 cm, while the average number of pods per plant ranged from 6 to 15. Pod length ranged from 3.5 to 22 cm. The average number of seeds per pod ranged from 2 to 5 and the average number of seeds per plant ranged from 3 to 49. There is potential to select each of these traits for further cultivation and improvement of the crop.

Conclusions

There was a significant difference among bean genotypes for components namely; number of seeds per pod and plant height, while the pod length and number of primary branches showed non-significant differences. Based on the reproductive traits, seven superior genotypes were selected for further evaluation.

54) Mulch-effect on weed growth, soil moisture, yield and yield components of the KwaZulu-Natal Province

Presenter: SB Radebe (Sibusiso.radebe@kzndard.gov.za)

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Introduction

Groundnuts (*Arachis hypogaea* L.) are one of the most important protein crops in South Africa. However, soil moisture and weed growth in groundnut production are the limiting factors. Mulches prevent soil water evaporation retaining soil moisture in the soil. The study assessed the impact of mulching treatments and explored economically feasibility and eco-friendly mulching options on groundnut production.

Materials and Methods

The experiment was laid out in a randomized complete block design (RCBD) with three replicates for two seasons (2012/2013 – 2014/2015) at Dundee Research Station. Six treatments included four mulching materials *viz.* (white roofing plastic, thatch grass, maize stover, Lucerne and two weeding practices *viz* hand weeding and no weeding which were studied against soil moisture levels, weed growth numbers and yield of groundnuts.

Results and Discussion

White roofing plastic at 10 – 15 cm soil depth significantly conserved 60% soil moisture followed by maize residue and thatch grass, which conserved 57% soil moisture respectively. White plastic, thatch grass and maize stover significantly reduced weed type, weed numbers and pod yield of groundnuts. Groundnut plants grown under white plastic, Lucerne, and thatch grass had the average yield of 3 t/ha.

Conclusions

The use of white roofing plastic as mulch could be costly. However, thatch grass naturally grows in abundance in the fields of KwaZulu-Natal Province of South Africa. Also thatch grass is environmentally friendly and recycles plant nutrients.

55) Introducing Moringa (*Moringa Oleifera*) as manure in maize (*Zea mays*) at Matsheremane project, Maruleng Municipality, Mopani District, Limpopo Province

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Introduction

The paper presents the potential of *Moringa oleifera* residues as manure in crops. A pot experiment designed in RCBD with six treatments was conducted. Applications of residues up to 80kg/ha increased maize performance and further applications more than 80kg/ha of residues decreased maize performance. Optimum levels of residues are required for improved performance. Moringa (*Moringa oleifera*) is being utilised for medicinal purposes and livestock fodder due to its nutritional value. The research institutions work on its adaptability to various temperature regimes, soil conditions and fertiliser amendments. However, its potential in crop production as manure was not fully investigated. The paper presents the impact of Moringa residues applied to a maize crop.

Materials and Methods

A pot experiment was carried out during 2018/19 cropping season. The experimental design was RCBD, with three replications with six treatments namely; 20 kg, 40 kg, 60 kg, 80 kg and 100 kg/ha of *Moringa oleifera* residues. Each treatment was mixed to 10 kg of soil and watered to field capacity for decomposition to occur. Two maize seeds were planted per bag per treatment and plants were thinned to one plant per bag at four weeks after planting. Data was collected on plant height, stem girth and yield, and was subjected to analysis of variance using the SAS statistical program.

Results and Discussion

The application of 80 kg/ha of moringa residues improved maize plant height and stem girth significantly ($P<0.0001$) at the Matsheremane project during the 12 weeks following planting. The application of 100kg/ha reduced plant height and stem girth significantly compared to the 80 kg/ha treatment. The application of 80 kg/ha increased grain yield significantly compared to more than all other treatments ($P<0.0001$)

Conclusions

The application of optimum amount of Moringa residues could possibly be used to improve crop performance and should be considered as manure in crops, but more data should be generated.

56) Effect of poultry manure rates on early growth of Warty gourd

Presenter: T Seepamore (theophilusseepamore@gmail.com)

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Introduction

Warty gourd (*Lagenaria siceraria*) is an important indigenous vegetable known in Southern Africa by most people. The objective of the study was to evaluate the effects of poultry manure on early growth of Warty gourd.

Materials and Methods

The experiment was carried out in a complete randomised design with 4 replications in a greenhouse. Four different rates (0, 20, 40, and 60 kg/ha) of poultry manure were used treatments to study the effects of poultry manure on early growth of warty gourd. All four rates were applied at planting in pots in the greenhouse, and the growth parameters studied were plant height, number of leaves, number of flowers, and number of branches, chlorophyll content, number of fruits, stem diameter, fresh biomass and dry biomass.

Results and Discussion

The study showed that the crop did not respond to all levels of poultry manure applied and the response to different application of poultry manure were significantly different. However, the crop showed positive respond to increased application of poultry manure. A strong positive response was observed from chlorophyll content, number of fruits and fresh and dry biomass as they increase with an increase in poultry manure rates. The crop showed a negative respond to high rate (60 kg/ha) of poultry manure in respond to plant height, number of leaves and number of branches. That poor growth was observed on the number of flowers and stem diameter, and again a poor respond was the observed in all plant variables recorded in respond the 0 kg/ha poultry manure applied. There was a significant difference on the response of chlorophyll content, number of fruits and fresh and dry biomass. There were positive and negative response in the number of leaves and number of branches as the crop responded differently from the rates. There was a significant difference in plant height, number of leaves, number of flowers, and number of branches, chlorophyll content, number of fruits, stem diameter, fresh biomass and dry biomass in response to different poultry manure rates applied.

Conclusions

The study revealed that different rates of poultry manure influences the early growth of warty gourd. High application rates of poultry manure showed a positive and negative significant different from the plant variables recorded. It was revealed that rate at 40 kg/ha of poultry manure had a significant difference in the plant height, number of leaves and number of branches. It can be concluded that 40 kg/ha can be recommended for the early growth on warty gourd.

57) Assessment of farmers' interest in participatory plant breeding in Gumbu community seed bank, Limpopo, South Africa

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Introduction

The negative impact of climate change on agriculture and therefore on food production is exacerbated by greater crop uniformity. An increasing number of studies show that biodiversity improves the capacity of agroecosystems to cope with extreme weather events and climate variability, allowing crops' evolution and adaptation to specific edaphic–climatic conditions. Participatory plant breeding (PPB), which is an approach that involve close collaboration between farmers and researchers, and other stakeholders, for plant genetic improvements, allows farmers to maintain genetic resources they value and enables them to participate in the development of new varieties that suit their needs. Therefore, the scope of the study was to assess the potential interest of the local farmers and the potential crops for PPB in Gumbu.

Materials and Methods

An exercise was conducted in 2019 at Gumbu village in the Limpopo Province, wherein a total 25 farmers that are currently members of the Gumbu Community Seed Bank, participated in the survey. In accomplishing the objective(s) of the study, a structured questionnaire was used to gather the demographic and participatory plant breeding information in the area and the data was analysed using SPSS 20.0.

Results and Discussion

The results revealed that all the participating farmers were females (100%) wherein 64% of these farmers were aged above 51 years. It was also revealed that 64% of the farmers financially depends on both farming and pension grand. The survey revealed that all the farmers were interested in being part of PPB and 28 different crop were listed for improvement then later conserved. Of these crops, 13.3% of the farmers had shown an interest on Okra followed by Cowpea (10.5%) then Sorghum (8.6%). Farmers also indicated that Okra, Cowpea and Maize were the major crops that had previously benefited from participatory crop improvements.

Conclusions

Farmers had shown an interest in being part of the participatory plant breeding and the first four main crops of interest were okra, cowpea, sorghum and maize.

58) Effect of zeolite on cabbage (*Brassica oleracea Var. capitata L*) growth, yield, water use and nutritional content

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Introduction

Cabbage (*Brassica oleracea* Var. *capitate* L.) is an important part of South African diet in both rural and urban households. The vegetable is cultivated under both commercial and smallholder conditions. Poor soil fertility and irrigation water shortage are challenges to the production of the vegetable. There is therefore, a need to find ways to improve soil fertility and increase water use efficiency, especially for smallholder farmers who cannot afford inputs. The objective of this study was to assess the effects of zeolite on cabbage growth, yield, water requirement and the nutritional quality of cabbage head.

Materials and Methods

A greenhouse pot study was conducted at the ARC Infruitec-Nietvoorbij, Stellenbosch (33.914476° S and 18.861322° E) from July to November 2018 where cabbage (variety Copenhagen) was grown on sandy soil. Temperature and relative humidity were not controlled during the period of the study. The experiment consisted of four treatments with six replicates and laid out in a randomised complete block design (RCBD). Zeolite was applied in the ratios 0:10, 1:9, 2:8, 3:7 zeolite to sandy soil. Irrigation was always applied immediately when the soil water content dropped below 50% field capacity.

Results and Discussion

Zeolite had no significant effect on plant height, leaf area, head circumference, diameter and fresh mass ($p>0.05$) of cabbage. However, dry matter content of cabbage head increased with increase in zeolite application. The amount of applied irrigation water decreased with increased zeolite, showing the water retention ability of the soil conditioner. In general, no treatment performed better than the other in terms of nutritional composition. However, zinc and boron were higher in the 0% zeolite treatment. The most abundant mineral was potassium. The nutritional values obtained for cabbage head in this study were comparable with those of traditional or wild vegetables.

Conclusions

Zeolite application did not influence cabbage growth and yield (head fresh mass) but improved dry matter contents of cabbage head as zeolite application increased. There was also a significant evidence that zeolite can contribute to improving water holding capacity of sandy soil. However, further research is required to test this type of study under a field condition.

59) Does summer and autumn rainfall have an impact on wheat yield?

Presenter: JA Strauss (johannst@elsenburg.com)

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Introduction

Rain-fed agricultural production systems based on conservation agriculture principles has shown great benefit in the sustainable production of wheat in the southern Cape. Soil structure improvement, infiltration rate and water holding capacity of the soil has been at the core of the improved sustainability. The aim of this paper is to evaluate the possible impact of rainfall in the different seasons on the eventual wheat yield.

Materials and Methods

The Tygerhoek long-term trial is currently in its 18th production year. The main systems tested consisted of two cash crop and 3 different pasture/crop systems. The rainfall data from December 2002 until the end of September 2018 was used. The impact of rainfall in summer, autumn and winter was analysed to determine the possible contribution to the eventual wheat yield. Possible system differences were also analysed using the SAS statistical analysis program. The Pearson product moment correlation was performed using the correlation procedure (PROC CORR), while stepwise linear regression and linear regression were performed using the regression procedure (PROC REG) of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Principal component analysis (PCA) with a Pearson correlation matrix was performed to investigate the relationship between the years and the different variables using XLSTAT (Version 2015.1.03.15485, Addinsoft, Paris).

Results and Discussion

The contribution of summer rainfall to the eventual annual yield was not significant and negligible. Autumn rainfall ($r = 0.67721$; $p < .0001$) had a more pronounced effect on the yield than winter rainfall ($r = 0.36493$; $p < .0.0019$) as detected with the PROC CORR procedure. In the stepwise, multiple regression showed that autumn rainfall contribution explained 15.21% of the variation in yield, while full season rainfall explained 54.79%. System differences were also detected. In three of the 5 systems autumn rain played a significant role in the eventual yield.

Conclusions

From the data, it is clear that the rainfall received and stored in the profile during autumn is significantly more important to the eventual yield of wheat produced in the winter. The belief that there should be no living plant on the field during the summer months is a therefore a myth and it opens the door to the possibility of summer cover crops.

60) An investigation of economically viable and practically feasible strategies for the control of *Senecio serratuloides* in the Koppies Dam Nature Reserve

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Introduction

Senecio serratuloides is not endemic to South Africa. Because of the concentration of game in a clumped distribution manner, some areas are underutilized and *Senecio* (very unpalatable) takes over and causing a decline in the grazing capacity. This plant was not present in the Free State. According to visual identifications, it is already present in the Northern, Eastern, and Central Free. Hypothesis: the use of herbicide can effectively control and eradicate *Senecio serratuloides* to restore the grass component of the grass-veld, thus increasing the grazing capacity of the rangeland. Aim: To effectively eradicate *Senecio* and to prevent it from becoming a huge problem, as Bankrupt Bush.

Materials and Methods

The treatments evaluated were as follows: Spray Picloram [1,0]% (HH); Spray Picloram [0,5]% (HL); Spray Picloram [0,5]% and mow (HLM); Mow twice a year (M2Y); Burn in April / May (BAT); Burn just after first rains (BSP) and No treatment (CNT). A random block design was used for 100 x 7 m plots and repeated four times. A plant survey was done in each plot with a 100 points line transect method, at 1m intervals across the length of each plot.

Results and Discussion

HH: Most effective method and cleared the veld completely in the eight-year period of the trail. HL: More or less the same results HH, but there were still some *Senecio* present after year 8.HLM: Did show a positive effect, but the use of a tractor and some other agricultural equipment make it difficult to execute. M2Y: The mowing of the treatment plot shows mixed results in variation over the years. BAT: The results vary, because of material available (severity of the fire) due to the available plant material. This was due to changing climatic conditions good rain and drought seasons, but there was a small decline in the numbers. BSP: More or less the same situation was visible in the spring burning treatment. CNT: The frequency only varies slightly over the years

Conclusions

Out of these results, it is clear the most effective control measure to control *Senecio* is by spraying it with Picloram at 1%. A further recommendation is that other herbicides, with different active ingredients be included in such a trail and the trial be conducted in other parts as well.

61) The potential use of SPAD-502 meter to assess nitrogen status in cassava (*Manihot esculenta L.*)

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Introduction

Optimal nutrient management is needed to close the cassava (*Manihot esculenta* L.) yield gap since the crop is usually cultivated with minimal or even no fertilizer inputs. The objective of the study was to evaluate the utility of the soil-plant analyses development (SPAD)-meter for assessing nitrogen (N) status in cassava.

Materials and Methods

Cassava plants (MSAF-1) were grown in bags in a greenhouse experiment, laid out in a randomized complete block design (RCBD). The treatments consisted of four N application rates (0, 100, 150 and 200 kg ha^{-1}) that were replicated three times. The SPAD-meter readings were collected from five different leaf positions (Lf_1 – Lf_5) located at the top of the main stem, recorded nine times between 15 and 180 days after transplanting (DAT). Blades of the youngest fully developed leaf (YFDL) collected at 3 – 4 months after planting (MAP) are the best tissue indicator for cassava plant's nutritional problems. Therefore, the five leaves which, were used to take SPAD readings were harvested and taken to the laboratory for N analysis at 98 DAT. Nitrogen sufficiency indices (NSI) were then used to estimate the N status of the plants.

Results and Discussion

The results showed that SPAD readings increased with time as well as increasing the N application rate. Mean readings for the lower leaves (Lf_4 and Lf_5) and Lf_3, (48.1, 44.6 and 45.2) were significantly higher ($p < 0.05$) than readings for the uppermost leaves (Lf_1 and Lf_2) (32.5 and 38.4) at 98 DAT. At 98 DAT, the mean readings for lower leaves and Lf_3 were positively correlated with the N application rates and leaf N concentration levels but, the uppermost leaves were negatively correlated. This indicated that there was a preferential distribution of N to lower leaves. Readings from the lower leaves were generally higher and had stronger relationships with the N application rates and leaf N concentration levels than Lf_3 and the upper leaves. Therefore, average readings for Lf_4 and Lf_5 were used for calculating NSI values. The N_{200} treatments had the highest average NSI = 1.04 compared to N_{100} (NSI = 0.99) and N_0 (NSI = 0.88). This indicated that N deficiency was immediately reflected in a low chlorophyll content, which was adequately registered by the SPAD-meter.

Conclusions

SPAD-meter can be used for estimating N status in cassava using the Lf_4 and Lf_5 at 98 DAT. The results showed that N should be applied at 200 kg ha^{-1} for cassava plants.

62) Early response of barley following different application methods and forms of lime

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Introduction

Soil acidity is a growth-limiting factor for crops and needs to be managed through the application of limestone. Limestone is immobile in soil. The incorporation of lime to greater depths in the soil profile is a limitation for most farmers in the Western Cape who have converted to conservation agriculture, which amongst other things, entails disturbing the soil to a minimum. The neutralisation of only the top soil by surface applied lime leads to pH stratification between the top and subsoil, which presents growth limitations for barley (*Hordeum vulgare*), a pH-sensitive crop. The aim of this study is to investigate the early response of barley to different methods of application and forms of lime.

Materials and Methods

Barley was established under ten lime treatments in a randomized block design, with four blocks. The treatments included surface application of lime with an 88% and 100% calcium carbonate equivalent, followed by crop establishment with a minimum-till planter. Once-off tillage treatments to incorporate surface applied lime into the soil, included tillage with either a disc plough or chisel plough or a ripper. Tillage is commonly used by farmers once every ten years, particularly when switching from lucerne to a cropping phase. Pelletised fine lime was applied in-row or broadcasted as well as a combination of these methods. Plant root and above ground biomass as well as leaf area index was measured.

Results and Discussion

Soils showed strong stratification of $pH_{(KCl)}$ from the 0 – 5 cm soil layer to the 15 – 30 cm soil layer. The early response of the barley root growth, leaf area index and biomass showed no treatment response ($P > 0.05$). This is likely a result of the slow response of lime in the soil, therefore showing no effect on plant growth within a period of a few months.

Conclusions

The effects of liming on crop growth is not seen within the first season, and liming should therefore be done in advance to allow reaction with the soil.

63) Identification of locally adapted improved groundnut varieties for smallholder farmers in Mpumalanga Lowveld

Presenter: NM Vilane (vilanem@mpg.gov.za)

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Introduction

Groundnut (*Arachis hypogaea L.*) is the second most important legume crop grown by the smallholder farmers in the lowveld and middleveld areas of the Mpumalanga Province. Today, groundnut is one of the most important legumes crops in the tropical and subtropical regions of the World, where rainfall is moderate, sunshine is abundant and temperature are high. It is an important cash crop grown by commercial as well as smallholder farmers in South Africa (Mathews *et al*., 2007).

Materials and Methods

The field experiments were conducted during 2017 - 2018 season to identify locally adapted groundnut varieties with greater yield for smallholder farmers in Nelspruit (25^{o} 25' 52" S: 30^{o} 57' 58" E) and Mzinti (25^{o} 41' 27" S, 31^{o} 43' 44" E). The groundnut varieties were planted in a randomized complete block design (RCBD) with 3 replications. The plot size was 4 rows of 4 m long with inter and intra – row spacing of 70 cm and 10 cm respectively. The seed placement was 5 - 7 cm deep. Analyses of variance of the data collected were performed using genstat 12th edition software package and means of the treatments were separated by the least significant difference (LSD) at 5% level.

Results and Discussion

The study showed that only 4 of the 22 varieties tested, *viz*; ICGV 07270 (1669 kg/ha), ICGV 06041 (1366 kg/ha), ICGV 07273 (1345 kg/ha) and ICGV 06040 (1230 kg/ha) had higher grain yields and a similar trend were observed with the pod yields ICGV 07270 (3130 kg/ha), ICGV 06041 (2962 kg/ha) and ICGV 07273 (2686 kg/ha and ICGV 06040 (2677 kg/ha) at Nelspruit. Furthermore 5 varieties recorded higher grain yields than Inkanyezi (control) at Mzinti ICGV 06144 (608 kg/ha), ICGV 06146 (619 kg/ha), ICGV 06041 (632 kg/ha), ICGV 06151 (640 kg/ha) and ICGV 07273 (665 kg/ha). With the pod yield, the following varieties recorded higher, ICCV 06146 (1333 kg/ha), ICCV 07273 (1274 kg/ha), ICCV 06151 (1255 kg/ha), ICCV 06041 (1214 kg/ha) and ICCV 06144 (1162 kg/ha) compared to the control variety (Inkanyezi). The differences however were not large enough to be significant.

Conclusions

Based on the current studies carried out in the Mpumalanga province the varieties ICCV06041 and ICGV 07273 were outstanding based on its grain yield and stability across locations.

64) Evaluation of water efficient maize for Africa (WEMA) in Mpumalanga Lowveld

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Introduction

Maize (*Zea mays*) is one of the most important grain crops grown by smallholder farmers in the Mpumalanga, Limpopo, KwaZulu-Natal and Eastern Cape provinces. The high sensitivity of maize to drought stress discourages smallholder farmers growing maize under rainfed conditions, from risking investment in best management practices, including quality hybrid seeds and fertilizers (Mashingaidze, 2012). As a result, average maize yields obtained by smallholder farmers are about one ton per hectare. In Sub-Saharan Africa, approximately 20 million metric tonnes of potential maize production are lost each year due to drought.

Materials and Methods

Six WEMA varieties were evaluated at three locations (1. University of Mpumalanga Farm, Nelspruit. 25°25’52” S: 30°57’ 58” E, 2. Luphisi. 25°16’51” S: 31°11’53.6” E and 3. Mbuzini.25 55’28” S: 31 56’11” E. 671m) within the Ehlanzeni district of the Mpumalanga Province during 2017 to 2018 cropping season. The performance of these varieties were compare with a standard WEMA variety WE3128 at all locations. Each variety was planted in a five-row strip of 40 to 50 m long depending on the space available at the location. The rows were laid out at 1 m apart and maize seeds were planted 6 to 7 cm deep at 30 cm apart along the rows. Observations such as stand establishment, days to tasselling, plant height at physiological maturity and grain yield were recorded from a net plot of 3 m^2 from each variety.

Results and Discussion

The results showed that all the 6 WEMA varieties out-yielded the control (WE 3128) at two locations (Mbuzini and Nelspruit). Whereas only two varieties yielded greater than the control at Luphisi. The increase in grain yield ranged from 118 to 121% at Luphisi, two varieties (WE 6208B with 3914 kg/ha and WE 6207B with 3797 kg/ha) yielded greater that the control (WE 3128 with 3225 kg/ha). However, at the University of Mpumalanga five varieties yielded higher than the control variety, the best grain yield was recorded in three varieties (WE 6207B with 4219 kg/ha, WE 6209B with 3097 kg/ha and WE 6208B with 3072 kg/ha). A similar trend was observed at Mbuzini and the best varieties were WE 6208B with 4206 kg/ha, WE 6206B with 4169 kg/ha and WE 6207B with 3975 kg/ha respectively.

Conclusions

Based on the studies carried out in Mpumalanga province, the WEMA varieties WE6207B and WE6208B were found outstanding based on grain yield and sustainability across the locations.

POSTER PRESENTATIONS – WEED SCIENCE

LISTED ALPHABETICALLY

65) Reduced glyphosate translocation correlates with glyphosate resistance in Plantago (*Plantago Lanceolata l.*) R biotype: a solid-state 31P & 13C NMR investigation.

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Introduction

Carbon-13 (^{13}C NMR) & Phosphorus- 31 (^{31}P NMR) nuclear magnetic resonance are essential tools to detect a vast array of organic & inorganic compounds (Ge *et al*. 2010). These procedures were utilised to determine the mechanism of herbicide resistance in a glyphosate resistant plantago (*Plantago lanceolata*) population.

Materials and Methods

Plantago biotypes obtained from the Robertson and Potchefstroom districts (putatively resistant (R) and susceptible (S)) were grown in small plastic pots in coarse gravel under glasshouse conditions and irrigated with a balanced nutrient solution. The mature leaves were sprayed with glyphosate and the young growing leaves were covered with aluminium foil. A drop of $^{13}C_2$ enriched glyphosate was applied at the middle of the youngest fully expanded leaf as described by Yu *et al*. (2007). Plant tissue was harvested later for in vivo solid state ^{31}P and ^{13}C NMR analysis and a set of control plants were left to grow out. The spectra's were acquired using an Agilent VNMRS 500 MHz two-channel NMR spectrometer using 4 mm zirconia rotors spinning at 10 000 Hz, utilizing a T3 HX CP MAS probe.

Results and Discussion

^{31}P NMR spectra from the S biotype gave a glyphosate signal at 13 ppm, at the same chemical shift as the (standard) C_2-labelled glyphosate and both relative to a $H_3PO_{4(aq)}$ reference standard. Glyphosate movement appears to be very quick in S biotypes and slow in R biotypes or perhaps absent (Yu *et al*. 2007), since no glyphosate signal was observed for the protected leaf of the R biotype. Similarly, for ^{13}C NMR, a small glyphosate signal was observed for the S Biotype which was established to be at 50 ppm using a $^{13}C_2$-labeled glyphosate standard.

Conclusions

Glyphosate translocation into young leaves of the R biotype was not observed. The results show lack of translocation to be the cause of glyphosate resistance in the plantago R biotype.

66) Evaluation of post emergence agro-chemicals in controlling Silverleaf Nightshade (*Solanum elaeagnifolium Cav*.)

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Introduction

Silverleaf nightshade (SLN) is a troublesome declared alien invader plant worldwide, competing with cash crops where ever it occurs. Farmers in South Africa experienced inconsistent control results with fluroxypyr, the only registered herbicide against SLN, hence the need to investigate alternative chemicals. The objective of this study was to compare five different agro-chemicals and the registered product against a control for their ability to manage SLN plant growth, at two trial sites.

Materials and Methods

Two research trials (sites Boskop & Margaretsdale) were conducted in the Tierpoort area, Free State province, South Africa. The chemical trials consisted of 6 chemical treatments and 1 water treatment (control). A randomized block design of the 7 treatments with 4 replications was laid out in old cultivated lands on both sites. The plots (6 m x 16 m) were sprayed twice during the growing season. Plant counts were done before spraying with the aid of 5 quadrates placed evenly in the inner 54 m^2 part of the plot.

Results and Discussion

At both sites, efficacy of fluroxypyr (treatment 1) was initially high and reduced SLN plants, but became less effective towards the end of 2011 and 2013 at site 1 ($P = 0.459$) and site 2 ($P = 0.937$) respectively. Glyphosate (treatment 2) supressed SLN plant growth significantly ($P<0.05$) during the first 2 years until the end of 2010 at both sites, but then the effect weakens with very little control until 2016. The trial sample DPX-EMA 208 (treatment 3) was not significantly more effective than the controls (treatment 7), except during the 2009 season at site 1 ($P = 0.017$). At the beginning of the trial, picloram (treatment 4) showed no significant control at both sites, however, in 2013 it was the second-best treatment. The effect also lasts after spraying stopped at site 1. Treatment 5 consists of two products, tebuthiuron and 2,4-D Amine. It gave the best results for all the treatments at site 1 since 2009 and for site 2 from 2011 onwards with significant less SLN plants ($P < 0.05$) compared to the controls.

Conclusions

Repeated use of treatment 5 may increase control efficacy of Silverleaf nightshade populations. Results suggested that this treatment could be a more effective substitute for controlling Silverleaf nightshade than the registered product (treatment1).

67) Investigation into the influence of smother crops on the improvement of biodiversity of insect species.

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Introduction

Insect biodiversity is under severe threat across the world. At present the rate of species decline is unprecedented. The increasing decline of arthropods can be mainly attributed to habitat loss due to agricultural intensification and ecosystem pollution by synthetic pesticides. A complex of pressures, namely insecticide- and herbicide- resistance together with environmental concerns, has prompted interest in new measures to improve current problem management practices in an agroecosystem. A sustainable alternative method of weed control involves the use of smother crops consequently reducing the dependence on herbicides. Crop diversification forms a central pillar of conservation agriculture. Thus, the use of smother crops facilitates plant diversity in the cropping system. In addition, the smother crops may act as an alternative food source and refuge for arthropod species. This will enhance the survival of these arthropods and protect the important ecosystem services they provide. This emphasizes the importance and provision of a wider ecosystem service currently limited by the over reliance on chemical crop protection methods. The aim of this research is to study the effect of smother crops on the improvement of biodiversity in a normal grain production system.

Materials and Methods

Smother crop plots were arranged in a randomised block design with four replicates in a field trial conducted at Langgewens and Tygerhoek. Treatments consisted of smother crop combinations serradella and rye, white mustard and lupin, saia oats and vetch, wheat and an untreated control plot. Two yellow water traps were placed in each treatment and these traps were emptied on a fortnightly basis. Counts were made of different insect species.

Results and Discussion

Where white mustard occurred more diamond back moths were encountered. Hover fly (*Syrphidae*) numbers, another predator of aphids, were low in all cases, which may indicate the influence of monoculture within the current production area. Hover flies are good indicators of biodiversity.

Conclusions

Integrating smother crops within a current grain production system as a safe haven for natural enemies may assist in the reduction of problem insect species in a sustainable ecologically safe manner.

68) Different cover crop mixtures compete with weeds for resources in the southern Cape.

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Introduction

Weed control has become increasingly challenging in conservation agriculture as continuous reliance on chemical herbicides results in herbicide resistance. Alternative methods for weed suppression are required to prevent dominant weeds competing with the cash crop. Cover crops are known to increase biodiversity, improve soil quality and compete with weeds. Direct competitive interference of different cover crop mixtures on weed biomass were investigated.

Materials and Methods

Ten cover crop mixtures and two controls (wheat and fallow), established in Riversdale and Riviersonderend were evaluated during the growing season in terms of resource competition. Seventeen cover crop species made up the 10 mixtures, each containing two or more of the cover crop species. Species consisted of berseem clover, crimson clover, faba beans, field peas, fodder radish, forage barley, forage oats, Japanese radish, lupins, phacelia, saia oats, spring rye, stooling rye, white clover, tillage radish, white mustard and woolly vetch. Light interception and green canopy cover were determined in-season. At cover crop termination, biomass production and botanical contribution of the cover crops and weeds were quantified. Mixed models were used to test for differences between treatments.

Results and Discussion

Light interception and green canopy cover was influenced ($P \leq 0.05$) by the interaction of days after emergence (DAE), location and treatment. Treatments at Riversdale intercepted more ($P \leq 0.05$) light and had a higher ($P \leq 0.05$) green canopy cover compared to Riviersonderend. At both locations, differences between the wheat and different cover crop mixtures were small, but more light were intercepted during the growing season and a greater green canopy cover were observed at 70 DAE compared to fallow ground. Higher rainfall at Riversdale ensured higher ($P \leq 0.05$) biomass production at termination (105 DAE) compared to Riviersonderend. At Riversdale, all treatments produced more biomass ($P \leq 0.05$) than the fallow treatment, but biomass production between the rest of the treatments were similar ($P > 0.05$). Weed biomass decreased from 2.5 t DM ha^{-1} in the fallow treatment to less than 0.4 t DM ha^{-1} in the other treatments. At Riviersonderend, biomass production in all treatments were similar ($P > 0.05$), but weed biomass decreased from 1.2 t DM ha^{-1} in the fallow treatment to less than 0.3 t DM ha^{-1} compared to the rest.

Conclusions

Differences in competition for light resources between planted cover crop mixtures, including wheat, are small. This study will continue, to determine if weed suppression is the result of resource competition only, including competition for soil nutrients, and if allelopathy from cover crops also potentially provides a suppressing effect.

POSTER PRESENTATIONS – SOIL SCIENCE

LISTED ALPHABETICALLY

69) Formation of retic properties in selected South African soils.

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Introduction

The formation of retic soil properties is governed by a conjuncture of different soil formation factors and processes. It is important to understand the genesis of soils to have a better understanding of the movement of soil particles and elements within the soil. Retic soil properties is the formation of *albic* material overlying a clay enriched subsoil (*argic or natric*), with the occurrence of albeluvic tonging (IUSS, 2014). The formation of retic soil properties is a destructive process as the soil loses is stripped from nutrients, organic material, structure and texture. This results in a soil layer with no advantages for plant growth and which is very susceptible to erosion. Controversy exist under soil scientists and experts over tongue formation, whether it is due to luviation processes or redox morphology. This study aims to characterize the selected profiles in detail physically, chemically, and morphologically; to determine which process or processes are active in the selected profiles, to determine if the formation of the *albic* material and tongues are due to luviation and/or redox morphology.

Materials and Methods

Soil samples containing albic tongues are collected from various sites. The samples are analysed for: seven fraction particle size distribution (Non-Affiliated Soil Analysis Work Committee, 1990); pH water and KCl (Non-Affiliated Soil Analysis Work Committee, 1990); Walkley-Black organic carbon content (Non-Affiliated Soil Analysis Work Committee, 1990); extractible iron and manganese with Dithionite-citrate-bicarbonate (Brinkman, 1970; Brinkman, 1979; Le Roux, 1996); oxalate and pyrophosphate Fe and Mn; ferrous iron, magnesium, and aluminium in interlayers through HF decomposition (Brinkman, 1979; Begheijn, 1979); and clay mineralogy by X-ray diffraction (Le Roux, 1996). Iron, Manganese and clay distribution determine which process are favoured. The experiments where conducted in accordance to the methods of the Non-Affiliated Soil Analysis Work Committee (1990), Soil and Plant Analysis Council (1999) and Tan (2005).

Results and Discussion

The last analyses are currently being done, therefor results and discussions can only be presented at the Combined Congress in January 2020.

Conclusions

The last analyses are currently being done, therefor results and discussions can only be presented at the Combined Congress in January 2020.

70) Stabilization of soil organic carbon within Silt+Clay Fraction in shrub- encroached grassland shallow soil

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Introduction

The encroachment of shrubs into previously open grasslands reduces the productivity of these grasslands. Intensification of shrub-encroachment affects key functions i.e. carbon (C) cycling and stabilization resulting in reduced herbaceous cover. This reduction in herbaceous cover through livestock trampling and the introduction of shrubs leads to compaction, which decreases aggregation (Podwojewski *et al*., 2014). Disturbance of soil aggregates leads to a loss C physically stabilized in shrub encroached soils. In this study, it was hypothesized that shrub-encroachment does not affect the distribution and stabilization of soil organic carbon (SOC) within aggregates of shrub-encroached plinthic soils.

Materials and Methods

In this study, a vegetation survey was conducted whereby two encroachment sites namely, open grassland (grass dominated) and shrub-encroached grassland (shrub dominated) were selected based on tree density. The average tree density for the open and shrub-encroached grassland sites were 400 and 1300 trees per hectare, respectively. Physical fractionation of surface soil (0 – 5 cm) collected from open and shrub-encroached grasslands was conducted to determine the distribution of SOC within macro-and- micro-aggregates. Soil aggregates were categorized into four fractions by a wet-sieving procedure, namely>2000 (large macro-aggregates), 212 - 2000 (small macro-aggregates), 50 - 212 (micro-aggregates) and <50 µm (silt+clay).

Results and Discussion

Both open and shrub-encroached grasslands were dominated by the small-large aggregates contributing to 46% and 50% of the aggregates respectively. Greater proportion of the SOC was stabilized in the silt+clay fraction. In this fraction, SOC was on average 133% greater in shrub-encroached compared to open grassland. The greater SOC within the silt+clay fraction is due to greater surface area and more exchange sites for carbon adsorption and organo-mineral interactions.

Conclusions

It can be concluded that the SOC physically stabilized within the silt+clay fraction is protected in the long-term. This accentuates the importance of this fraction as the main factor driving SOC stabilization in shrub-encroached grassland.

71) Suitability of selected ecotopes for the application of climate and water smart technologies.

Presenter: M Khuzwayo (mduduzi.fokazi6@gmail.com)

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Introduction

Many resource poor rural communities in arid and semi-arid areas of South Africa experience a decline in crop production due to unfavorable climatic conditions and poor soils. However, climate and water smart technologies (CWST) have the potential to improve production in a sustainable manner. The aim of this study was to characterize selected ecotopes for selected in-situ biophysical properties and use the outcomes to evaluate the suitability for the application of appropriate CWST. The term ecotope is defined as an area of land on which the natural resources (climate, topography and soil) that influence yields are reasonable homogeneous (MacVicar *et al.*, 1974).

Materials and Methods

The study was conducted in Gladstone (Free State) and in Swaymane (KwaZulu-Natal) where the Gladstone/Valsrivier (G/Va) and Swaymane/Griffin (S/Gf) ecotopes were evaluated. These ecotopes were characterized according to the procedure described by Hensley *et al.* (2019) and their suitability for the application of appropriate CWST was evaluated using criteria suggested by Botha *et al.* (2014). Each ecotope was characterized in terms of long-term (LT) climate (minimum and maximum temperature, evaporation, precipitation), soil (soil form, texture, depth) and topography (slope, locality). Profile pits were dug at each ecotope and soils were classified according to the South African soil classification system (Soil Classification Working Group, 1991). Soil samples were taken from each horizon for analysis. The slope was determined using a GPS. Ecotope characterizations were used to identify appropriate CWST for that particular ecotope. Consequently, the in-field rainwater harvesting (IRWH) and mechanized basins were selected on the S/Gf, while only IRWH was selected for the G/Va. Where IRWH was applied, it was combined with mulching, supplemental irrigation and organic manure.

Results and Discussion

G/Va (effective rooting depth > 1200 mm; 35% clay in A-horizon; 3% slope; LT precipitation 426 mm) and S/Gf (effective rooting depth > 1200 mm; 35% clay in A-horizon; 3 - 8% slope; LT precipitation 866 mm) met requirements for application of selected CWST.

Conclusions

Biophysical properties from selected ecotopes indicated that these ecotopes are suitable for the use of appropriate CWST.

72) Automated soil CO_2 flux measurement.

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Introduction

The natural soil CO_2 flux is ten times that generated by the combustion of fossil fuels (Schlesinger & Bernhardt, 2004). When the soil is disturbed (ploughed), the soil CO_2 flux increases to as much as 27% higher than the natural flux (Kidson, Swanepoel & Beukes, 2011). The understanding of the soil carbon cycle is imperative for the calculation of the soils potential C sequestration rate and C losses. The Vaisala Carbocap® infrared gas analyser was used for the measurement of soil CO_2 flux during a conservation agriculture/ploughing trial, at Zeekoeigat, near Roodeplaat (Kidson *et al.,* 2011). A limitation of using a single infrared gas analyser was the reduced number of measurements that were obtainable per day. To overcome the limitations of a single chamber, an automated system was constructed comprising three separate chambers. Commercial automated instruments for the measurement of soil CO_2 flux are available, but are relatively expensive.

Materials and Methods

An automated system was designed and built using a Campbell Scientific data logger and the Vaisala infrared gas analyser. Soil flux 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 waste air in the pipe was vented to prevent contamination. Then measurements for chambers 2 and 3 followed, returning to chamber 1.

Results and Discussion

The instrument is functioning well with a smooth transition to the next operation. The program is flexible, so additional chambers may be added to the system, and the period for measuring the soil flux can be altered. This is important as the soil CO_2 flux varies throughout the season.

Conclusions

The results, in the preliminary trial, using the automated soil CO_2 flux instrument showed that: 1) The instrument has good repeatability; 2) It gathers more data values for a research plot and 3) More data values will compensate for soil variation, providing an improved understanding of the soil's CO_2 flux.

73) Effects of zeolite soil amendment on soil microbial enzyme activities associated with potted Swiss chard and cabbage crops.

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Introduction

Soil quality deterioration limits crop production efficiency. Zeolite soil amendment has the potential to increase soil water and nutrient retention and improve soil quality. However, crops with different nutritional requirements, such as Swiss chard and cabbage, may respond differently to zeolite application. Soil enzyme activity is one of the first soil characteristics to respond to soil alterations (Adetunji *et al*. 2017) and has been shown to be affected by zeolite application. The objectives of this study were to determine whether (1) different rates of zeolite will affect soil microbial enzyme activity differently in potted soil of Swiss chard and cabbage crops and (2) enzyme activity is different under these crop types.

Materials and Methods

A greenhouse pot experiment was conducted to assess the impact of zeolite on soil microbial enzyme activity at the end of the growing season of cabbage (*Brassica oleracea* Var. *capitate* L.) and Swiss chard (*Beta vulgaris* Var. *cicla*). Zeolite was applied at the ratios 0:1, 1:9, 2:8 and 3:7 to sandy soil in 30 cm diameter plastic pots, with a total content in each pot weighing 12 kg. A basal fertilizer of 1.17 and 3 g pot^{-1} urea (46) and single-super phosphate (20), respectively, were applied to all pots. Potassium chloride (50) was also applied as basal fertilizer at 1.92 and 1.44 g pot^{-1} for cabbage and Swiss chard, respectively. A total of 2.22 and 0.66 g pot^{-1} urea were also applied to cabbage and Swiss chard in split applications, respectively. The soil enzymes analysed were *β*-glucosidase, phosphatase and urease.

Results and Discussion

The results showed that the activity of phosphatase was higher in the cabbage than in the Swiss chard soil. *β*-glucosidase and urease activities were higher in the Swiss chard than the cabbage soil. The increase in zeolite application generally increased urease enzyme activity, while it decreased that of phosphatase and *β*-glucosidase. Phosphatase and *β*-glucosidase correlated positively in both Swiss chard and cabbage soils. However, plant available phosphorus had no relationship with phosphatase activity and there was no relationship between *β*-glucosidase activity and soil carbon. While urease activity in Swiss chard soil correlated positively with NO_3-N.

Conclusions

Different rates of zeolite affect soil microbial enzyme activity differently. Crops with different nutritional requirements exert different effects on soil microbial enzyme activity.

74) Tillage, soil texture and mineralogy effects on respiration in some South African soils

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Introduction

The effects of tillage on soil structure and associated soil properties such as soil respiration may differ in different soils. The current study established how soil respiration responds to tillage in soil with different texture and mineralogy.

Materials and Methods

Soil samples were collected from four different sites in the Limpopo province, South Africa. The soils were classified as Glenrosa with sandy loam texture, Dundee with loamy sand, Hutton with clay, and Shortlands with clay. The soils were dominated with quartz in the Glenrosa and Dundee, while Hutton and Shortland with kaolinite. The samples were taken from the surface 0 – 20 cm under conventional tillage (CT) and no-till (NT) land. Soil organic matter (SOM), texture, and mineralogy were determined. The soils were wetted to activate the micro-organisms and incubated for 70 days at 30^{o}C. The soil respiration (SR) was determined using alkali trap method (Rowell, 2014) on a weekly basis. The study was conducted in triplicates and arranged in a RCBD. Data was subjected to ANOVA using GLM procedure of Minitab version 19. Means were compared using paired t-test at ($P \leq 0.05$). The Pearson correlation coefficient (r) was used to measure the strength of linear dependence between variables.

Results and Discussion

There was a significant difference in SOM among all studied soils. The difference was attributed to the texture and mineralogy of the soil. The SOM increased as the clay content increased. This was attributed to the formation of organomineral complexes between clay and organic particles with strong bonds (Nciizah and Wakindiki, 2012). This implies that clay plays a role in sequestering carbon. Quartz had a strong negative linear relationship ($r = -0.66$) with SOM, while kaolinite had a strong positive linear relationship ($r = 0.96$). The SR increased in soils dominated with quartz and decreased in soils dominated with kaolinite. This suggests that kaolinite holds SOM, thereby reduces SR. The SR increased by 18.95 g CO_2 $m^{-2}d^{-1}$ in CT and decreased by 13.88 g CO_2 $m^{-2}d^{-1}$ in NT. This could be due to increased exposure of SOM under CT, which speeds up oxidation, thus intensifying SR.

Conclusions

Soils with higher clay content and kaolinite protects organic carbon from decomposition. The SR was higher in CT than in NT in all studied soils. It was concluded that less intensive tillage such as NT will reduce SR.

75) Effect of different cover crop regimes on the enzyme based soil alteration index 3 (AI3) in a Chardonnay/Richter 99 vineyard.

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Introduction

Disturbed and variously polluted Italian soils were found by Puglisi *et al.* (2006) to be characterized by appreciably different enzyme indexes than unaltered soils. Of the indexes tested, alteration index 3 (AI3) discriminated effectively ($p > 0.005$) between altered and unaltered soils (Puglisi *et al.*, 2006). Further, in a Western Cape apple orchard, Meyer *et al.* (2014) found that AI3 correlated ($p > 0.05$) with soil organic matter, yield and yield efficiency under organic and conventional orchard soil surface management practices. These findings inspired confidence that the AI3 index could also prove to be an effective method for the quantification of soil quality and health in local vineyards. The objective of the study was to determine the effects of different cover crop regimes on AI3 in a Chardonnay/Richter 99 vineyard.

Materials and Methods

Soil samples were collected over a two-year period (2009 - 2010) from a Chardonnay/Richter 99 vineyard near Robertson, South Africa (33°50'S, 19°54'E). The experiment was a completely randomised design, with five treatments replicated four times. The five cover crop treatments were as follows: T1: Clean cultivation, with mechanical control in work row; T2: Full surface chemical control of weeds; T3: Full surface straw mulch; T8: Biennial cover crop; T5: Permanent cover crop. Soils were sampled on three occasions (February 2009, July 2009 and May 2010) at a depth of 0-15cm. *β*-glucosidase, phosphatase and urease activities were used to calculate soil alteration index scores (AI3 scores), using the formula and coefficients developed by Puglisi *et al.* (2006).

Results and Discussion

Applying full surface straw mulch (with minimal chemical control) resulted in the highest index score, implying the best soil health status; confirming wider experience that mulching favours soil microbial decomposition processes. The treatment in which full surface chemical control of weeds was applied was associated with the lowest index score and thus, reduced enzyme activities, implying the poorest soil health status. Similarly, chemical control using glyphosate was found by Meyer *et al.* (2014) to have a non-target negative effect on soil microbial enzyme activity in a Western Cape apple orchard soil. The treatment through which clean cultivation through mechanical control was applied as well as the annual and perennial cover crop treatments, were intermediate.

Conclusions

Collectively, these findings inspire confidence that the AI3 index could prove to be an effective method by which soil quality and health may be reliably quantified in vineyards of the Western Cape.

76) Synergistic effects of biochar and sewage sludge on spinach (*Spinacia oleracea L.*) yield and phosphorus availability in a Calcic Luvisol and Vertic Cambisol in Glen Valley, Botswana.

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Introduction

Few studies have investigated the role of co-application of biochar and organic amendments on soil quality and crop productivity in high-input cropping systems. In this study, field experiments investigated the effects of biochar and sewage sludge on phosphorus (P) availability and spinach yields in a Calcic Luvisol and Vertic Cambisol.

Materials and Methods

Ten treatments with 3 levels of biochar (0, 2.5, 5 tons ha^{-1}) and sewage sludge (0, 6, 12 ton ha^{-1}) were applied in each season. Co-applications increased plant-available P above chemical fertilizer in both seasons by 15 – 88% and 29 – 265% for the Luvisol and Cambisol, respectively. Significant ($p<0.05$) yield increase by 38 – 56% on the Luvisol occurred if sewage sludge was added at 12 ton ha^{-1} with or without biochar while combination of 6 tons ha^{-1} sludge and 5 ton ha^{-1} biochar application resulted in the highest ($p < 0.05$) cumulative crop yield (33.6 ton ha^{-1}) in this soil type over two seasons.

Results and Discussion

Sole biochar amendment on the Luvisol at 2.5 and 5 ton ha^{-1} increased crop yield by 53 and 65%, respectively, while, sewage sludge alone could only significantly increase crop yield if applied at 12 tons ha^{-1}. Marginal yield increase from high rates of sole organic amendments and chemical fertilizer occurred on the Cambisol, but co-applications decreased yields.

Conclusions

Our results indicate that there was greater improvement in P availability and crop yields on the Luvisol due to integration of low rates of biochar and sludge under high-input horticulture.

77) Characterization of soil texture, CEC and pH using hyperspectral proximal sensing.

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Introduction

The soil texture, CEC and pH are very much important soil properties in agriculture, because since they help to determine the soil quality of soil. They all have great effects on the soil and it is important to assess these properties in the soil in order to have up-to-date information about them. This study was aimed at assessing these parameters by the use of hyperspectral proximal sensing, which can be considered as a new tool with advantages of quick, high spatial resolution, low cost technologies well as rapidity. The objective was to identify relevant bands from hyperspectral proximal sensing that provided acceptable reflectance for determination of soil texture, CEC and pH.

Materials and Methods

Spectroradiometer was used at the farm to measure the reflectance from the surface of the sampling point. A sample was collected from each point and sent to the laboratory for analysis.

Results and Discussion

The results from the laboratory were associated with the results from the spectroradiometer. The regression models of CEC, pH water, pH (KCl), clay%, silt% and sand% had in this case predictors at wavelengths of 1877 nm, 1839 nm, 994 nm, 635 nm, 645 nm and 1833 nm, respectively. The predicted values and true values of clay%, silt%, sand% and pH (KCl or H2O) had high RMSE values and weak relationship between predicted values and true values. Although CEC also had weak agreement between predicted values and true values, it was better than all the other parameters.

Conclusions

The results did not show a good relationship and the acceptable reflectance for determination of the parameters. So it was not possible to determine soil features, such as clay and sand content and CEC based on reflected electromagnetic radiation data obtained with a spectroradiometer.

78) Sensitivity and calibration of the FT-IR spectroscopy on the concentration of heavy metal elements in solution.

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Introduction

The scale of contaminant migration from sanitation systems, depend on highly variable climatic conditions, range of geological formations and soilscapes. The analysis time, cost, laboratorial simplicity, need of chemical reagents, and sample amount per analysis is important in monitoring contaminants. The Fourier transform infrared (FT-IR) spectroscopy has emerged to be very effective in analysis of any sample (Quintelas *et al*., 2018). Advances in the IR spectroscopy has led to the use of an interferometer and the Fourier-transform algorithm. The FT-IR spectroscopy operates through the interface of an IR beam with a sample. IR radiation excites the vibration of covalent bonds between atoms. The product is an infrared spectrum that mirrors the complete chemical composition of the sample (Quintelas *et al*., 2018). Application of the (FT-IR) techniques for the investigation of heavy metal elements has significantly developed due to their flexibility and accuracy (Naumann, 2000; Quintelas *et al*., 2018). To attain reproducible results, sample treatment procedures, IR measurement techniques and IR acquisition parameters have to be controlled and calibrated rigidly (Naumann, 2000). Use of chemometric models such as PCR, relate the multiple spectral intensities from numerous calibration samples to the recognized analytes within samples, by removing the random variation (noise) and retain the principal components that capture the important variation (Thomas *et al*., 1990).

Materials and Methods

In this study, 48 leaching soil columns, PVC pipes with a height of 1.5 m and a diameter of 11 m, were packed with a 90% sandy soil at a bulk density of 1.5 and a profile depth of 0.5 m. Heavy metal solutions with known concentrations of 2, 7 and 10 mg/L of Ag, Cd, Cu, Pb and Zn were used to leach the columns. Leachates were collected at 10 intervals and analysed with the FT-IR spectroscopy for absorbance. The spectral data was calibrated with TQ- Analyst 9 software, following a quantitative analysis, PCR method. The data was transformed by smoothing using the Savitzky-Golay filter algorithm with a 3rd order polynomial.

Results and Discussion

The calibrated absorbance had good RMSEC correlation coefficients with regression squares of 0.98 (Ag, Cu, Pb) and 0.99 (Cd, Zn). Sensitivity and accuracy was done by randomly generating 50 representative leachate samples, analysed with an Atomic adsorption spectrometer and compared with the FT-IR spectroscopy.

Conclusions

FT-IR spectroscopy has demonstrated to be relatively reliable for heavy metal determination purposes with the data currently available.

79) Effect of pot leachate of different plants on the growth and development of wheat plants (*Triticum aestivum* v. SST 027) and some aspects of the soil microbial community.

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Introduction

Plant roots have a variety of functions, including anchorage of the plant, the absorption of nutrients and water, as well as the production of root secretions with growth regulating properties. Root secretions could be species specific and may contain allelopathic compounds that affect rhizosphere functions. The aim of this study was to determine the effect of leachates of different plants on the growth of the soil microbial community of recipient plants.

Materials and Methods

In this greenhouse study, Biolog EcoPlates™ were used to indicate the effect of pot leachate from six different donor plants (wheat, barley, two lupine cultivars and two ryegrass species, one of which is a known weed) on the soil microbial community of the recipient pot in which wheat was grown. Unsterilised soil obtained from two diverse localities in the Western Cape was used. Donor leachate was applied to the recipient plants weekly and its growth was monitored weekly until plants reached maturity. Soil of recipient pots were used to inoculate Biolog EcoPlate™ and the carbon utilisation patterns were compared to the pattern obtained for the soil microbial populations before treatment commenced. The same soil solution was also used to inoculate nutrient agar plates to monitor heterotrophic growth on nutrient agar.

Results and Discussion

The leachates from different plant species had different effects on the growth of the recipient wheat plants as well as on the soil. The origin of the soil used in this experiment was an important factor controlling plant-plant and plant-microbe interactions, since the effects of the same leachates from the different soils differed significantly. Biolog EcoPlates™ can be used as an indicator of the allelopathic activity of plants.

Conclusions

Findings suggest that root leachates can influence the microbial community structure in the rhizosphere and intrinsic differences of the soil is an important factor controlling plant-plant and plant-microbe interactions.

80) Impact of soil types on tepary bean (*Phaseolus acutifolius*) productivity.

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Introduction

Tepary bean (*Phaseolus acutifolius*) is a food legume, which is cultivated by growers in Limpopo province. The farms in the area cover a variety of soil types. The productivity of the legume in the various soil types has not been determined exhaustively. Therefore, the objective of this study was to determine the productivity of tepary bean using four distinct local soil types namely, Hutton (Ferralsols), Glenrosa (Leptsols), Shortlands (Luvisols) and Dundee (Fluvisols).

Materials and Methods

Soil samples from each soil type were collected at a depth of 0 – 30 cm from each of four farms located in Vhembe District (Limpopo Province), sieved and placed into 5.0 L pots prior to planting. Two seeds of tepary bean were planted per pot and subsequently thinned down to one per pot. A randomized complete block design with three replicates was used in the study. Soil organic carbon was measured using Walkley Black Method and pH was measured in water on the four distinct soil types prior to planting. The number of primary branches (NPB), number of seeds per pods (NSP), number of pods per plant (NPP) and plant height (PHT) were recorded at maturity.

Results and Discussion

At maturity PHT, NPB, NSP and NPP were subjected to the analysis of variance using Statistix 10.0. The results showed that there were significant ($P<0.05$) differences between the soil types in terms of both organic carbon (OC) and pH. In addition, there were highly significant ($P<0.01$) differences between the soil types for each of the productivity variables except for NPP. The highest NSP (4.42) and PHT (76.83 cm) were observed in the Glenrosa soil, while Hutton produced the shortest (27.70 cm) plants with the lowest NPP (7.0). Hutton and Dundee produced the lowest PHT and NPP. The productivity variables of tepary bean were influenced by variation in the organic carbon and soil pH in the Glenrosa soil. The Glenrosa soil had the highest pH of 6.75, in comparison with the Hutton (5.88), Dundee (5.79), and Shortlands (6.26). Dundee showed highest OC (1.08%) compared to other soil types. Consequently, other factors may also have affected their productivity.

Conclusions

The results suggested that, at the pH values in the current study, Glenrosa was the most productive soil for tepary bean in the area. It is recommended that liming or nutrition trials should be conducted next, in order to improve productivity on each of the soil types. Beans tend to favour a slightly higher pH soil.

81) Assessing vertical distribution of soil organic carbon stocks in Westleigh soil under shrub encroached rangeland, Limpopo Province, South Africa

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Introduction

Encroachment of shrubs and bushes into previously open grasslands has been observed in many parts of the world for the past 50 years. Shrub encroachment is the invasion of destructive unwanted woody species causing an imbalance of the grass: bush ratio. Accurate quantification of the vertical distribution of soil organic carbon (SOC) content in relation to land cover transformations, associated with shrub encroachment is crucial because deeper lying horizons have been shown to have a greater capacity to sequester SOC. Despite this, in-depth soil carbon dynamics remain poorly understood, especially in arid and semi-arid rangelands. In this study, it was hypothesized that bush encroachment reduces the level of SOC.

Materials and Methods

A vegetation survey of the study site was done whereby areas were demarcated and characterized into open and shrub-encroached grasslands. From each area, three pits were dug (randomly allocated) per encroachment level. Soil samples were collected vertically at 10 cm depth intervals at both sites, from the same soil type and topographic position. Soil samples were sent to the lab and for analyses for chemical and physical characteristics in an effort to identify the physicochemical factors controlling SOC dynamics. Pearson's correlation coefficient (r) was used to test the strength of the correlation ($P<0.05$) between SOC content and selected soil properties.

Results and Discussion

SOC content was significantly greater in the shrub-encroached area than in the open grasslands ($P<0.05$). The results showed that the proportion of SOC content was on average 19% and 13% greater in the topsoil (0 - 20 cm) and subsoil (20 - 70 cm) respectively, under shrub-encroached compared to open grasslands. Greater SOC content under shrub-encroached grassland in the topsoil may be attributed to higher SOC input from plant litter. In the topsoil, SOC content was positively correlated with phosphorus ($r = 0.60$; $P < 0.05$) while in the subsoil it was positively correlated with porosity ($r = 0.52$), phosphorus ($r = 0.54$), exchangeable calcium ($r = 0.37$), zinc ($r = 0.41$) and copper ($r = 0.46$). These findings suggest that SOC content is more chemically stabilized in the subsoil via complexation interactions with exchangeable cations and heavy metals.

Conclusions

Greater SOC is found in shrub-encroached grassland. However, SOC content under both shrub-encroached and open grasslands decreased with depth. In the subsoil, low SOC content may be due to correlated with polyvalent cations while this relationship is less apparent in the topsoil. This study highlights that factors controlling the level SOC content differ in the topsoil and the subsoil.

82) Response of soil chemical properties and inorganic phosphorus fractions to long-term fertilizer application

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Introduction

The application of phosphorus fertilizer is the most common practice to ensure crop yield in an agricultural ecosystem. However, the excessive P fertilizers and manure resulted in P accumulation in the soil and soil available P increasing, posing possible environmental hazards and an associated cost increase. Therefore, the objectives of the current study were to determine the effects of long-term fertilization with chemical fertilizers and manure on (i) selected soil properties; and (ii) inorganic P fractions in long-term experiment with three typical soils.

Materials and Methods

The long-term field experiments (22 years) were arranged in a randomized complete block design (RCBD) with three replications in Zhengzhou, Qiyang, and Gongzhuling. Five treatments assessed were (1) unfertilized control (CK); (2) nitrogen and potassium (NK); (3) nitrogen, phosphorus and potassium (NPK); (4) NPK plus farmyard manure (NPKM) and (5) NPK plus maize straw (NPKS). The application rates were 165 kg N ha^{-1}, 36 kg P ha^{-1}, 68 kg K ha^{-1}, 40.5 kg ha^{-1} manure, and 5.3 kg ha^{-1} straws for Gongzhuling; 353 kg N ha^{-1}, 62 kg P ha^{-1}, 146 kg K ha^{-1}, 40 kg ha^{-1} manure and 9.3 kg ha^{-1} straws for Zhengzhou; and 300 kg N ha^{-1}, 53 kg P ha^{-1}, 100 kg K ha^{-1}, 84 kg ha^{-1} manure and 2.76 kg ha^{-1} straws for Qiyang. Soil samples from top layer (0 – 20 cm) were selected randomly from each plot to determine soil chemical properties (soil pH, $CaCO_3$, Fe_2O_3, Al_2O_3, soil TP, Olsen P, SOM) and the soil inorganic P fractionation (Ca_2-P, Ca_8-P, Al-P, Fe-P, occluded-P, and Ca_{10}-P). An SPSS 20.0 was used for analysis of variance and means separations.

Results and Discussion

Treatments with P applications (NPK, NPKS, NPKM) increased some of the soil properties and inorganic P fractions compared with NK and CK in all the three sites. The application of chemical fertilizers with the addition of manure (NPKM) significantly increased soil Olsen P (75.25 mg kg^{-1}), total P (1.07 g kg^{-1}), SOM (20.73 g kg^{-1}) and all the inorganic P fractions such as Ca_2-P (100.21 mg kg^{-1}), Ca_8-P (162.36 mg kg^{-1}), Al-P (100.55 mg kg^{-1}), Fe-P (134.22 mg kg^{-1}),occluded-P (187.74 mg kg^{-1}), and Ca_{10}-P (236.77 mg kg^{-1}) compared with CK across the three sites. The SOM concentration was further observed to be significantly higher in Gongzhuling (20.69 g kg^{-1}) followed by Qiyang (16.53 g kg^{-1}) then Zhenzhou (13.52 g kg^{-1}) across the treatments. The Fe_2O_3 and Al_2O_3, on the other hand, were significantly higher in Qiyang, recording 4.05 g kg^{-1} and 2.59 g kg^{-1}, respectively across the treatments.

Conclusions

This study demonstrated that the combined application of manure with chemical P fertilizer is not only a better strategy for managing P in soil but also has a positive impact on the physicochemical properties of the soil.

83) Holistic approach to soil testing and external fertilizer application

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Introduction

Phosphorous and potassium in the soil exist in different fractions i.e. total amount of nutrient, the buffering fraction which influences the distribution between the solution and solid phases and the fraction held on the soil solution. Soil tests are used to determine the quantity and intensity factors of soil P and K. In many respects soil tests levels are operationally defined where the related soils buffering capacity of the soil is not included in the interpretation of the soil test results (Fox and Kamptath, 1970; Borling *et al*, 2001; Bern and Joern, 2006). The lack of specificity in these processes contribute to the inconsistencies in the calibration process. Soil testing services continue to apply a constant requirement factor (RF) value when making fertilizer recommendations (Johnston *et al*., 1999, Poswa *et al*., 2014; Elephant and Miles, 2016). The aim of this study is to determine nutrient requirement factors for phosphorous and potassium across different bio-resource groups with different soil properties under different land uses.

Materials and Methods

Soil samples from each bio-resource group were incubated with four levels of K and P using potassium dihydrogen phosphate as the source of fertilizer. Potassium levels of 0, 50, 100 and 150 mg/L and P levels of 0, 40, 79 and 119 mg/L were added. Phosphorous and potassium were extracted using four extractants namely, Melich 3, Troug, Ammonium Acetate and Bray 2.

Results and Discussion

Significant differences were observed between bio-resource groups. This warrants further investigation into the fertilizer recommendation process and its accuracy in estimating available nutrients for plant uptake.

Conclusions

Soil specific nutrient requirements factor should be used in making fertilizer recommendation.

84) The influence of selected soil properties on the functionality of ephemeral pans in the Northern Cape province, South Africa

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Introduction

The climatic conditions of the Northwestern part of South Africa promote the occurrence of ephemeral pans (Kotze, 2009). Pans are usually formed due to low perennial water flows, which are determined by low rainfall and the high evaporation of the area. Ephemeral pans have several main functions. They are able to control flooding and also sustain many different aquatic species (Kotze, 2009). The functionality of pans is influenced by several factors including the amount of rainfall in the area, evaporation rate, and the pan's soil properties. There is, however, a huge gap in knowledge regarding the pans in the Northern Cape due to lack of development, implying few or no ecological impact assessments being done in this province (Schael *et al.*, 2015). This study aims to investigate how soil properties influence the functionality of ephemeral pans in the Northern Cape Province by determining their elemental analysis, geomorphological context, vegetation, and aquatic species and lastly, by mapping the distribution of pans.

Materials and Methods

A total of 98 pans were randomly selected from four ecoregions namely: Bushmanland, Kalahari, Ghaap Plateau and Upper Karoo in the Northern Cape Province. Soil samples were collected from four randomly sited profiles in each pan, resulting in 616 soil samples. The following analyses were performed; particle size analysis, exchangeable and soluble cations, cation exchange capacity, pH, Mn, and Fe using standard methods (Non-Affiliated Soil Analysis Work Committee, 1990). Clay mineralogy was determined using X-ray diffraction analysis. The analyzed soil properties were used as an input in a GIS to model pans distribution in the Northern Cape.

Results and Discussion

Data is still being collected and will be reported on.

Conclusions

This project was important in highlighting and contributing towards the knowledge of the biodiversity of pans in the arid Northern Cape.

85) Effects of soil texture and compaction on potato (*Solanum Tuberosum*) tuber yield attributes

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Introduction

Potatoes (*Solanum tuberosum*) are grown in various soils in South Africa, which are prone to compaction. Soil compaction, in general, has a negative effect on potato crop production but there is little evidence in South Africa. Therefore, the aim of this study was to investigate the effect of compaction and soil texture on yield, length and dry matter of potato tubers.

Materials and Methods

Soils were collected from four different locations in Vhembe District (Limpopo Province, South Africa). The soils were classified as Loamy sand, fine sandy loam, sandy loam and clay. 21 kg of each soil were filled into 15 L pots and compacted into two levels of bulk density (1800 kg m^{-3} and 2500 kg m^{-3}). Sifra potato cultivar was used as a test crop. The experiment was a randomized complete block design replicated three times. Bulk density was measured before planting while yield, length and dry matter of potato tubers were measured immediately after harvest. Data was subjected to ANOVA using GLM procedure of SAS V. 9.4 and means were compared using Duncan's Multiple Range Test at ($P \leq 0.05$).

Results and Discussion

There was a significant difference among the soil types for all yield, length and dry matter of the tubers. The longest tubers (58.3 mm) were produced in the loamy sand soil. This length may be due to the excellent pore size of loamy sand which allows for easy growth of tubers. While the lowest fresh tuber yield (233.1 g pot^{-1}) and tuber dry matter (32.4 g pot^{-1}) were observed for the fine sandy loam, this could be due to the high drainage of water and nutrients necessary for the growth of tubers in fine sandy loam. The effects of compaction differed significantly ($p < 0.05$) for tuber length, tuber dry matter and tuber yield. Compaction of soil resulted in >70 % reduction in tuber length in the clay soil. This could probably be due to the high stickiness of clay soil, which makes it difficult for the tuber to strive.

Conclusions

The results indicated that soil compaction negatively affect tuber yield suggesting that the experiment be conducted in the field for more practical results.

86) Shoot, root and grain yield of chickpea (*Cicer Arietinum*) genotypes in response to biochar application

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Introduction

Low soil nutrient availability, especially nitrogen (N) limits crop growth and yield in South Africa. The study therefore investigated the effect of poultry litter (PL) biochar on growth (shoot and root) and yield of four chickpea genotypes.

Materials and Methods

A pot experiment was conducted at the University of Venda's School of Agriculture Experimental Farm situated in Thohoyandou Limpopo Province. The experiment was a 4 x 3 factorial design with Poultry biochar type (PL), three levels of biochar (BC) at 0, 15 and 30 t/ha and four chickpea genotypes of the desi cultivar. Pots measuring 25 cm height and 25 cm diameter were filled with 5 kg of loamy sand soil arranged in a complete randomized design (CRD) with three replicates. Roots and shoots collected at podding stage were dried at 105 ^{o}C to obtain dry weight. Grain yield collected at harvest maturity was air dried and weighed. Data obtained was subjected to ANOVA using GenStat and significant means were compared using LSD test at ($P \leq 0.05$).

Results and Discussion

Poultry biochar application affected shoot and root dry weight as well as grain yield. An increase in PL biochar rates generally resulted in higher root and shoot dry weight in genotype 2. The effect of biochar on grain yield was not significant in any of the four chickpea genotypes. In contrast, biochar application increased the number of seeds per pod in all four genotypes, but did not significantly increase grain yield in any of the four genotypes. The observed markedly higher root and shoot dry weight in genotype 2 compared to other genotypes could not be explained as the genotypes received the same treatment.

Conclusions

The application of biochar at 30 t/ha increased shoot and root dry weights in chickpea genotype 2. However, biochar had no significant effect on grain yield in any of the genotypes. Since this study was short term and biochar effect is envisaged to be long term, further trials that will involve PL biochar application higher than 30 t/ha and chickpea genotypes are crucial if biochar is to be used as an alternative soil amendment. More research is needed to evaluate the effect of biochar on root and shoot dry weights, involving various application rates and soil type.

87) Impact of precipitation and vegetation on soil erosion modulus and sedimentation in the Welbedacht catchment, Free State Province, South Africa

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Introduction

An ongoing research project is being conducted at the Welbedacht catchment, situated on the Caledon River near Wepener in the Free State in quaternary (D23), South Africa. The research sought to: (i) enhance our understanding on erosion modulus through the use of Revised Universal Soil Loss Equation (RUSLE) model and Geographic Information System (GIS), (ii) investigate the impact of both vegetation and precipitation on erosion modulus and sedimentation. Erosion modulus represents the soil erosion amounts per unit area and time period and used to discriminate soil erosion intensity.

Materials and Methods

Mostly secondary data namely the harmonized data, digital elevation model (DEMs), normalized difference vegetation index (NDVIs), rainfall data from ARC stations was used in this study. The RUSLE model was the applied to evaluate soil erosion through integration of several factors including climate, land use, soil, topography, and vegetation. The data for the 2011, 2013, 2014 and 2017 was used in the study. This is because these are the cross sections of the dam; also the same four periods are used for the vegetation analysis of the NDVI's, ecological restoration indicators maybe added (as they are the way of assisting recovery of an ecosystem that has been demolished).

Results and Discussion

Soil erosion intensity is expected to differ in certain periods. Rainfall simulations were done in different vegetation, soil types and crust on erodibility and runoff, which is a percentage of total simulated rain. More runoff was observed at areas that had bare soil, and there was more infiltration than runoff in areas that were covered by grass. The sediment rate at the catchment is 2.6% every year.

Conclusions

It can be concluded that both vegetation cover and rainfall intensity have an impact on soil erosion. Surface cover notably decreased the runoff and soil erosion, by increasing slope roughness and decreasing the runoff velocity.

88) Characterization and evaluation of soil resources for sustainable land use planning of Timatjatji community farm, Limpopo, South Africa

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Introduction

South Africa has limited productive lands with most of it being unsuited for agriculture (Smith, 1998). The establishment of a criteria for evaluating agricultural land potential is important for improving crop productivity. Hence decline of yields as a consequence of miss-informed land use decisions poses a threat to sustainable agriculture in South Africa. In the case of Timatjatji farm, non-uniform growth pattern of wheat crop and the yields below expectations has been one of the main concerns. In this study it was hypothesized that the variable yield production of wheat was not affected by poor land use planning.

Materials and Methods

A detailed free soil survey guided by aerial photograph, changes in slope gradient and soil surface features was conducted on a 25 ha farm to investigate the extent to which soils vary. Soil pits were dug based on the variability of soils and classified following a Taxonomic System of South Africa. Soil information was matched with bio-physical data to determine the potential of the soils. Soil, slope, land capability and land potential maps were generated using ArcGIS.

Results and Discussion

Soil varied across the farm with Sepane (25%) being the dominant soil form followed by Bonheim (21%), Rensburg (18%), Katspruit (15%), Arcadia (12%) and Dundee (9%) respectively. Capability class II corresponded to potential class L5; class III and IV were in relation with class L6; and class VI corresponded with class L7. The land capability results showed that 91% of the area was arable where only 9% was non-arable due to the accumulation of clay in the B-horizons resulting in a limiting layer. When climate of the area was considered, it further revealed that the study area has low cropping potential due to heat, moisture stress and shallow soils.

Conclusions

Timatjatji farmers failed to reach their targeted yield due to lack of knowledge and poor land use planning. Because of high soil variation, farmers should avoid uniform application of fertilizers and adapt to variable soil management. Based on land evaluation results, the farmers must consider changing their land use to planted pasture due to poor internal soil drainage and restricted effective rooting depth.

89) On-site effects of accelerated erosion on direct physical soil quality indicators

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Introduction

Accelerated soil erosion is a serious agricultural problem in South Africa limiting soil productivity and yet little is known about its effect on soil quality. This study aimed to provide a less laborious, less time consuming and inexpensive protocol of estimating the effects of accelerated erosion on soil quality.

Materials and Methods

Four sites within the Vhembe district, Limpopo Province with different soil types classified as (Glenrosa, Hutton, Shortlands and Dundee) were used. In each site, two areas classified as Not Visibly Eroded (NVE) and Visibly Eroded (VE) were assessed using physical soil quality indicators (bulk density, aggregate stability, soil moisture, soil texture and colour). The study was arranged as matched pairs design of RCBD and replicated three times. Data obtained was subjected to the student paired T-test using Minitab version 19 and significant means were compared using Turkeys HOD test at ($P \leq 0.05$).

Results and Discussion

The most stable structure was observed in NVE area as compared to VE while medium while large stones were observed in VE areas of the studied soils. Light brown colour was found in Glenrosa and Dundee in VE area, while NVE area showed dark coloured in all studied soils. Aggregate stability generally decreased by more than 10% in VE area. The decrease in aggregates stability can be attributed to detachment of aggregates during the process of erosion (Lal, 2015). Moisture content was high in Shortlands and Hutton by 14 % as compared to Dundee and Glenrosa. This could be due to high clay content in Shortlands and Hutton. Accelerated erosion had significant effect ($p \leq 0.05$) on aggregate stability and moisture content in all studied soils. Bulk density in Dundee was 1.5 g/cm3 higher than Hutton, Shortlands and Glenrosa which exhibited low bulk density of 1.3 g cm^{-3}, 1.2 g cm^{-3} and 1.1 g cm^{-3} respectively in the VE area. However, the effect of accelerated erosion was not significant for bulk density in both NVE and VE area.

Conclusions

The study showed that VE area had low aggregated stability, moisture content and increased bulk density in all studied soils. However, the effects of accelerated erosion was significant between NVE and VE area in all physical soil quality indicators examined except for bulk density. Accelerated erosion had considerably impact on VE area, which reduces quality of soils.

90) Evaluating the treatment of heavy metals in very acidic waste water by activated carbon

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Introduction

The manufacturing, mining and agriculture industries produce waste water containing a range of heavy metals (HM) and other pollutants. Waste water from these anthropogenic activities has diverse pH values, for example, electroplating (pH 1 – 2), acid mine drainage (pH 2 – 4) and landfills have a wider range (pH 4 – 9). Activated carbon (AC) has been used for water and waste-water treatment as it is a very effective adsorbent making it ideal for removing a variety of dissolved pollutants (Foo & Hameed, 2009). Highly acidic waste water poses a risk to South Africa's groundwater resources, soil and public health. The objective of this study was to determine if AC adsorption is a suitable treatment option for removing pollutants from very acidic waste water (pH < 2).

Materials and Methods

Leaching columns made from PVC pipes were packed with sandy soil (Bainsvlei soil form) and granular AC made from pinewood. The treatments comprised of AC (pH 10.2) mixed with soil at rates of 5, 10, 15 and 20 w/w % and a control (no AC), n = 3. Landfill surface runoff was collected from the Southern Bloemfontein landfill site's collection pond and its pH was lowered to below 2 with HNO_3 and stored at 4ºC for preservation. An amount of 428 mL landfill surface runoff, calculated based on the mean annual rainfall (541 mm) of the city of Bloemfontein and the diameter of the soil columns (110 mm), was used to leach the soil columns. The soil columns were leached over 16 days at 5-day intervals. Leachate was collected 24 hours after the leaching event and analysed for Zn, Pb, Cu and Fe, using an ICP, and the pH and electrical conductivity (EC) were measured before and after leaching.

Results and Discussion

Only the 5% (w/w) treatment produced leachate after the first leaching event due to the large internal surface area and highly developed porous structure of the AC. More leachates were collected over time and only after the fourth event did the 20% (w/w) soil column produce 260 mL leachate, showing the highest water holding capacity of 85%. After leaching, the pH increased from approximately 1.8 to between pH 8.5 and 9.1 for all treatments. The pH increased from below 2 to above 8 for all soil columns with AC, implying that the HM solubility decreases and are adsorbed onto the AC or precipitated (Bourgh & Loch, 1995). The EC results showed that there was a decrease in concentration of salts (from 6.93 to 2.4 mS cm^{-1}), and the amount of AC mixed in with soil does not influence the salt content.

Conclusions

Soil amended with AC increased the WHC by up to 85%. The increase in pH and decrease in EC indicated the possibility that HM, salts and other matter were adsorbed onto the AC and removed from the modified landfill surface runoff. This suggests that AC influences the water retention properties of soil and has the potential to adsorb heavy metals and other pollutants from very acid waste water.

91) Evaluation of technology exchange tools to empower rural communities

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Introduction

Community backing for agricultural research can be a vital action to increase the competitiveness of the national agricultural sector. New technologies are often introduced to rural communities in order to improve their rural livelihoods, but not yielding the anticipated outcomes. Various technology exchange tools can be applied to capacitate impoverished rural communities with the necessary skills and knowledge to use the new technologies successfully. It was hypothesized that practical hands-on training is the most efficient tool to empower rural communities.

Materials and Methods

Field demonstrations/experiments were carried out at homesteads and croplands in the Krwakrwa community near Alice in the Eastern Cape in order to demonstrate appropriate rainwater harvesting techniques to increase crop production and biogas production as renewable energy source. Information on the use and application of the new technologies were provided to community members by means of knowledge transfer and technical-knowhow. Tools used during technology exchange included: joint research, cooperative agreements with community members, technical community meetings, trade shows, information distribution through posters, pamphlets, training manuals, educational agricultural videos, 3-dimentional scale models as well as practical hands-on training. Empowerment, as capacity building through technology exchange, was evaluated by assessing skill transfer, skill application, increased individual confidence and community application and expansion.

Results and Discussion

As in-field rainwater harvesting (for food production) and biogas production (renewable energy) are new concepts that community members are not familiar with, they found it difficult to understand the principles of these technologies. Many of the aging community members are illiterate and could not read and understand the training manuals provided. Communication was not in their mother tongue language and slowed down the reception concept. Where practical hands-on training was provided community members were able to grasp complicated processes such as runoff, evapotranspiration and feeding and maintenance of bio-digesters easily.

Conclusions

Hands-on training and visual observations of benefits (increased crop production / reduced energy costs) proved to be the most efficient tools for the uptake of new technologies. Care should therefore be taken to ensure that the correct technology exchange tools are used to introduce new technologies to rural community members.

NOTES

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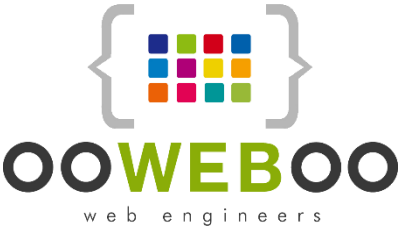

Thank you!