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ABSTRACTS

ORAL PRESENTATIONS

LISTED ALPHABETICALLY

Rapid Incineration of Soil Organic Carbon

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INTRODUCTION

Testing soil organic carbon (SOC) is costly and results are variable. The two standard methods are dry combustion (LECO) and wet chemical oxidation (Walkley-Black). Both of these methods are lacking in precision, and both require sophisticated laboratory equipment and trained technicians. Given the increase in interest in carbon sequestration, low-cost testing methods have attracted substantial interest from farmers and project managers. Experiments with a field technique for rapid incineration of SOC are described.

MATERIALS AND METHODS

The rapid incineration field test (RIFT) for determining SOC involves the direct application of intense heat, above 1000 °C, from a physical blue flame under pressure typically delivered through a butane torch lighter. In order to illustrate effectiveness and accuracy RIFT was correlated with a reference method, dry combustion with a LECO device, and with another commonly used indirect method, i.e., the Walkley-Black wet chemical oxidation method. Eleven soil forms were collected from the Southern Cape region and they were subjected to the three testing methods. Furthermore it was thought prudent to ascertain whether the accuracy of RIFT can be improved by correcting for another variable like clay. A correction matrix tool for enhancing RIFT accuracy with the use of clay content was developed.

RESULTS AND DISCUSSION

It was found that RIFT is as effective as dry combustion LECO analysis, and in 72% of the soil forms even more effective than Walkley-Black with correlation coefficients $r = 0.9434$, $p < 0.01$; $R^2 = 0.8899$. On application of the correction matrix tool the correlation coefficients improved significantly to $r = 0.9771$, $p < 0.01$; $R^2 = 0.9548$. Another finding was also that RIFT illustrated less variability than both the LECO and Walkley-Black methods. Lastly it was ascertained that the RIFT device and methodology is indeed more cost effective, less energy dependent, faster and safer in terms of the need to use potentially hazardous chemicals.

CONCLUSIONS

The rapid incineration technique provides a cost-effective, reliable alternative to more costly (and polluting) established techniques, and further studies are recommended on a wider range of soils.

***Keywords**:* Soil organic carbon, Rapid Incineration Field Test, dry combustion, loss-on-ignition, wet chemical oxidation.

THE EFFECT OF DIFFERENT COVER CROPS ON THE SOIL AND NUTRIENT STATUS OF NON-BEARING 'ROYAL GALA'/ MM 109 APPLE TREES.

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INTRODUCTION

Selected annual cover crops can be used to suppress weeds and nematodes. A soil health factor that demands attention is the organic carbon (%C) content of soils. Nitrogen-fixing cover crops can supplement/replace inorganic nitrogen applications. Therefore, the effect of different cover crops on the soil nutrient status and carbon content are being investigated.

MATERIALS AND METHODS

Five cover crop treatments were applied at Vyeboom farm ($34^0$05'18.11'S-$19^0$05'22.57''E) near Grabouw, namely *Festuca arundinacae* (dwarf Fescue) (B1), *Avena strigosa* cv Saia (Saia oats) (B2), *Ornithopus sativus* cv Emena (pink Seradella) (B3), a mixture of Saia oats and pink Seradella (B4), as well as a mixture of *Brassica napus* cv. AVgarnet (canola) and *Brassica juncea* cv. Caliente 199 (Caliente) (B5). The %C and nutrient status of the soil, was determined end of October. The N_{tin} was monitored fortnightly until the end of January.

RESULTS AND DISCUSSION

The dry matter production (DMP) of the Saia oats and pink Seradella mixture (B4) was the highest (7.63 t/ha), followed by the Saia oats monoculture (B2) with a DMP of 5.29 t/ha. The %C in the soil of B1 tended to be lower than that of B2, B3, B4 and B5. The N_{tin} in the 0-75 mm soil layer of B2, B3, B4 and B5 exceeded that of B1 from 28 October to 20 December 2013, with the exception of B2 and B5 on 28 October, as well as B5 on 27 November.

CONCLUSIONS

The annual cover crops tended to increase the %C in the soil, as well as made N more readily available to the tree roots. The permanent cover crop caused the total soil in-organic N to be less than the generally accepted norm of 10-15 mg/kg. N is more readily available to the tree roots during the growing season. This lasts longer where an N – fixing monoculture is used.

ACKNOWLEDGEMENTS

HortgroScience, National Research Foundation of South Africa (NRF-THRIP TP120807633) and ARC for financial support.

***Keywords**:* Cover crops, inorganic nitrogen, organic carbon, soil nutrient status.

EFFECT OF AMARANTHUS CRUENTUS L. RESIDUES AND EXTRACTS ON LETTUCE (LACTUCA SATIVA L.) SEED GERMINATION AND SEEDLING GROWTH

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INTRODUCTION

Allelopathy is the process through which certain plants, weeds and crop species, release chemicals affecting other species growing in the surrounding area. These phytochemicals can leach into the soil to succeeding plants and can either inhibit or stimulate their germination, growth and yield of other plants. Several amaranth species have allelopathic properties, and leaf extracts and residues from *Amaranthus cruentus* have been shown to inhibit lettuce germination and seedling growth. The aim of this trial was to examine the effect of different varieties of A. cruentus on lettuce germination and growth.

MATERIALS AND METHODS

The allelopathic potential of plant residues and extracts from three varieties of *A. cruentus* (Anna, Arusha and Imbaya) were evaluated. Dried plant leaves were finely ground and extracted with dichloromethane (DCM), methanol and water. A double layered agar (5%w/v) technique was used to evaluate the effect of the dried plant residues (10 and 50 mg $10mL^{-1}$) and extracts (5, 10 and 20 mg $10mL^{-1}$) on seed germination and growth of lettuce seedlings. The extracts were dissolved in the respective solvents (1 ml) and transferred to filter paper which was placed between agar layers in six-well plastic dishes. Filter papers with only the solvents were used as controls. Five lettuce seeds were placed on the top surface of the agar. A completely randomised bock design was used with three replicates. After three days the lengths of the radicle and hypocotyl, as well as germination percentage were determined. All results were compared to the controls and subjected to statistical analysis.

RESULTS AND DISCUSSION

Seed germination was most markedly inhibited by residues of Arusha (26.7%). Radical growth was inhibited significantly by residues of all three varieties at 1mg mL^{-1}, although Anna caused the most severe inhibition of 93%. Residues of cultivar Anna was also responsible for 86% inhibition of hypocotyl elongation at 1mg mL^{-1}. All residues of the varieties inhibited radical and hypocotyl growth severely by up to 97% at 5mg mL^{-1}. Even at the lowest concentration of extracts for all the varieties inhibited of seed germination (80-90%) as well as organ elongation. DCM and water extracts of Arusha and Anna were most inhibiting whereas the methanol extract of Imbaya caused the greatest reduction in organ development.

CONCLUSIONS

Residues of all three all Amaranth varieties caused a significant reduction in organ elongation, with the greatest effect being found at the highest concentration. Water and DCM extracts showed the highest inhibition of germination and organ elongation for all the varieties.

Keywords: Allelopathy, Amaranth, Extracts, Germination, Seedling, Varieties

EFFECT OF MESOTRIONE RESIDUES ON SOME DRY BEAN CULTIVARS

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INTRODUCTION

Mesotrione, a callistone or triketone herbicide, is registered in South Africa for the control of annual broadleaf weeds and grasses in maize. At recommended rates mesotrione persists in the soil and waiting periods of up to 24 months are recommended prior to planting sensitive crops. It would be useful to know if cultivars of sensitive crops show differences in sensitivity to mesotrione. The objectives of this study were to determine if differences in sensitivity to mesotrione occurred in some dry bean cultivars, as well as the lowest concentration that would cause significant damage to dry bean seedlings.

MATERIALS AND METHODS

A pot trial was carried out in an air-conditioned glasshouse (28/18°C day/night) at Bloemfontein. Two small white canning bean (Teebus RCR2 and S-RR1) and six red speckled bean cultivars (Tygerberg, Kranskop HR1, PAN 9249, PAN 116, PAN 148 and PAN 128), were incorporated into this trial. Mesotrione was applied at 51.2, 1.6, 5 x 10^{-2}, 1.5 x 10^{-3}, 4.9 x 10^{-4}, 1.5 x 10^{-6}, 4.8 x 10^{-8} and 0 µg ai kg^{-1} soil. Herbicide and water, sufficient to bring the soil to 70% FC, was thoroughly mixed into 1.27kg of soil in a polythene bag, which was then placed in the pot before six seeds were planted and the bag sealed to prevent evaporation of moisture. Bags were opened once seedlings had emerged. Numbers of days to emergence, number of emerged seedlings as well as phytotoxicity symptoms were monitored. Harvesting took place after 28 days and plant height in addition to mass (fresh and dry) determined. All data were converted to a percentage of the control treatments to negate inherent cultivar differences prior to statistical analysis.

RESULTS AND DISCUSSION

Symptoms varied from bleaching and necrosis at the higher rates, through malformed and crinkled leaves to no symptoms at the lowest rates. Highly significant effects due to both cultivar and mesotrione rate were noted on plant height, and a highly significant interaction effect on dry mass. Emergence percentage, between 80 and 100%, was only affected by cultivar ($P<0.01$). Mesotrione decreased both plant height (65%) and dry mass (56%) at 51.2 µg ai kg^{-1}, and dry mass (23%) at 1.6 µg ai kg^{-1}, but no statistical decreases from the untreated control were noted at any other application rates. Plants of PAN9249 were taller than those of PAN116. It was not possible to group the cultivars based on their reaction to mesotrione, indicating that both the small white canning beans and speckled beans were equally susceptible to mesotrione, although small white beans were more sensitive than the speckled beans at 51.2 µg ai ha^{-1}, these differences disappeared at higher concentrations.

CONCLUSIONS

Significant damage was caused up to 1.6 µg kg^{-1} mesotrione, equivalent to the amount in this soil approximately 90 days after application. The 270 day waiting period prior to planting dry beans is sufficient to avoid damage to the cultivars tested on the soil type used. There are cultivar differences in sensitivity, but no distinct groups could be identified, even at the highest rate of application. This trial should be repeated using more soil types and a wider selection of cultivars.

Keywords: mesotrione, phytotoxicity, sensitivity, waiting period

WATER STRESS PRIOR TO ANTHESIS RESULTS IN HIGHEST YIELD LOSS IN UPLAND RICE (*ORYZA SATIVA CV. NERICA*)

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INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food crop for 50% of the human population. Upland rice cultivation is gaining popularity as a water-saving system as production in lowlands is threatened by water shortages. Limited knowledge on effects of intermittent water stress (WS) on upland rice growth and production remains a hindrance to improvements in adapting rice to water-limited conditions and improving water use efficiency. If rice growth parameters are properly defined over a range of soil water conditions, it will aid in explaining the contribution of WS to yield gaps in upland rice.

MATERIALS AND METHODS

Upland rice (cv. NERICA 4®) was grown under a rain-out shelter using optimal agronomic management practices. In addition to a well-watered control (CT), four WS treatments were imposed for the duration of different growth stages (GS): tillering (Ti), panicle initiation (PI), anthesis (AT) and grain filling (GF). During the WS treatments, irrigation was withheld at GS. Weekly measurements of soil water content, tiller number, plant height, leaf area index (LAI), fractional interception of radiation, stomatal conductance during WS, dry matter yield (DM) of stems, leaves, panicles and spikelets were taken and data analyzed using SAS version 9.3.

RESULTS AND DISCUSSION

Early WS before AT reduced growth and yield parameters significantly ($p < 0.001$), more than WS after AT, especially from PI to physiological maturity (PM). A delay in number of days to PI, booting, first flower and AT stages in early-stressed rice was highly significant ($p < 0.001$) compared to other treatments, although the plants tended to matured at the same time as CT. Reduction in total leaf area duration (LAD) at PM was highest for rice stressed at Ti. Grain yield (GY) and top DM at harvest were correlated ($p < 0.05$, $r = 0.50$-0.67) to LAD, showing that smaller canopies due to early WS translated into less final dry matter yield. Unexpected, spikelet sterility was significantly ($p = 0.037$) reduced only for Ti but the 1000-grain mass at harvest was similar (22.2±0.9 g). Generally, GY and harvest index (HI) at PM reduced but it was only significant for Ti and PI. Estimated GY and HI at harvest were at least 50% lower for Ti and PI, compared to CT (4.46 Mg ha^{-1} and 0.42, respectively). The increase in flag leaf N concentration (g 100 g^{-1}) that was observed at AT for Ti (3.5) and PI (3.84), compared to CT (3.26) could not be explained with leaf area after recovery.

CONCLUSIONS

Early WS had the most profound effect on upland rice yield performance due to reduction in LAD. Morpho-physiological responses are particularly significant in early GS and may be useful in explaining phenological requirements of Nerica in water-limited upland areas.

Keywords: deficit irrigation, leaf area duration, New Rice for Africa®, phenology

USING POOR QUALITY MINE WATER FOR IRRIGATION: ARE THERE OPPORTUNITIES FOR INCREASING GYPSUM IMMOBILISATION?

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INTRODUCTION
The imminent acid mine drainage (AMD) problem facing the Vaal Basin potentially has major economic, social and environmental repercussions. Previous work done by the University of Pretoria in Mpumalanga has shown that common field crops can be economically grown using poor quality coal mine water when the water contains relatively high concentrations of calcium and sulfate. The reason for this is that as the crops transpire and concentrate the soil solution, the calcium and sulfate ions precipitate out as gypsum and so are effectively removed from the water. This results in root zone salinity being maintained at levels suitable for crop production and far below what would be expected when irrigating with saline water containing higher levels of more soluble ions such as sodium, magnesium and chloride. Furthermore, gypsum precipitation was found not to result in any physical or chemical changes that would adversely affect soil productivity over the long-term. In this study, we investigated the use of irrigation as part of a treatment strategy for the more pressing gold mine water problem.

MATERIALS AND METHODS
A laboratory-based study was used to evaluate (a) the use of local iron-manganese wad and aluminium sulfate as alternative treatments to standard neutralisation with lime, and (b) to experimentally simulate land treatment of the mine water using Ergo mine tailings and two soils. Long-term simulations of crop growth and salt dynamics using the point scale SWB-Sci model were conducted to investigate the fate of salts in cropping systems located in the Vaal Basin when irrigating with neutralised mine water.

RESULTS AND DISCUSSION
Direct application of raw AMD to mine tailings resulted in about 75% of the salts being sequestered, while application to a black clay resulted in as much as 90% salt sequestration. For the long-term simulations, an estimated 34-69% of added salts could be precipitated as gypsum. Highest gypsum precipitation was estimated for the Western Basin mine water neutralised using limestone and lime or neutralised using a limed-aluminium sulfate treatment. Root zone salinity levels were simulated to remain below the threshold which would have an impact on wheat and soybean growth, while yields of maize were simulated to be impacted consistent with this crop's greater sensitivity to salt.

CONCLUSIONS
Based on these results, it is recommended that the irrigation option of treating neutralised gold mine water be investigated more thoroughly, as this could present a way of dealing with this water in a way that is not as energy intensive and expensive as reverse osmosis.

ACKNOWLEDGEMENTS
This paper is based on findings from two Water Research Commission (WRC) projects to be completed in 2014 (WRC project numbers K5/2233//3 and K8/1058//3). Financial and technical support from the WRC is hereby acknowledged.

Keywords: acid mine drainage, quality

EMERGY EVALUATION OF WHEAT PRODUCTION UNDER RESOURCE-CONSERVING AGRICULTURE IN NORTHERN ETHIOPIA

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INTRODUCTION

Resource-conserving agriculture (RCA) combines *in situ* soil and water conservation tillage practices (*terwah* and *derdero*) with conservation agriculture improved soil quality and crop yield to minimize environmental impacts. Emergy analysis was used to analyse three tillage systems of RCA, to compare and contrast resource use, productivity, environmental impact and overall sustainability of wheat production systems in northern Ethiopia.

MATERIALS AND METHODS

Emergy analysis of wheat grown, in 2009 and 2013, under RCA was conducted based on Odum's (1996) findings in northern Ethiopia. Three tillage treatments were used as described in Tesfay et al. (2012): (i) *Derdero+ (*DER+) was a bed and furrow planting system, ploughed once at planting time by refreshing the furrows and 30% of crop residue retained (ii) *Terwah+* (TER+) was similar to DER+ except the furrows made at 1.5 m interval and (iii) Conventional tillage (CT) ploughed three times and crop residue removed. Emergy indices of empower density (ED), environmental loading ratio (ELR), environmental sustainability index (ESI) and Emergy yield ratio (EYR) were calculated for each planting system.

RESULTS AND DISCUSSION

The Emergy (seJ ha^{-1} yr^{-1}) for the proportion of free non-renewable resources among which runoff, soil loss and loss of SOM in 2009 and 2013 was significantly higher with CT (6.64E8) and (1.13E9) was followed by TER+ (5.04E8) and (5.65E8) with DER+ the lowest with (2.99E8) and (2.96E8), respectively. The total wheat production Emergy obtained in both years was significantly the highest in DER+ followed by TER+ and the lowest in CT. The Emergy of purchased inputs (fertilizer, seed, labour, animal power, herbicide), in 2009 and 2013, were 1.86E15 and 7.65E15, 2.49E15 and 1.84E15 and 9.84E+15 and 1.57E15 in DER+, TER+ and CT, respectively. The total purchased input Emergy for CT was largest due to frequent plowing and high labour required for weeding, while in RCA tillage was done once and weed was controlled with glyphosate. The ELR of wheat production in 2009 and 2013 was 1.89E9 and 1.04E9, 2.53E+9 and 1.22E9, 1.0E10 and 5.07E9 in DER+, TER+ and CT, respectively.

CONSLUSION

The lowest values of ESI and ED with DER+ followed by TER+ and highest with CT, indicating the highest level of sustainability in the DER+ planting system. Emergy indices measurements showed that the CT planting system had the greatest environmental impact (stress) on the farming system in both years (2009 and 2013).

Keywords: conservation, sustainability, wheat

STIMULATING AFRICAN ORGANIC FOOD PRODUCTION

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INTRODUCTION

The problems of African food insecurity have been well documented, and many projects aim to support small scale farmers with research and extension advice. Fewer provide support with market linkages, and this paper reports on three initiatives which have successfully reduced smallholder production risks through market support.

MATERIALS AND METHODS

Work on the KwaZulu-Natal South Coast (Margate) by the *Siyavuna Development Centre* shows that if the risk of marketing is removed, farmers do respond. Results of a questionnaire carried out on a representative sample of the member farmers examines how they have been able to expand production with assistance from the Centre.

Supplementary to this survey, two research projects from Uganda (twelve years, 500,000 organic farmers) and Zambia (six years, 40,000 organic farmers) show how these two National Organic Agricultural Movements are supporting emerging commercial farmers.

The first survey summarises an M Tech study just nearing completion, and the Ugandan and Zambian studies are part of two new doctoral proposals under development.

RESULTS AND DISCUSSION

Five critical factors that limit the ability of smallholder farmers to participate in the fresh produce supply chain were identified by the *Siyavuna Development Centre*: The first critical factor, transport and distance to markets, is related to the physical distance to the market. The second factor is product quality which also relates to product standards and packaging. The third factor is product quantity relating to the production volumes, consistency and variety of supply and access to storage facilities. The fourth critical factor is the relationship between the seller and buyer. The barriers to entry are mainly related to the power relations, type of trade agreement and trade price. The last critical factor relates to barriers to entry due to a lack of, or inaccurate market information.

In Uganda, farmer training, organic certification and access to export markets were identified as key constraints, and were addressed by the development of training capacity and by the Export Project for Organic Products from Africa (EPOPA). This grew from a small beginning in 2002 to the export of US$35 million worth of certified organic produce in 2012 (pineapples, bananas, cashew nuts, cotton, coffee, vanilla and shea butter). Key factors were the development of training courses and capacity, the establishment of a local organic certification agency (UgoCert) and closer links between exporters and producers.

In Zambia, the scale of production was more modest, with only small support from EPOPA, and slow but steady growth over the past six years; the successful strategies are not yet clear to the researchers.

CONCLUSIONS

Stimulating commercial organic production requires risk reduction and market development. Quality management is important, both for certification and for meeting consumer demands. Capacity building should take the form of marketing support, farmer training and institution building.

Keywords: Organic farming systems; farmer support.

WEED SPECIES COMPOSITION AND DENSITY FOLLOWING SIX YEARS OF CONSERVATION AGRICULTURE

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INTRODUCTION

Conservation agriculture (CA) is a sustainable management system that optimises yield while reducing input costs. Despite achieving great successes in the adoption of CA practices, weed management remains one of the biggest challenges. Weed dynamics are strongly linked to tillage practices, crop rotation and cover crops – all the aspects associated with adoption of CA. This study evaluated weed species and density after six years of practising CA.

MATERIAL AND METHODS

Thirty-six plots were selected from the Zeekoegat CA trial, north of Pretoria. The treatments included tillage practice (reduced (RT) vs. conventional (CT)), cropping system (maize monoculture, maize/soybean rotation and maize/cowpea intercropping) and fertilizer level (optimal vs. low). Weed species composition and biomass were determined from 2 x 1 m^2 quadrats in each plot. Soil samples for weed seed bank analysis were collected at 0-5, 5-10 and 10-15 cm depths using a hand-held spade and soil auger. The soil samples were placed in plastic containers in a glasshouse for germination tests. Seeds were allowed to germinate for 20 days, during which new emerging seeds were identified and removed daily. When no new seeds germinated, the soil was turned over for a second assessment whereby the seeds from the bottom were allowed to germinate.

RESULTS AND DISCUSSION

A total of 11 weed species were identified in the field experiment under both RT and CT. Tillage had a significant effect ($P<0.05$) on weed biomass, with an average of 153.33 g/m^2 and 241.66 g/m^2 for RT and CT respectively. However, tillage had no significant effect ($P>0.05$) on weed density. Nineteen weed species were identified in the soil seed bank samples. The results from the weed seed bank trial showed a significant effect of tillage. The total number of germinated weed seeds in the seed bank study was significantly higher ($P<0.05$) in RT compared to CT plots. The number of weed seeds that germinated across all depths was statistically similar for CT, while RT had a higher number of germinated seeds at 0.5 cm depth, and the weed numbers declined with soil depth.

CONCLUSION

After six years of practising CA it was found that tillage had a significant effect on weed biomass, which was higher in CT compared to RT plots. No effects of cropping system or fertilizer level were measured. Weed seed bank trials indicated equal distribution of weed seeds throughout the soil profile, while weed seeds were more abundant at the surface of the RT soils.

Keywords: Tillage, Weed biomass, Weed management, Weed seed bank

SHOULD BREEDING EFFORTS ALSO FOCUS ON BREEDING FOR NUTRITIONAL QUALITY IN SOUTH AFRICAN WHEAT CULTIVARS?

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INTRODUCTION

The ultimate goal of any research programme engaged in agriculture or food science is to ensure that efforts are put into contributing to food security at all levels. However, malnutrition still remains a major global challenge to human health mostly in African countries. Wheat (*Triticum aestivum* L.) grain houses a number of attractive health beneficial constituents in various forms that have increasingly being associated with improved health upon regular consumption. Wheat is an important crop which is widely used for the production of various products including bread which is highly consumed by many South Africans on a regular basis. Inexplicably, mineral malnutrition and the impact of other diseases that develop as a result of malnourishment in humans still remain quite prevalent in South Africa, and little or no attempts have been made to naturally improve other essential health beneficial constituents found in bread wheat in South Africa. Over the years, research on wheat largely invested efforts into improving grain yield, wheat quality components, disease resistance and other traits. However, little or no efforts have been made to generate information on other wheat constituents like the essential micronutrient and selected secondary metabolite profile of South African bread wheat genotypes. Various wheat accessions have been screened for their variation in Fe and Zn in other parts of the world. More attempts are needed to look at the variation of certain metabolites in other countries than South Africa.

UNDERSTANDING THE PROBLEM

Bio-fortification is one attractive approach to naturally fortify crops, but bio-fortification of wheat relies on rudimentary information on the wheat's nutritional profile of wheat genotypes. Furthermore, most or all important South African wheat genotypes have never been characterized for their levels of other essential health beneficial traits. The study encompasses efforts to initiate phenotypic characterization of selected-essential micronutrients and -metabolites in certain South African wheat genotypes and to further explore how variation of unexplored traits relates to that of other traits of high importance in the South African wheat industry.

CONLUSION AND RECOMMENDATIONS

South African wheat genotypes need to be characterized for their nutritional quality to decipher if breeding efforts need to be put into breeding for nutritional quality or not as an effort towards sustainable breeding and contributing towards food security.

Keywords: wheat, nutritional quality, malnutrition, health, breeding efforts

VALIDATING SAP FLUX DENSITY MEASUREMENT METHODS IN POTTED CITRUS SINENSIS

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INTRODUCTION

The measurement of stem sap flow is a widely used indirect approach for estimating tree water use. The sap flow methods used to quantify stem sap flow require insertion of probes which results in sap stream disruption and this leads to a systematic underestimation of sap flow. As a result, correction factors relating the measured heat pulse velocity to actual sap flow are needed to account for flow blockages and wounding. Therefore, the main aim of this study was to validate the heat ratio method (HRM) for citrus using a weighing lysimeter in a glasshouse. Once properly validated, the method can be used to determine water use of citrus orchards as part of a Water Research Commission solicited a project.

MATERIALS AND METHODS

Transpiration of small potted citrus and eucalyptus trees was measured using small, stable and well calibrated weighing lysimeters. Sap flow was determined using the HRM. Validation included linear regression analysis between transpiration (T) determined from the weighing lysimeter and T determined from the HRM.

RESULTS AND DISCUSSION

A good correlation ($R^2 > 0.7$) was observed in eucalyptus between the weighing lysimeter and the HRM. Employing HRM in citrus yielded good results in the first window of calibration exercise ($R^2 = 0.78$), however, in the following calibration exercises a poor correlation ($R^2 < 0.4$) between the weighing lysimeter and the HRM was observed. Whilst the calibration coefficient remained fairly constant over a number of days in eucalyptus (0.92-1.00), the calibration coefficient was not consistent in citrus across different calibration windows. Although there was a fairly good correlation in eucalyptus between the weighing lysimeter and the HRM, on average T estimated by the HRM was overestimated by 9% as compared to the lysimeter.

CONCLUSION

Although heat pulse techniques provide a relatively simple way of quantifying whole tree transpiration, these methods do not appear to give reliable data in citrus, due largely to their inconsistencies. In future other methods, such as thermal dissipation probe (TDP), will be evaluated in citrus and validation will be conducted for longer periods, so that day to day transpiration data from sap flow techniques will be correlated against the gold standard (weighing lysimeter).

ACKNOWLEDGEMENTS

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Keywords: probes, water use

THE CONTRIBUTION OF LEAF AND EAR PHOTOSYNTHESIS TO GRAIN FILLING IN WHEAT

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INTRODUCTION

Stress affects every aspect of plant growth and metabolism. However, plants have the ability to adapt themselves to these stresses by different mechanisms. In most plants, all green parts contribute photosynthates to the crop yield. In wheat plants, photosynthesis is not only performed in the leaf blades but also in other green parts such as the ears, stems and leaf sheaths. The flag leaf is an important source of carbohydrate production in most cereal crops and is considered to be one of the most important components in determining grain yield potential. It is generally accepted that genotypes which are able to sustain photosynthesis in the flag leaf for a longer time, tend to yield higher. In the present study the effect of various leaves and tillers on yield related traits and final grain yield was determined.

MATERIALS AND METHODS

Seeds of two wheat cultivars were germinated in petri-dishes in a growth cabinet at temperatures of 20°C-22°C. After seven days of germination the seeds were transplanted in pots and grown in a glasshouse. Four pots represented a replication and four replications were used. The experiment was laid out in a randomized split block design. In this experiment defoliation was used to reduce photosynthetic capacity to simulate the source limitations imposed by different kinds of stress, such as drought and hail damage. To examine whether carbon supply may limit yield, the defoliation was done in two phases, namely at flag leaf stage (GS 15) and at anthesis (GS 20). In total eight treatments of defoliation were applied. The leaf area was recorded for the flag leaf and other leaves by using a *Li-cor* leaf area meter (Li-3100). At physiological ripeness all the tillers and ears were harvested. The number of kernels was counted and the yield determined for the respective treatments.

RESULTS AND DISCUSSION

An analysis of variance for leaf area and other yield related traits showed a significant effect ($P<0.05$) for the treatments (removal of green photosynthetic parts) on leaf area, number of ears/plant, number of kernels/ear, thousand kernel mass and yield per plant. The results revealed a prominent overall reduction in number of ears per plant, number of kernels per ear and yield per plant when the flag leaf, which is the main photosynthetic organ, was removed. During the vegetative period removal of the flag leaf lead to a decrease of 35% in yield, while a decrease of 60% in yield was evident with the removal of the flag leaf during the reproductive phase. A smaller contribution from other leaves and stems was also observed in this study.

CONCLUSIONS

The results of the study highlighted the major contribution of the flag leaf towards the yield related traits studied. It is clear that limiting the carbon supply during the vegetative stage had less effect on yield than during the reproductive stage. Damage of the photosynthesis area early in the growing season is early compensated for by later growth.

Keywords: flag leaf, photosynthesis, photosynthates, yield, wheat

RESPONSE OF IRRIGATED SOILS TO ON-FARM MANAGEMENT DECISIONS: A GLIMPSE AT CENTRAL SOUTH AFRICA

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INTRODUCTION

Soils at Vaalharts and Orange-Riet Irrigation Schemes have been irrigated for longer than 50 years. These soils were selected for irrigation based on criteria evaluating their properties for drainage. Unfortunately, matching soil properties and drainage conditions to management decisions and quality of water resources remains a challenge. The evaluation of soil properties for irrigation can contradict the response of soil to management decisions when irrigating with a specific water quality. The aim of this paper is to investigate this opposing process by assessing the response of different soils to present and best practices.

MATERIALS AND METHODS

During four growing seasons weekly and seasonal measurements (physical, chemical, agronomical and management) were made at 30 measuring points on 16 farms. The model SWAMP (Barnard et al., 2015) was used in combination with the measurements in a descriptive capacity to solve the soil water and salt balances at the measuring points, and in a predictive capacity to analyse long-term best practice that lasted 20 years.

RESULTS AND DISCUSSION

The expected increase in soil salinity with deteriorating soil irrigability (texture and hydraulic conductivity) and drainage conditions (shallow water table 1-2 m deep with salinity of 100-400 mS m^{-1}) under current practices was not considerable when irrigated with water of variable salinity (20–220 mS m^{-1}). This phenomenon was attributed to associated mechanisms, i.e. more efficient leaching of freely drained sandy soils and sandy loam soils with lateral flowing water tables (irrespective of their salinity), and salt precipitation in clayey soils. Under best management practices, predictive yield losses were severe in freely drained sandy soils, and moderate to none in either water table or clayey soils. The reasons being the high profile available water capacity (PAWC) of water table and clayey soils, which reduces osmotic stress and causes more efficient leaching during periods of high rainfall events (every 5-6 years), compared to freely drained sandy soils with a low PAWC.

CONCLUSIONS

Given sufficient water supply, continuation with the status quo (current practices) on these soils might be sustainable, irrespective of soil irrigability and drainage conditions. Employing best practices on soils with low PAWC posed higher cropping risks (osmotic stress) and requires better managerial inputs. The opposite is also true for either water table or clayey soils with high PAWC when soil infiltrability is good, lateral flow of the saturated zone below the water table possible and salt precipitation evident.

ACKNOWLEDGEMENTS

The Water Research Commission (www.wrc.org.za) for funding the research.

Keywords*:* Field crops, irrigation, soil salinity, water quality, shallow water tables

EFFECT OF WAXING AND METHYL JASMONATE ON CHILLING INJURY AMD SOME PHYSIOLOGICAL PARAMETERS OF 'EUREKA' LEMONS

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INTRODUCTION

The exportation of lemons (*Citrus limon*) requires a certain cold treatment of maintaining fruit for 28 days at 1°C, a procedure that commonly leads to the occurrence of chilling injury, rendering fruit unmarketable. While certain treatments, such as the application of the plant growth regulators (PGRs) methyl jasmonate (MJ) and salicylic acid, as well as their combination have been proposed as practices to avoid occurrence of chilling injury, little is known about the effect of waxing in combination with PGRs.

MATERIALS AND METHODS

'Eureka' lemons were dipped into 10µM MJ solutions and followed by application of wax and either stored at room temperature or at 1°C for 0, 14 and 28 days. Thereafter fruit quality parameters (mass loss, respiration) certain biochemical markers (antioxidant capacity and total phenolics) of the flavedo were determined.

RESULTS AND DISCUSSION

Waxing significantly reduced fruit moisture loss ($P<0.01$), respiration rate ($P<0.05$) and maintained a good fruit appearance by reducing chilling injury, outperforming MJ by itself; nonetheless, confirming earlier results (Siboza et al., 2013), MJ significantly outperformed the control. Analysis of fruit mass and respiration revealed that waxing reduces mass loss and respiration rate more so that MJ application. The rind antioxidant capacity as well total rind phenolics were significantly higher in the MJ treatment; waxing affected neither rind phenolics nor rind antioxidant capacity on day 0 and 28, but resulted in significant differences on day 14 of the cold storage.

CONCLUSION

Combining the established effect of MJ application to enhance the resistance of lemons to chilling injury with wax application possibly outperforms the MJ only treatment as both treatments operate on a different mode of action. This combination treatment needs, however, to be tested further before exact recommendation can be made.

Keywords: lemon, chilling injury, waxing

HPLC AND COLORIMETRIC DETERMINATION OF SHIKIMIC ACID LEVELS IN CROPS AFTER GLYPHOSATE TREATMENT

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INTRODUCTION

The shikimic acid pathway is one of the major biosynthetic pathways in higher plants responsible for the biosynthesis of aromatic amino acids and secondary metabolites. Glyphosate is a non-selective, broad-spectrum, post emergence, systemic herbicide that is used globally. Glyphosate inhibits a key enzyme in the shikimic acid pathway: 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). Inhibition of EPSPS results in the accumulation of high levels of shikimate. Since shikimate accumulation is a direct result of herbicide inhibition of EPSPS, shikimate can potentially be used as a convenient biomarker to measure glyphosate exposure as well as glyphosate resistance. The aim of this study was to quantify shikimic acid levels in non-Roundup Ready (RR) and RR crops after being treated with glyphosate using high performance liquid chromatographic (HPLC) analysis as well as a colorimetric assay.

MATERIALS AND METHODS

Non-RR and RR maize and soybean plants were grown under greenhouse conditions on the UP experimental farm, in triplicate. Plants were treated with different doses (dose response) of glyphosate and sampled at different time intervals (time response). HPLC analysis and a colorimetric assay was performed to quantify and compare the concentration of shikimic acid present in non-RR and RR maize and soybean plants. SAS statistical software was used to test for significance between treatment means.

RESULTS AND DISCUSSION

HPLC analysis showed that shikimic acid concentrations in non-RR plants were significantly higher compared to RR plants. In RR plants there were no significant increase in shikimic acid levels between control and glyphosate treated plants. In non-RR plants the levels of shikimic acid accumulation increased over time and as the concentration of glyphosate rates applied increased. The colorimetric assay was used to indicate the presence of shikimic acid (glyphosate damage) based on a colour change. The intensity of the colour change was directly related to the shikimic acid concentration in the sample.

CONCLUSIONS

In the colorimetric assay a colour change indicates shikimate accumulation at levels relative to the intensity of the colour. This can therefore be used to develop an easy-to-use test to determine the effectiveness of glyphosate treatments as well as to determine if glyphosate is the causal agent of crop damage after herbicide applications.

Keywords: Aromatic amino acids, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), non-RR crops, RR crops, shikimic acid accumulation.

ARC HONEYBUSH SEED-ORCHARDS: IMPACT ON SUSTAINABILITY

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INTRODUCTION

In the past twenty years a small herbal tea industry has developed along the coastal districts of the Eastern and Western Cape provinces of South Africa where the endemic shrub honeybush (*Cyclopia* spp.) grows naturally. This herbal tea, with various health properties, quickly became popular internationally and currently more than 200 tons are exported annually. Soon the rapid growth in demand put the honeybush industry under pressure and a sustainable supply could not be met. Even though most of the tea is collected from wild populations, the sustainability of these supplies is under threat and an alternative source of plant material is needed. To address this, the ARC has developed a commercialisation strategy to deploy improved genetic material from its breeding programme through commercial seed-orchards.

MATERIALS AND METHODS

Several selections were made in three of the six commercial species of *Cyclopia*. These selections were multiplied vegetatively (as clones) through cuttings. More than 60 plants per clone (genotype) were raised and used to establish a seed-orchard for each species. The plants were planted in a fully randomized complete block design to assist evenly balanced pollination between genotypes. The first orchard was planted in November 2010.

RESULTS AND DISCUSSION

Seed was harvested for the first time from the *C. subternata* seed-orchard in November 2012. To date about 10 kg seed have been harvested, enabling the industry to establish 100 ha of plantations. This equals the area previously established by the industry from seed collected from the wild. Thus, within four years of the establishment of the first seed-orchard, the industry was able to double the area of commercial plantations.

CONCLUSIONS

The ARC honeybush seed-orchards contributed significantly in a very short period of time to the provision of a sustainable source of quality seed for commercial honeybush tea production. Not only has this enabled the industry to become more sustainable, but it is also protecting the biodiversity of the natural population, by reducing the quantities of seed and plant material harvested from wild populations.

ACKNOWLEDGEMENTS

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Keywords: *Cyclopia*, honeybush, seed-orchard, seed production

A PROPOSED FIELD KEY TO THE CLASSIFICATION OF SOUTH AFRICAN SOILS

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Review

In 1991, the Soil Classification Working Group published the book: Soil Classification – A Taxonomic System for South Africa, which formed the framework for soil classification in the country. The aforementioned document is still widely used by soil science professionals, students, agriculturalists and others.

Full comprehension of the 1991 document may pose challenging for some individuals, especially for newcomers to the field of soil classification. Furthermore, evaluating different soil diagnostic criteria in the field using the aforementioned document may be a laborious and time consuming process. It is due to the aforementioned challenges that a field key to the classification of South African soils was developed, aimed at aiding the novice and expert alike by reducing possible errors in classification and decreasing the amount of time spent classifying soil.

The proposed field key is aimed at identifying soil horizons within a profile by means of the rapid assessment of diagnostic criteria. The structure of the key is based on two main features, namely the extent of soil structure formation and the inherent soil horizon hierarchy that is present within the Soil Classification handbook of 1991. The field key is in the form of a flow-chart that eliminates non-relevant soil physical and chemical properties until a match is found.

The field key is solely based on information extracted from the Soil Classification handbook of 1991, thereby decreasing ambiguity in the soil classification process.

Keywords: Diagnostic criteria, soil classification, soil structure

INCREASING CROP YIELD AND RAINWATER PRODUCTIVITY THROUGH RAINWATER HARVESTING AND CONSERVATION TECHNIQUES

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INTRODUCTION

Poverty and food insecurity are generic to rural communities in South Africa. Crop yields and rainwater productivity (RWP) are low because these areas are marginal for crop production due to: (a) low and erratic rainfall; and (b) high evaporative demand. To improve smallholder productivity, crop production and RWP need to be increased through the application of appropriate rainwater harvesting and conservation (RWH&C) techniques. Rural households have access to arable land which are not utilized productively. The objective of this study was to increase crop yield and RWP by making use of appropriate mechanical RWH&C techniques on croplands.

MATERIAL AND METHODS

Statistically laid out on-station field experiments over four growing seasons (2008/09 - 2011/12) and on-farm field demonstrations over three seasons (2009/10 - 2011/12) were conducted in the Eastern Cape, Limpopo and Free State provinces. Conventional tillage (*CON*), no-till (*NT*), minimum tillage (*MIN*), mechanized basins (*MB*), in-field rainwater harvesting (*IRWH*) and Daling plough (*DAL*) techniques were used. On-station experiments were conducted on the Fort Cox/Valsrivier (Eastern Cape), Toowoomba/Hutton and Toowoomba/Arcadia (Limpopo) and Glen/Oakleaf and Glen/Swartland (Free State) ecotopes. The Krwakrwa/Hutton (Eastern Cape), Lambani/Shortlands (Limpopo) and Merino/Arcadia and Feloane/Arcadia (Free State) ecotopes were used for on-farm demonstrations. Maize was used as indicator crop with a plant population of 22 000 plants ha^{-1}. Parameters measured were seed yield and RWP.

RESULTS AND DISCUSSION

Grain yield results indicate that *IRWH* induced the highest mean yield followed by *DAL*, *MB*, *CON* and *NT*/*MIN*. *IRWH*, *DAL* and *MB* increased maize yields on average by 12, 11 and 8%, respectively, compared to *CON*. RWH techniques *(IRWH* and *DAL*) increased mean yield by 12 and 9% compared to *CON* and conservation techniques (*NT*/*MIN* and *MB*), respectively. RWP values indicate that *IRWH* and *DAL* induced the highest mean RWP, followed by *MB*, *CON* and *NT*/*MIN*. The RWH techniques (*IRWH* and *DAL*) and *MB* increased RWP on average by 11 and 6%, respectively, compared to *CON*.

CONCLUSIONS

Implementation of appropriate RWH&C technologies on croplands can improve crop yield and RWP in rural communities. For optimal yields and RWP values the implementation of *DAL*, *MB* and *IRWH* on soils with < 29%, 29-36% and > 36% clay, respectively, is recommended.

Keywords: crop yield; rainwater harvesting and conservation; rainwater productivity

USING SOIL CHEMICAL TRENDS AS RECENT INDICATORS TO IMPROVE MORPHOLOGICAL AND HYDROMETRICAL INTERPRETATIONS OF HYDROLOGICAL RESPONSE

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INTRODUCTION

Detailed chemical analysis of soils can at the very least improve or replace conventional indicators of conceptual hydrological response models (CHRMs), which form the basic structure of hydrological models. The use of hydrometry to design these models was recently improved using soil morphology, however the robust nature of soil morphology responds slowly to hydrological changes and hydrometry is tedious and merely snapshots of hydrological processes. Soils interact with water and the process leaves useful signatures as the chemical properties represents the recent average environmental conditions. The hypothesis is that the distribution of chemical properties in soils and soilscapes can serve as an indicator of recent hydrological response.

MATERIAL AND METHODS

The 29 profiles in the Weatherley catchment (van Huyssteen et al., 2005) were statistically analysed. The dependent variables were analysed using a mixed linear model fitting the factors hydrological response type and diagnostic horizon. The chemical profile of each soil profile was plotted for trends in chemical properties.

RESULTS AND DISCUSSION

The chemical properties were correlated with pedological processes expected in diagnostic horizons. Low pH, base cations, Fe and Mn were found in soils where redox processes are dominant, especially in the interflow soils, while responsive soils with stagnating water were enriched with base cations. The chemical properties were also horizon specific, therefore able to indicate more than one process in a profile and therefore determine the dominance of different processes. Crucially, chemical properties changed where there was water regime change while soil morphology indicated an ancient water regime.

CONCLUSION

Soil chemical properties are able to identify recent flowpaths and water regimes in soil, therefore improving morphological and hydrometrical interpretations of hydrological response of soils.

Keywords: Hydropedology, chemical properties, recent indicators, hydrological response

EFFECT OF PLANT DENSITY ON THE PERFORMANCE OF SIX SOYBEAN CULTIVARS GROWN AT THREE LOCALITIES IN SOUTH AFRICA

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INTRODUCTION

Soybean (*Glycine max* L merril) is cultivated in many countries of the tropics and subtropics. It is popular in Japan, Korea, China and Taiwan, while is global consumption is increasing very rapidly. Soybean is a rich source of vitamin A and a good source of carbohydrate, protein, oil and iron. Globally, soybean is probably the largest source of vegetable seed oil and protein as it contains about 40% crude protein and 20% oil. In South Africa, farmers are more interested on obtaining the seed density that will concurrently improve seed yields and oil, thus leading them to competitive markets. To this end, farmers across the country are applying soybean seed density at individual discretion. This study was therefore initiated to evaluate the effect of plant density on the productivity of six soybean cultivars grown at three localities in South Africa.

MATERIALS AND METHODS

An agronomic field trial was conducted at Potchefstroom, Rustenburg and Bethlehem during 2013/14 summer planting season. Treatments consisted of six plant densities (200 000, 250 000, 300 000, 350 000, 400 000 and 450 000 plant/ha) and six round-up ready (R) soybean cultivars (LS 6240, PAN 1454, PAN 1654, PAN 1500, LS 6164 and PAN 1614) at three rows spacing (45, 75 and 90 cm). Treatments were laid out randomised complete block design in split-split plot arrangement. All data collected were tested for comparable magnitude before a weighted combined analyses of variance was performed using SAS. Shapiro-Wilk's test was performed on the standardised residuals to test for deviation from the normality. Pairwise comparison was also performed on the least square means of significant effects using the Fishers LSD-test at 5% probability level.

RESULTS

The interaction effects of locality x density, locality x cultivar and density x cultivar was significant for soybean grain yield. Potchefstroom had the highest mean grain yield of 4390 kg ha^{-1} across all treatments while Rustenburg had the lower yield of 3410 kg ha^{-1}. Soybean planted at 400 000 plants ha^{-1} and 45 cm row spacing gave the highest yield of 5176 kg ha^{-1}, while lowest yield of 3085 kg ha^{-1} was obtained at 200 000 plant ha^{-1} and 90 cm row spacing. On the interaction of locality x density, significantly higher yield of 6004 kg ha^{-1} was obtained at Potchefstroom with 400 000 plants ha^{-1} and 45 cm row spacing, while low yield (2407 kg ha^{-1}) was observed at Rustenburg with 350 000 plant ha^{-1} and 90 cm row spacing. Interaction of locality x cultivar showed that PAN 1500R planted at Potchefstroom and recorded yield (4749 kg ha^{-1}) significantly higher than LS 6240R with 2587 kg ha^{-1} at Rustenburg. The interaction of density x cultivar showed that PAN 1500R planted at 400 000 plants ha^{-1} and 45 cm gave best yield of (5820 kg ha^{-1}) significantly higher than PAN 1454R planted at 350 000 plants ha^{-1} and 90 cm (2510 kg ha^{-1}).

CONCLUSION

Across the sites, soybean grain yield was significantly affected by plant density. There was a locality x density, locality x cultivar and density x cultivar interaction effects of soybean seed yield. The plant density of 400 000 plants ha^{-1} at row spacing of 45 cm resulted in highest soybean yield of all the cultivars.

Keywords: Plant density, row spacing, seed yield, soybean cultivars

EFFECT OF SEED TREATMENT WITH SELECTED PLANT GROWTH PROMOTING RHIZOBACTERIA ON MAIZE YIELD UNDER FIELD CONDITIONS

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Introduction

The inoculation of maize with Plant Growth Promoting Rhizobacteria (PGPR) has been found to significantly increase total yields and has potential as agrochemical replacement. The aim of the study was to evaluate the effect of PGPR on maize yield under field conditions.

Materials and methods

The study was conducted in the Limpopo province of South Africa over three seasons. Field trials were conducted under dryland conditions on Huttons, Arcadia and Clovalley ecotopes and under irrigation on Shortlands ecotope. Soil nutrients were supplemented with LAN (28) and Superphosphate (10.5%) to a total of 100kgN ha^{-1} and 75kgP ha^{-1} at planting. Maize seed (cultivar P1615R) was treated with a Perlite powder formulation of the various PGPR strains before planting. Each bacterial inoculant constituted a treatment that was replicated six times. Each replicate consisted of 4 X 200m plant rows (22 000 plants per ha). Data was analysed using SAS 9.2 at p=0.05 and the means separated using Dunnett's t-test.

Results and discussion

The Shortlands, Arcadia and Huttons ecotopes were planted during the 2011/2012 season. The best performing inoculant in Shortlands ecotope was *Lysinibacillus sphaericus* strain T19 resulting in 25.22% yield increase compared to the 8.54 tha^{-1} control yield. The commercial product Brus® resulted in the highest yield in the Huttons ecotope soil with 16.57% yield increase compared to the control yield of 3.02 tha^{-1}. In contrast, a decrease in yield was observed in the Arcadia ecotope ranging from 2.88% to 19.24% compared to the control yield of 5.05 tha^{-1}. This observation corresponds with other studies that reported that soil porosity influences PGPR efficacy. Only the 2012/2013 Shortlands trial survived the drought due to supplementary irrigation. *Bacillus cereus* strain S7 followed closely by T19 increased yield by 34.14% and 24.63% respectively compared to the 3.8 tha^{-1} control yield. During the 2013/2014 season the Clovalley ecotope was planted with the best performing inoculants selected from the previous trials which also included a mixture of these inoculants. The best results were obtained with the mixture resulting in 24.72% increase over the control yield of 2.79 tha^{-1}.

Conclusion

This study demonstrated that PGPR can substantially increase maize yield under field conditions. There was variability observed in projected yield increase over different seasons, as observed by other researchers. Despite this variability, inoculant *L. sphaericus* resulted in a more consistent yield increase compared to the other inoculants.

Keywords; inoculant, maize, PGPR, yield increase

GEOTECHNICAL PROPERTIES OF PEDOLOGICAL SOILS

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Introduction

Pedologists and geotechnical engineers have different experience and interest in soils, i.e. the main interest of agronomists and ecologists is the potential of the soil to sustain plant growth, whilst the geotechnical engineers are more interested in the behaviour of the unconsolidated material above the bedrock with respect to foundation and structural stability.

South Africa make use of a Taxanomic (pedologic) soil classification system with zero or minimum reference to geotechnical descriptions i.e. Atterberg limits, grading analyses, linear shrinkage etc., Creating such a geotecnical classification system within the taxonomic pedologic system will contribute to a major extend to land use planning and infrastructure development. The integration of the taxonomic system and geotechnical systems will avoid duplication in mapping programmes, analysis and cost.

Objectives

The objective of this project is to do a grouping of the pedological soil units into a more homogeneous soil classes. The first step is to reduce 70 soil forms, five A-horisons, and 21 subsurface horizons to more or less 15 soil classes with related geotechnical characteristics. Formulating a field guide of these geotechnical properties combined with pedological units will simplify the usage for multi-disciplinary fields like geology, geotechnology, rehabilitation and soil science.

Materials and methods

The following methods were used to determine these geotechnical properties of the 15 soil classes: dispersive tests, swelling, linear shrinkage, Atterberg limits and the optimum water content for maximum dry density. Representative samples of the 15 soil classes were sampled throughout South Africa.

Results and discussion

An abundance of pedological data are available from the Institute for Soil Climate and Water (ISCW) and consultants in agri-business, together with geotechnical data from geotechnical engineers. These data could be integrated after a correlation reference baseline has been established. This would require some real-time pedological and geotechnical characterization of each group with a range in specific properties, i.e. particle size distribution, plasticity index, etc. and reclassify according to the USCS and AASHTO geotechnical systems.

Keywords: Geotechnical properties, pedological classification, multi-disciplinary project

SPATIAL DISTRIBUTION AND CHEMICAL PROPERTIES OF BLEACHED TOPSOILS OCCURING ON RED AND YELLOW-BROWN APEDAL SUBSOILS.

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INTRODUCTION

Bleached topsoils occur on red and yellow-brown apedal subsoils but these soils are currently not taxonomically distinguishable from their non-bleached counterparts. Bleaching is an important pedological indicator and should be recognised. Topsoil bleaching on well-drained subsoils is poorly understood thus defining diagnostic criteria for the classification of such soils is difficult. This study aims at understanding the spatial distribution of bleached topsoils and assessing their chemical and physical properties to provide clues on their genesis.

MATERIALS AND METHODS

The Profile database and sub-samples collected from the soil store of the Institute for Soil, Climate and Water were used in this study. Soil colours were measured both visually (Munsell colour chart) and spectroscopically (Konica-Minolta spectrophotometer). Using both methods soils were classified as bleached or non-bleached, following the criteria outlined in the South African soil classification system (Soil Classification Working Group, 1991).

RESULTS AND DISCUSSION

Visual colour measurement by Munsell chart comparison, only detected 25% of bleached soils identified with the spectrophotometer, highlighting the difficulty of visually detecting bleaching. No significant difference was found between the occurrence of topsoil bleaching on various terrain units, aspects or slope angles. Bleaching occurrence was significantly related to lithology, with the frequency of bleaching being highest in siliceous rocks and lowest in mafic rocks. Clay movement from the A to B horizon showed no significant trends in terms of bleaching. Bleaching tendency was significantly related to reducible Fe and exchangeable Mg percentage, which may relate to parent material composition. No clear bleaching trend was observed for exchangeable Na percentage. Bleaching tendency increases with decreasing base saturation, with the highest incidences of bleaching occurring on dystrophic soils, which could relate to both parent material and soil age.

CONCLUSIONS

The spatial distribution of bleached soils is not clearly linked with landscape unit, aspect or slope angle, but bleaching occurrences are largely controlled by parent material composition, which determines the initial Fe content of the soil.

ACKNOWLEDGEMENTS

The ARC-ISCW are acknowledged for providing access to the Profile database and soil store.

Keywords: Albic properties, ochric, ultis

EMERGENCE RESPONSE OF SUNFLOWER CULTIVARS (*Helianthus annuus* L.) TO HIGH SOIL TEMPERATURES

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INTRODUCTION

Seedling emergence is a vital stage during sunflower (*Helianthus annuus* L.) establishment. An abiotic stress, such as high (above 40°C) soil temperature, can cause delayed emergence which lead, to below optimal population density and ultimately poor yield. The objective of this experiment was to determine the effect of temperature (above the optimum of 20 to 30°C) and cultivar on the emergence, above ground and root growth of sunflower seedlings.

MATERIALS AND METHODS

An experiment was conducted in the glasshouses of the Department of Soil, Crop and Climate Science at the University of the Free State. Four temperature treatments (35, 40, 45 and 50°C) were applied on a Bainsvlei soil (loamy sand, 5% clay) to seven commercially available cultivars of two South African companies and the experiment was repeated (planting one and two). The experiment was laid out as a randomized complete block design with four replications. Emergence was counted every day after plant and emergence index was calculated. Root length of the tap root was measured by extracting five randomly selected plants 24 hours after plant, with first emergence (cracking of soil surface by protrusion of hypocotyls) and 48 hours after first emergence during the experiment. The experiment was terminated 10 days after plant and dry mass was determined after it was oven dried at 50°C for seven days. Data was analysed using the statistical program SAS 9.2® and means were separated with Tukey's Least Significant Test at 5% probability.

RESULTS AND DISCUSSION

Emergence of sunflowers occurred within the first seven days after planting, but an increase in soil temperature also increased the days to emergence. The results clearly indicated that emergence index (EI) declined with an increase in soil temperature. A moderate decline was visible from 35 to 45°C, but from 45 to 50°C the decline was extreme. Root length results of seedlings 24 hours after planting were inconsistent between plantings. The results from root length with surface crack and 48 hours after surface crack indicated that root length at 35°C was significantly greater than that at 45 and 50°C. Dry mass was lowest at 50°C for both plantings. Morphological variation was visible for sunflower seedlings at the selected temperatures, but there were no definite visible differences between cultivars. Deformed seedlings were observed at temperatures above 40°C.

CONCLUSIONS

Sunflower emergence and seedling growth at high soil temperatures differs between South African cultivars.

ACKNOWLEDGEMENTS

Agricol (Pty) Ltd. and Pannar (Pty) Ltd.

Keywords: Seedlings, emergence index, sunflower, soil temperature

GROWTH OF DIFFERENT HOT PEPPER TYPES AS INFLUENCED BY IRRIGATION SYSTEM AND IRRIGATION FREQUENCY

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INTRODUCTION

The effective use of irrigation has become a key component in the production of high value crops such as hot pepper (*Capsicum* spp.) in arid and semi-arid regions. The objective of the study was to evaluate four types of hot pepper grown under hot climatic conditions in Limpopo Province of South Africa using drip and centre pivot irrigation systems.

MATERIALS AND METHODS

Four independent field trials were conducted at Ukulima Farm under either drip irrigation at 75% of field capacity (FC) or three centre pivot irrigation systems at 100%, 75% or 50% of FC. Each trial was laid out as a randomized complete block design with four replications. Treatments in each irrigation system consisted of four pepper types randomised within the four block replications. The four pepper types were Jalapeno, Long Slim Cayenne, Habanero Red and Serrano Chili. Parameters that were recorded included plant height, number of leaves, number of primary and secondary branches, days to 50% flowering, total number of fruit and fruit mass. The combined data of the four trials were subjected to an appropriate analysis of variance (ANOVA). Means of significant effects were compared using Student's t-LSD (least significant difference) at a 5% significance level.

RESULTS AND DISCUSSION

For all irrigation systems, there were no significant interactions between pepper type and irrigation frequency for plant height, number of leaves and number of primary branches. However, there were interactions between pepper type and irrigation frequency for number of secondary branches, days to 50% flowering, total fruit number and fresh mass. Days to 50% flowering was reached in a shorter period when 100% irrigation was used. Highest total fruit numbers were found when 100% and 75% irrigation was used. Highest fresh mass was obtained at 100% irrigation when compared to other irrigation systems. Hot pepper plants performed better under centre pivot compared to under drip irrigation system.

CONCLUSIONS

Irrigation system and irrigation frequency had significant effect on fruit mass and other growth parameters. Centre pivot irrigation at 100% FC resulted in the highest pepper fruit mass and other measured growth parameters such as number of leaves, plant height, primary and secondary branches, and total fruit number when compared to other irrigation frequencies and drip irrigation.

Keywords: Capsicum, centre pivot, drip irrigation, fruit mass

INFIELD EFFICACY AND SELECTIVITY OF AMICARBAZONE AND TANK MIXTURES WITH PENDIMETHALIN AND ACETOCHLOR IN SUGARCANE.

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INTRODUCTION

Weed control in sugarcane in Zimbabwe is aimed at maintaining weed free fields. This takes between 8-14 weeks after planting / harvesting during the peak weed period [September to March]. A cost effective approach is the use of herbicides with long residual period to achieve broad-spectrum control. The objectives were to determine combinations of herbicides that provide broad spectrum pre-emergence control with one application during the peak growth period.

MATERIALS AND METHODS

The efficacies of dosages of Amicarbazone 700 g a.i.•ka^{-1} alone were evaluated on broadleaf, grass weeds and sedges in sugarcane fields. Trials were established at six sites in both plant and first ratoon crops from 2007 to 2012. Soils were siallitic and basalt self-churning clays with 14 to 30% clay content and 1.2% to 2.8% organic matter content. Amicarbazone 700 g a.i.•ka^{-1} and its tank-mixture with Pendimethalin 500 EC or Acetochlor 900 EC were also evaluated on weed control, effect on cane growth, cane and sugar yields against Acetochlor Atrazine tank mix. Trials were laid out in randomised complete block design and replicated four times. Treatments consisted of different dosages of Amicarbazone 700 WDG and tank-mixes with Pendimethalin or Acetochlor as well as to a prescribed tank-mix of Acetochlor Atrazine.

RESULTS AND DISCUSSIONS

Amicarbazone alone was effective in the control of weeds at pre-emergence and was better than Pendimethalin or Acetochlor. Amicarbazone's efficacy alone was comparable to that of a tank-mix of Amicarbazone and Pendimethalin in areas without *Rottboellia cochinchinensis* (Lour.). Amicarbazone or its tank mix with Pendimethalin or Acetochlor caused chlorosis in plant cane but not in ratoon cane. From September to March, a single application of Amicarbazone maintained fields weed-free up to canopy closure of row middles. At early post emergence of the weeds, Amicarbazone was more effective in controlling broadleaf weeds compared to grass weeds. *Rottboellia cochinchinensis* was not controlled at early post emergence.

CONCLUSIONS

Amicarbazone effectively controlled weeds other than *Rottboellia cochinchinensis* up to sugarcane canopy closure. Where *Rottboellia cochinchinensis* is a challenge, growers are advised to use a tank-mix of Amicarbazone and Pendimethalin.

ACKNOWLEDGEMENTS

Zimbabwe Sugar Association is highly acknowledged for funding this work.

Keywords: Amicarbazone, canopy closure, row middles, sugarcane, weeds.

THE ROLE OF SOYBEAN CYSTEINE PROTEASES IN PREMATURE NODULE SENESCENCE UNDER WATER DEFICIT CONDITIONS.

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INTRODUCTION

Nodule lifespan and nitrogen fixation in soybean is sensitive to water deficit conditions, inducing premature senescence that can lead to nitrogen limitations and decreased yield. A better understanding of the nodule senescence process, especially drought induced senescence might allow us to identify markers that could be used to select cultivars with improved tolerance. Two key enzymes during senescence are papain- and legumain-like cysteine proteases. Their role is mainly in cell death and protein remobilization. Better regulation of these steps might lead to increasing soybean root nodules ability to fix nitrogen during water deficit conditions and preventing yield losses.

MATERIALS AND METHODS

Sixty soybean plants (*Prima*) were grown in a greenhouse using vermiculite as growth medium. Plants were exposed to three water deficit conditions; 60%, 40% and 30% vermiculite water content (VWC) respectively for five days. At a plasticron index of 3.6, plants weren't watered anymore until they reached 60%, 40% and 30% VWC respectively. Ten plants were then kept at the respective percentages for 5 days after which they were harvested. A growth analysis was done by determining growth stage using the plasticron index and determining fresh and dry mass. Leaf water potential was measured using a pressure bomb while nodule water potential was measured using a pshycrometer. Total antioxidant capacity (µmol (Trolox)/ g FW) was measured using FRAP analysis. Messenger RNA was isolated from the nodules and transcriptome sequencing was done on the Illumina True Seq platform. Data analysis was done using the Galaxy platform. Q-PCR was done to confirm the results obtained by transcritome sequencing.

RESULTS AND DISCUSSION

The dry and fresh mass as well as nodule and leaf water potential measurements, gives a clear indication that soybean plants at 30% VWC, experienced severe stress with a significant difference when compared to plants at 60% VWC. A transcriptome analysis revealed 30 papain-like cysteine proteases were found to be expressed in nodule tissue. Six papain-like proteases showed to be induced by water deficit and two were only expressed during water deficit conditions. Eight legumain-like proteases were expressed in nodules but were induced by senescence as well as water deficit. A significant difference in total antioxidant capacity was seen from 60% VWC to 40% and 30% VWC indicating an increase in reactive oxygen species.

CONCLUSION

Water deficit stress in soybean affects the plant growth and development as well as the lifespan and nitrogen fixation ability of nodules. Six papain-like proteases are directly involved in the protein remobilization process during water deficit conditions due to genes being only induced by water deficit and not by natural senescence. Legumain-like genes showed that they aren't water deficit specific but are rather senescence associated genes.

Keywords: Cysteine proteases, nodules, water-deficit

QUANTIFICATION OF DRYING INDUCED ACIDITY AT THE MINERAL-WATER INTERFACE

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INTRODUCTION

Wetting and drying cycles are frequent events in soil environments; however, most of our understanding of chemical conditions on mineral surfaces is confined to fully hydrated systems. The chemical conditions on dry or drying mineral surfaces are known to be quite different to those on a fully hydrated surface. There are a number chemical changes that occur when field moist soils are air-dried including; an increase in reducing potential, extractable Mn and dissolved organic carbon (Bartlett and James, 1980). Changes in the structural stability of clay minerals after repeated wetting and drying cycles have also been reported (Doucloux et al 2002). Many of these changes have been related to the increase in surface acidity on the drying mineral-water interface yet due to the difficulty of measurement, the pH changes have never been quantified on various clay minerals. The reversibility of pH changes has also not been established. This study aims at quantifying the pH changes that occur on smectite and kaolinite minerals, saturated with different cations. The reversibility of drying-induced changes is also investigated.

MATERIALS AND METHODS

Drying-induced changes were quantified by sorbing a pH indicator (methyl orange) onto the surface of Al^{3+}-Mg^{2+}-Ca^{2+} or Na^{+}-saturated smectite and kaolinite minerals. The clay-indicator pastes were allowed to dry while infrared spectra were continually measured using attenuated total reflectance Fourier transform Infrared spectroscopy.

RESULTS AND DISCUSSION

The results show that only Al^{3+}-smectite shows acidification below pH 4.8 with drying. The pH starts to decrease on the Al^{3+}-smectite surface even when significantly hydrated (gravimetric water content ~ 125 mg/m^2), and falls to between 1.2 and 1.4 when completely air-dry. The drying induced pH decrease is completely reversible on rewetting, suggesting large pH oscillations may occur on smectite surfaces with appreciable exchangeable Al^{3+}. Aluminium saturated kaolinite did not show significant acidification in response to drying, but a 0.1 M $AlCl_3$ solution evaporated to a final pH of 2.8. The enhanced acidification observed on Al-smectite clay compared to a solution containing free Al^{3+} ions highlights the role of highly charged surfaces in the hydrolysis reaction that occurs within the hydration shell of exchangeable Al^{3+} ions.

CONCLUSIONS

Drying induced pH changes are only observed in Al-smectite systems, other saturating cations did not influence the pH substantially. Little pH change was observed on kaolinite clays. This suggests that only in low base status, high CEC soils (e.g. Alisols), would wetting and drying cycles lead to extreme pH fluctuations.

Keywords: acidification, dehydration, evaporation, metanil yellow, rehydration, reversibility

CHARACTERISATION AND FUNGICIDE SENSITIVITY OF NORTHERN CORN LEAF BLIGHT (*EXSEROHILUM TURCICUM)* ISOLATES.

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INTRODUCTION

Northern corn leaf blight (NCLB; causal agent: *Exserohilum turcicum*) is one of the most common and widespread maize leaf diseases in South Africa with yield losses as high as 50% being recorded (Perkins and Pederson 1987). The aim of the study was to identify and characterise selected NCLB isolates in terms of race type, fungicide sensitivity and phylogenetic relationship.

MATERIALS AND METHODS

Race typing was conducted on 26 NCLB isolates using near-isogenic lines (B68, B68-*HtN*, A632, A632-*HtN,* V26, V26-*Ht1*, V26-*Ht2*, V26-*Ht3, Oh43, Oh43-Ht1, Oh43-Ht2* and *Oh43-Ht3)* in seedling trials. The effect of three fungicides (azoxystrobin/difenoconazole; carbendazim/ fluzilazole and epiconazole/pyraclostrobin) at 0, 0.25, 0.5, 0.75, 1 and 2 times recommended dose (six replicates) was tested *in vitro* on twelve selected NCLB isolates using a well method. Control obtained were expressed as a percentage of the control and analysed as a split-split plot (P=0.05). Nine isolates (eight maize isolates and one sorghum isolate) were screened with 13 SSR (simple sequence repeat) markers (Haasbroek et al. 2014) and a UPGMA (Unweighted Pair Group Method with Arithmetic mean) dendogram generated.

RESULTS AND DISCUSSION

Five NCLB races were identified (Race 3, 3N, 23, 23N and 13N). Isolate-by-fungicide interaction was significant indicating that certain isolates were better controlled by specific fungicides that others. The NCLB isolate obtained from sorghum was genetically different from the maize isolates. Low bootstrap values were obtained but one cluster of maize isolates showed strong differentiation (e.g. Ht96 from Orania and Ht110 GWK area)

CONCLUSION

NCLB isolates collected differed based on race and sensitivity to various fungicides tested. Low bootstrap values between maize isolates may indicate genetic homogeneity, although the well-supported clade suggests that the addition of more isolates may lead to better differentiation and support from bootstrap values.

Keywords**:** *in vitro,* race, simple sequence repeats

PEPPER (*Capsicum spp.*) BREEDING ADVANCEMENTS AT TEXAS A&M UNIVERSITY

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INTRODUCTION

Peppers are an important vegetable and spice crop throughout the world. Texas production has shifted mostly to hot peppers for processing. Importation of peppers from Mexico has increased dramatically to supply the growing demands in the U.S.A. Higher yields, quality and resistance to biotic and abiotic stresses are key to the sustainability of the Texas and U.S. pepper industries.

MATERIALS AND METHODS

The Vegetable and Fruit Improvement Center at Texas A&M University has an active breeding program for hot and sweet peppers to address industry and consumer needs. In order to identify novel genes for resistance to insects and pathogens, more than 300 germplasm accessions from the USDA-GRIN were screened in three locations (Weslaco, Uvalde and College Station) over two seasons with no pesticide applications. Five selections of *C. chinense* and *C. baccatum* with multiple insect and disease resistance traits were utilized as male parents to cross with elite female breeding lines of *C. annuum*. More than 50 introgression lines were created for genetic studies and multiple backcross families were developed to combine pest resistance and fruit quality.

RESULTS AND DISCUSSION

Severe pressure from leafminers, aphids, thrips, bacterial leaf spot (BLS), Tobacco Etch Virus and Tomato Spotted Wilt Virus was recorded in the field plots. Five accessions were observed to resist all three diseases, leafminers and aphids. Only two accessions were partially resistant to onion thrips. Controlled inoculations of parents, F1, F2 and backcross progeny with TEV, TSWV and BLS revealed heritable resistance. A single, dominant gene for TEV resistance was identified and is undergoing allelism tests with other potyvirus resistance genes. Resistance to TSWV and BLS did not behave as single, dominant genes. Resistance to bacterial leaf spot was quantitative in nature and race non-specific. High level resistance to the 10 known races was evident in several *C. baccatum* and *C. chinense* introgression lines. Initial screening suggests that a single, dominant gene may confer resistance to leafminer in *C. annuum x C. chinense* families. A very high level of resistance to both leafminer and aphids in C. annuum x C. baccatum families was observed. Inheritance studies have not been carried out yet, though resistance has been maintained through several backcross generations.

CONCLUSIONS

Heritable resistance to multiple disease and insect pests is available in the *Capsicum* germplasm. Introgression of novel resistance genes into TAMU heat-tolerant, elite pepper lines will provide growers with better yields and fruit quality.

ACKNOWLEDGEMENTS

We appreciate the financial support of the New Mexico Chile Commission.

Keywords: breeding, genetics, insects, resistance, viruses, yield

IS IT POSSIBLE FOR POLLUTED AGRICULTURAL LAND TO RECOVER AFTER POLLUTION FROM A GOLD MINE TAILINGS DISPOSAL FACILITY?

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Introduction

The rehabilitation and remediation of degraded agricultural landscapes adjacent to gold tailings disposal facilities (TDF's) has become a primary concern in recent decades. Due to the lack of environmental legislation and enforcement thereof, minimal surface rehabilitation took place on the old Stilfontein mining complex prior to 1992. Old mining activities and re-mining of old gold TDF's leaded to the formation of a pollution plume on the adjacent grazing land north of the TDF 5, which lead to necessity to monitor the quantity and severity of the pollution plume over 30-month period.

Materials and Methods

The old Stilfontein Gold Mine TDF's are located in the North West Province, approximately 30 km west-south-west of Potchefstroom and north of the N12 highway. Mining started in 1952 until 1992 and re-mining of the first TDF's started in 2002.

In August 2011, a 30-month monitoring period started on the polluted area via the effectuation of monthly monitoring assessment across twelve fixed points, nine of which falls in areas with evidence of accumulating salts on the soil surface and the remaining three in areas without accumulating salts on the soil surface to serve as control sites and tri-monthly interval assessments of three transect lines which were selected over the extent of the polluted area.

Geochemical soil properties, of which some include pH, EC, XRD, CEC, exchangeable cations and anions, were conducted on the twelve fixed points as well as the employment of the Descending Point method to determine the species composition and quantity.

Results and Discussion

From the beginning of the 30-month monitoring period, the soil pH values remained neutral to slightly alkaline due to the neutralising effect of the dolomitic bedrock in this area. The EC values of the soil decreased significantly from 2010 to 2014; during dry seasons as of 2012, no sulphate salts accumulated on the soil surface. This was confirmed both visually and through the employment of XRD determination at the fixed points. In 2012 a total of 24 different grass species were found, whereas in 2014 a total of 36 different grass species were found. The overall vegetation quantity and composition of all the twelve fixed points increased from 2012 to 2014 with no site species composition lower than 10 different grass species per site in 2014.

Conclusion

This investigation shows that it is possible for agricultural land on dolomitic parent material affected by gold TDF's to naturally recuperate from pollution and degradation and support grass vegetation.

Keywords: Gold tailings disposal facilities (TDF), Pollution, Agricultural land, Dolomites

ARE WE REALLY THE FIRST TO APPLY MINIMUM-TILLAGE?

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INTRODUCTION

Certain tillage practices were increasingly linked to conservation and environmental aspects and the awareness started to rise also in South Africa. Since 2002, the Water Research Commission of South Africa invested in research around the dryland salinity problem of the Berg River catchment in South Africa to determine the mechanisms contributing to river salinity and whether mitigation measures could be established.

METHODS

Various observations were made while investigation the problem and adequate information was developed to populate and run hydrological models for this purpose. We also made numerous field observations normally not reported on that helped to confirm our modelling and better our understanding of this system. We specifically investigated all soil properties that influence the fate of rain water in the soils. This included soil physical properties like bulk density, compaction, surface properties, and vegetation cover, the stability of soils and many more. The specific land use and landuse included Renosterveld (the natural occurring veld type) was logged.

RESULTS AND DISCUSSION

From our investigation we found that the soils showed cultivation practice-specific behaviour. Soils subjected to minimum and no-tillage, showed much better qualities for crop production. Minimum-tillage, currently the preferred method, showed that the soil developed a better structure and had faster hydraulic conductivity as compared to the other cultivation practices. Minimum-tillage also resulted in lower salt accumulation than conventional till. These soils developed a larger water holding capacity and were more supportive in terms of dryland crop production. The densities of these soils were also recorded over time. We found that density changes occurred through the year. When we compared these results with the natural occurrence of soils in undisturbed sites, we found that the general soil physical patterns and responses from our minimum-till sites, resembled that of the natural occurring soils.

CONCLUSION

We found conclusive evidence to say that the Swartland soils are well suited for minimum tillage and that the conditions developing from these actions, is manageable and results in ultimate sustainability. What this meant is that we proved beyond any doubt that the practice of minimum-till also signifies the maximum possible sustainability in these crop production systems.

Acknowledgements

Water research Commission of SA and the NRF for supporting this research financially.

Keywords: tillage, salinity, sustainability

Determining plant available water of mine tailings material for rehabilitation purposes

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INTRODUCTION

The rehabilitation of tailing storage facilities (TSF) is crucial for the surrounding environment and more specific agricultural soils in the vicinity of mines. Effluent water draining from a TSF along with other factors such as dust production can decrease adjacent land to such an extent that production decrease to sub-standard yields. By rehabilitating these TSF, surrounding areas as well as some of the TSF could be used for agricultural purposes. Establishment of sustainable vegetation on these sites are fundamental to most rehabilitation programs and to do so it is essential to control the water regime in the top one meter of tailing sites. The more plant available water (PAW) contained in the tailings the better the environment for plant species to succeed to adult hood and reproduction. the objective of this study was to determine plant available water of tailing materials to be more specific with respect to rehabilitation specifications i.e. species selection and density of seeding and if necessary also to improve irrigation scheduling where applicable.

Materials and methods

For this study the standard *Soil Science Society of America* method was used in determining the water retention of the different tailing materials. Water between FC (30kPa) and PWP (1500kPa) is described as PAW. This is a useful tool in selecting plant species. Tailing species that were used included Gypsum, gold, platinum, coal, andalusite, fluorspar, kimberlite and foskor mine tailings.

Results and discussion

Most of the tailing materials that were evaluated showed remarkable results. Indicating a relatively high percentage of PAW in relation to natural soils. Particle size distribution (PSD), clay content, clay mineralogy and water retention are distinguishing factors between tailing materials and natural soils. This is due to tailing materials mostly consisting out of crushed rock and un-weathered primary minerals as appose to secondary minerals in natural soils. As a result, the lack in clay mineralogy in most tailing materials caused the bulk of the water to be available to plants only at low suction potentials and this could be a problem during times of drought.

Conclusion

Considering the above, better irrigation programs should be developed to pave the way to a better success rate in rehabilitation of TSF. This will lead to more productive and less polluted agricultural activities in the immediate vicinity as well as the general area.

Acknowledgements

Participating members on this project was THRIP, Frazer Alexander Tailings and NWU

Key words: agricultural land, pollution, rehabilitation, clay content, clay mineralogy

EFFECTS OF N, P AND K FERTILIZATION ON MAIZE POLLEN QUANTITY AND QUALITY.

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INTRODUCTION

Maize (*Zea mays* L.) as staple food crop, it is the third most important cereal crop in the world after wheat and rice. Despite maize popularity in food research, its pollen quantity and quality as influenced by soil nutrient status is seldom assessed. Pollen quantity and quality directly influence successful pollination, kernel set, and resultant grain yield. The main aim of this paper is to assess maize pollen quantity and quality as influenced by N, P and K.

MATERIALS AND METHODS

A randomised complete block design trial was carried-out at the University of Pretoria's Hatfield Experimental Farm in the 2013/2014 season. Maize plots were treated with different fertilizer combinations; 0 (control), N, P, K, NP, NK, PK, NPK, W, WN, WP, WK, WNP, WPK and WNPK, each replicated four times. Compost was applied in W-containing plots for three seasons between 2003 and 2005. Tassels were collected from 7 to 9 weeks after planting. To quantify pollen quantity, five tassels were collected per replicate between 7 and 8 am daily. Tassels were kept in a beaker with water covered with plastic-film and placed on a sheet of paper for pollen collection. After 24 hours tassels were lightly shaken, fallen pollen was collected, sieved, weighed then put into vials. Pollen quality was determined in terms of pollen viability and germination, using Alexandra's test and hanging-drop method respectively. Significant differences were determined at the 5% probability level using Tukey's HSD test.

RESULTS AND DISCUSSION

There was a significant difference in pollen weight per plant as influenced by different fertilizer treatments ($p>0.05$). N and WK obtained pollen weighing 2.8 and 2.6 g respectively which were significantly higher ($p>005$) to other treatments. WNPK and NPK had significantly highly viable pollen with 83.3% and 76.4% respectively. Significantly higher germination percentage was obtained in WNPK and NPK with 76.59% and 72.08% respectively. There was a strong positive correlation (90.85%) between pollen viability and germination capacity, whilst a weak negative correlation (4.9%) between pollen quantity and viability.

CONCLUSIONS

There was a significant difference in pollen quantity and quality as influenced by different fertilizer combinations ($p>0.05$). Maize plants receiving N only produced the highest quantity of pollen, while WNPK and NPK treated plants produced high quality pollen (higher viability and germination capacity). Plant nutrition plays a vital role in pollen production and viability.

ACKNOWLEDGEMENTS

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Keywords: maize, pollen quantity, pollen viability, pollen germination

SITE-SPECIFIC, RISK-BASED WATER QUALITY GUIDELINES FOR SUSTAINABLE IRRIGATION

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INTRODUCTION

Agriculturists use irrigation water quality guidelines (IWQG) to assess the suitability of a specific water source for irrigation, while the Department of Water and Sanitation (DWS) use them in setting and managing Receiving Water Quality Objectives (RWQO). The decision by DWS to apply '*risk to use'* in the development of future RWQOs, necessitated a revision and repackaging of the current guidelines.

MATERIAL AND METHODS

A team of specialists reviewed the current South African and international IWQG to identify the factors that determine general and site specific risks associated with water quality constituents, and to evaluate the information that is available to quantify these risks and promote irrigation on a sustainable basis. This knowledge is being incorporated into a prototype Decision Support System (DSS) (the so-called *Technology Demonstrator*) that calculates the effect and risk for soil quality, crop yield and quality and irrigation equipment when a given water quality is considered for irrigation.

RESULTS AND DISCUSSION

The *Technology Demonstrator* demonstrates the most important features of the new guidelines using electrical conductivity, chromium(VI), zinc, corrosion, *E. coli* and a pesticide as trial constituents. It operates at three levels or tiers. Tier 1 provides generic guidance that resembles the 1996 IWQG. It is the most conservative of the three tiers. Tier 2 makes use of pre-defined data bases that allow the user to select, for example, an appropriate climatic region, soil characteristics, crop to be irrigated and irrigation system, and in so doing, introduces some level of site-specificity. Tier 3 guidelines, which are essentially risk assessment guidelines, will be used for highly site-specific water quality assessments and use the climate, soil, crop and other characteristics of a specific site. Constituents are evaluated for the effect they have on soil quality, crop yield and quality and irrigation equipment. In addition to quantifying the risk associated with a specific constituent concentration, user friendly displays convey the implications for irrigation. It is envisaged that the complete DSS will cater for up to 40 water quality constituents; including several not catered for in the 1996 IWQG.

CONCLUSIONS

A *Technology Demonstrator* was developed to demonstrate the most important features of new software based irrigation water quality guidelines that will satisfy the needs of both agriculturists and DWS. The guidelines will assess the '*risk to use'* irrigation water and allow for much greater site-specificity than current guidelines.

ACKNOWLEDGEMENTS

This paper reports on progress made with a project entitled "Revision of the 1996 South African Water Quality Guidelines: Development of a risk-based approach using irrigation water use as a case study" (WRC Project No K5/2399) emanating from a Water Research Commission directed call for research proposals.

Keywords: Crop quality, crop yield, Decision Support System, soil quality, water constituent

NITROGEN MANAGEMENT EFFECTS ON TUBER INITIATION OF SELECTED POTATO CULTIVARS

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is the world's most important non-grain food crop, but sustainable production is currently under threat. Local potato producers are under immense financial pressure due to increased input cost. Tuber initiation (TI) onset and duration affect tuber yield, size distribution and quality. Nitrogen (N) management can affect TI and it also contributes substantially to input cost. This study focused on N rate and timing effects on the onset and duration of TI, final yield, size distribution and quality of selected cultivars.

MATERIALS AND METHODS

A factorial field trial was laid out as a split-plot RCBD with three replicates on the University of Pretoria's Hatfield Experimental Farm. Three cultivars (BP1, Eos and Lanorma) were allocated to the main plots. Sub-plots consisted of three N levels (R1=160 kg/ha N, R2=240 kg/ha N and R3=360 kg/ha N) and three N timing treatments (T1=30% N at planting, 70% N ±3 weeks after emergence; T2=50% N at planting, 50% N after emergence and T3=70% N at planting, 30% N after emergence). Weekly destructive harvests were conducted for growth analyses and to assess TI status. At final harvest tuber yield, size distribution and quality were evaluated. Data was statistically analysed using SAS Version 9.3.

RESULTS AND DISCUSSION

Preliminary results showed that there were significant differences between cultivars in the onset and duration of TI, but no N timing effects occurred. Eos had already started TI one week after 50% emergence, whereas Lanorma and BP1 only initiated tubers from the second week. BP1 initiated tubers from two weeks after emergence until late in the season. On the contrary, Eos and Lanorma initiated most tubers early in the season. Final tuber yield significantly increased from rate R1 to R3. All three timings influenced final tuber yield significantly, with T3 producing the highest final tuber yield for each cultivar. Marketable yield was significantly influenced by cultivar, timing and nitrogen rate. For cultivar Lanorma R3 significantly increased yield, compared to R1. A tendency was observed that T2 and T3 gave highest marketable yields compared to T1. Early TI played a crucial role in Lanorma's high marketable yield since it initiated most of its tubers within two weeks after emergence and resorbed very few tubers later in the season. Specific gravity (SG) decreased significantly at the highest N level (R3). Cultivar also significantly affected SG. Chip colour was not influenced by N rate and timing, but by cultivar, with BP1 and Lanorma giving significantly higher colour values compared to Eos.

CONCLUSIONS

These preliminary results suggest that N treatment combination R2 and T3 was optimal to ensure high yields and acceptable tuber quality under the specific conditions. The trial needs to be repeated to confirm results before final recommendations can be made.

ACKNOWLEDGEMENTS

Potato South Africa for funding and GWK for supplying the potato seeds.

Keywords: Application timing, nitrogen rate, tuber initiation, tuber quality

A STUDY ON POLLEN VIABILITY, POLLINATION AND FRUIT SET OF *MORINGA OLEIFERA* LAM. TREES GROWING UNDER SUB-OPTIMAL GROWING CONDITIONS

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INTRODUCTION

Moringa oleifera Lam., a tree naturally grown in the tropics, is becoming increasingly popular due to its multitude of useful attributes as water purifier, nutritional supplement and biofuel. High seed yields are essential for oil production but the question is, how would sub-optimal growing conditions affect seed production? The success of self- and cross pollination of trees under these conditions might give some indication of the expected seed production.

MATERIALS AND METHODS

Ten trees were randomly selected in an 8 yr old *Moringa oleifera* orchard at the Experimental Farm of the University of Pretoria (25°45'S, 28°16'E), at an altitude of 1372 m above sea level and an average annual rainfall of 674 mm.

Pollen was collected from flowers at three flowering stages for *in vitro* germination. The hang drop method was applied to allow pollen to germinate. Germinated and ungerminated pollen were counted under a light microscope. For *semi-in vitro* pollination, flowers starting with anthesis were emasculated and bagged. On the second day, flowers were collected, self- and cross-pollinated and pedicels inserted in plastic dishes containing agar medium. For each treatment, there were five replications with five flowers each. Flowers were incubated and after the second day, flowers were fixed and pistils were dissected, softened in 5M KOH, 'stained' with aniline blue and viewed under a confocal microscope.

For the field experiment, eighteen 6 year old trees from the same orchard were randomly selected in late autumn. Four inflorescences per tree with an average of 5 flower buds, ready for anthesis, were selected. All open flowers and younger flower buds were removed and the inflorescences closed using muslin cloth bags. Two bags for each treatment were tagged randomly on each tree. The following day, for cross-pollination, flowers in early anthesis were emasculated and the inflorescences bagged again. For selfing, flowers in two of the bagged inflorescences per tree were not emasculated. Cross- and self-pollination were performed for each treatment on the fourth day. Pollinated flowers were observed on a weekly basis and the % fruit set was calculated.

RESULTS AND DISCUSSION

One, two and three day old pollen germinated equally well *in vitro*. There was no obvious difference in the number of ovules between semi-*in vitro* self- and cross-pollinated ovaries observed in February and May, however, pollen tube penetration differed. The success rate of fruit set from cross- and self-pollinated flowers was initially high, but decreased over time.

CONCLUSIONS

From trees flowering under cooler climatic conditions, it can be concluded that pollen is viable and the stigma is receptive, but fruit set is low.

Keywords: pollen germination, flowers, ovaries

EFFECT OF SHALLOW WATER TABLES ON THE EVAPOTRANSPIRATION AND IRRIGATION REQUIREMENT OF WINTER WHEAT AND MAIZE IN A SEMI-ARID REGION

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INTRODUCTION

Over-estimation of the irrigation requirements of crops grown in the presence of shallow water tables can cause waterlogging problems. When managed properly, water tables can contribute significantly towards plant evaporation and are therefore recognized as an important water resource in agriculture. The objective of this study was to quantify the capillary contribution from shallow water tables towards the evapotranspiration of irrigated wheat and maize grown on two different soil types.

MATERIALS AND METHODS

Lysimeter experiments with wheat and maize, planted during two consecutive seasons, were conducted at the Field Research Facility of the University of the Free State. Two sets of 15 lysimeters each, one filled with a yellow sandy soil and the other with a red sandy loam soil was used. Water tables were introduced from the bottom of each lysimeter by means of a manometer and bucket system. The treatments, replicated three times and randomly allocated to each soil type were as follows: i) Control without a water table (WT); ii) WT kept constant at 1.0m; iii) WT kept constant at 1.5m; iv) WT falling from 1.0m to 1.8m before recharging and v) WT falling from 1.5m to 1.8m before recharging. Soil water content was determined using a neutron probe and the weekly evapotranspiration (ET) was calculated with the soil water balance equation described by Hillel (1980). The amount of water that was required to reset the water tables represented the contribution of the water tables towards ET. Data were subjected to analysis of variance (ANOVA) using NCSS.

RESULTS AND DISCUSSION

The results showed that the capillary contributions from the water tables towards seasonal ET were influenced by water table depth and soil type. WT contributions in the red loamy sand were significantly ($P<0.05$) higher than those from the yellow sand. Maximum contributions occurred from WT depths of 1.0m for both soils and crops. WT contributions ranged from 38 to 63% and from 25 to 53% of the total seasonal ET of wheat and maize, respectively.

CONCLUSIONS

The irrigation requirement of wheat and maize can be decreased with the amount of water supplied by a shallow water table, when present. Irrigation water savings of up to 63% for wheat and up to 53% for maize can be achieved when irrigation scheduling is adapted to enhance crop water uptake from shallow water tables.

ACKNOWLEDGEMENT

This research emanates from a project financed by the Water Research Commission (WRC).

Keywords: Irrigation scheduling, water saving, lysimeter, water table depth

GROWTH AND PHOTOSYNTHETIC RESPONSE OF DIFFERENT SUGARCANE VARIETIES TO RIPENER APPLICATION

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INTRODUCTION

Chemical ripeners e.g. 2-chloroethyl phosphonic acid (Ethephon) are effective agents for altering carbon partitioning within sugarcane towards storage of sucrose. Sugarcane varieties are known to react differently to chemical ripeners but the physiological and growth responses between varieties that are involved in achieving an increase in final sucrose yield are currently unknown. Chemical ripeners are assumed to reduce stalk and leaf growth thus reducing the sink demand for sucrose for sugarcane growth. This study aimed to determine whether stalk growth, leaf growth and CO_2 assimilation rates differed between varieties before and after Ethephon application, and whether these differences could explain varietal differences in ripener efficacy.

MATERIALS AND METHODS

Three sugarcane varieties (N42, N47 and N51) were grown for two seasons (of approximately 12 months each) at Mount Edgecombe (29° 42' 24" S, 31° 02' 45" E) under drip irrigation, when required. The experimental design consisted of a complete randomised block with two treatments (Control and Ethephon) and five replicates for each variety x treatment combination, where each plot consisted of five sugarcane rows of 8m per row. Stalk height, leaf length and width, calculated green leaf area, and stalk population were measured monthly from one month after plant emergence. CO_2 assimilation rate (A_n), stomatal conductance (g_s) and transpiration (E) were measured with a LiCor 6400 photosynthesis system once before and after Ethephon application (12 weeks before harvest) at 1.5 L ha^{-1}. Sugarcane yield (t ha^{-1}), sucrose content (%) and sucrose yield (t ha^{-1}) at harvest were determined for all treatments.

RESULTS AND DISCUSSION

Ethephon did not significantly affect stalk elongation, but did suppress leaf length and width, which caused a significant reduction in green leaf area in all three varieties, compared to the control. A reduction in leaf area lowers the sink demand for growth, thus more sucrose could be available for storage. N51 had significantly higher A_n, g_s and E than N42 and N47 under control and Ethephon treatments. All three varieties showed a reduction in A_n, g_s and E in response to Ethephon application. A reduction in assimilation rate lowers the source strength available to produce sucrose but the net balance between sucrose production and sucrose consumption for growth after Ethephon application will determine the response of sucrose content. At harvest, the varieties responded differently to Ethephon. Sucrose content ranged from 10.63% (N51) to 12.73% (N47) in the control treatments. Application of Ethephon did not increase sucrose content in N42 and N47, but a 6% increase in sucrose content was found in N51.

CONCLUSIONS

Ethephon suppressed leaf growth and caused a reduction in assimilation rate in all three varieties, although the effect on sucrose content at harvest was different between varieties. The data derived from sugarcane growth and photosynthetic response to chemical ripeners will be used to inform the development sugarcane crop model to explain changes in structural plant processes (e.g. leaf and stalk elongation rate) and the impact on source strength (e.g. photosynthesis).

ACKNOWLEDGEMENTS

The authors would like to acknowledge the involvement and participation of the SASRI Technical Team.

Keywords: Sugarcane, ripening, variety, yield effects

REDUCING HEIGHT AND LODGING IN CANOLA (BRASSICA NAPUS L.) USING PLANT GROWTH REGULATORS

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INTRODUCTION

In South Africa, canola (*Brassica napus* L.) is produced under short day conditions during winter months. These conditions, together with high fertiliser application levels required to maximize grain yields, often result in tall growing bulky crops which are prone to lodging. This will especially be true if canola production is expanded to irrigated areas. The primary objective of this study was to determine the effect of anti-lodging plant growth regulators (PGRs) on the agronomic and quality characteristics of commercial canola cultivars under South African conditions.

MATERIAL AND METODS

This study was conducted under field conditions at three research farms, as well as controlled glasshouse conditions at Welgevallen Research Farm, situated in the Western Cape Province of South Africa. Foliar treatments consisted of a control (untreated) and four PGRs; CeCeCe® 750 (chlormequat chloride), Moddus® 250 EC (trinexapac-ethyl), Primo MAXX® (trinexapac-ethyl), and Kelpak®, applied either individually or in combination with wetting agent at budding stage (growth stage 3.1) of canola. Whilst glasshouse trials were conducted with spring canola cultivars "Hyola 555TT" and "43C80", field trials were done with Hyola 555TT only. Monitoring and measuring various plant parameters during different growth stages of canola, the morphological and physiological impact of PGR-treatments on growth and development were determined.

RESULTS AND DISCCUSSION

With the exception of a few improved plant growth parameters, Kelpak® and CeCeCe® 750 treatments generally did not have a large effect on growth, yield or plant height of canola. Though Primo MAXX® tends to reduce plant height in all trials; reductions were only significant during one of the glasshouse trials. Fortunately, compared to the control, none of the PGRs significantly reduced the leaf area, number of flowers or number of pods plant^{-1} during this study, while Primo MAXX® and Moddus® 250 EC tend to increase the grain yield under field conditions. This study indicates that PGRs can possibly be used to improve lodging resistance and yield of canola. Identifying the most effective PGRs on specific cultivars, the results of the study will contribute to the knowledge of using PGRs in canola to reduce lodging and improve grain yields in South Africa.

CONCLUSIONS

This study showed that Primo MAXX® without any doubt has the potential to reduce plant height, lodging and possibly improve grain yield in canola. However, it is recommended that further research be done as PGRs response may be dependent on the cultivar, PGR combinations, application timing and rates. Additionally, economic analysis needs to be conducted to determine the cost benefit ratio of PGR usage.

Keywords: Canola, Lodging, Plant growth regulators

IT IS TIME TO PLANT SOYBEAN IN MOZAMBIQUE!

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INTRODUCTION

Soybean (*Glycine max L.*) is emerging as an important cash crop in Mozambique. The crop is expanding within the farming communities, both spatially, as well as in production per unit area. This trend is as a result of concerted efforts among partners involved in research and promotion of soybean in Mozambique. However, information on proper management of this relatively new commercial crop is limited. Consequently, knowledge on best management practices such as planting time, inoculation, fertilization, pest and disease control require refining. The objective of this study was to evaluate the growth, yield and yield components of promiscuous soybean genotypes grown on six planting dates across four agro-ecologies and to identify the best time to plant in these ecologies.

MATERIALS AND METHODS

A field trial was conducted during the 2013/2014 season at four locations in Mozambique: Angonia, Muriaze, Ruace and Sussundenga, using a split-plot design with four replications. Planting date was assigned the main plot and varieties as sub-plot. Six soybean genotypes were sown on six planting dates, beginning in the first week of December with 10 day-planting intervals. Data on crop development and growth characteristics, including duration of specific growth stages, plant height, nodulation, pods, seed weight and yield were collected. Other data collected were leaf chlorophyll content, carbon assimilation and stomatal conductance. In addition, biomass and seed samples were collected to analyze for total nitrogen content. A two-step data analysis was conducted in PROC GLM (SAS 9.4).

RESULTS AND DISCUSSION

Average yield decreased from 2928 kg ha^{-1} for the first planting date to 436 kg ha^{-1} for the sixth planting date across genotypes and locations. Similarly, biomass production declined progressively from 7668 kg ha^{-1} to 1404 kg ha^{-1} from the first to sixth planting date, respectively. At Ruace, a high soybean production environment, daily yield loss due to late planting ranged from 45 – 77 kg ha^{-1}. In general, all parameters measured decreased for all soybean genotypes at all locations as planting delayed.

CONCLUSIONS

Planting soybean at the appropriate time complements clean seed selection and good management practices. Early planting of soybean after onset of rains, is recommended in all the four agro-ecologies and could be extrapolated to other locations in Mozambique. Proper timing of soybean planting lead to early maturing of the crop which escapes terminal drought that frequently reduce yield. Analysis of chlorophyll and carbon assimilation data to understand physiological changes that occur in the soybean plant as planting delays is on-going

ACKNOWLEDGEMENTS

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Keywords: Agro-ecologies, genotype, planting date, soybean, yield

THE INFLUENCE OF SOIL QUALITY OF ANTHROPOGENIC MINE SOILS ON THE CHLOROPHYLL FLUERESCENCE OF SOME WINTER CROPS

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INTRODUCTION

Phytostabilizaton is a technique within phytoremediation, which involves the establishment of vegetation in anthropogenic mine soils in order to immobilize potentially toxic trace elements, and for the physical stabilization of the surface of these materials. The aim of this investigation was to evaluate the influence of different characteristics of these anthropogenic soils on the chlorophyll fluorescence of selected plant species, in order to facilitate a successful phytostabilization methodology.

MATERIALS AND METHODS

Soil analyses were done on composite samples from different growth mediums. The chlorophyll fluorescence of six winter crop species was measured with the Handy-Pea Instrument from Hanzatech Instruments. The different winter crop species used during the trail were Canola, Radish, Wheat, Oat, Rye Grass and Red Clover. The different chlorophyll fluorescence parameters were also used to evaluate the vitality of the plants. The vitality of the plants subjected to various soil stress conditions was measured as a function of photosynthetic ability. It is expressed as PI_{ABS}, and takes into consideration the ability of the plant to absorb and convert sunlight into chemical energy.

RESULTS AND DISCUSSION

Toxic metal trace elements which were encountered are Cd, Cr, Zn, Cu, As, U ect. The stress factors associated with the different anthropogenic mine soils, negatively affected plant vitality, thereby limiting the ability to convert sunlight into chemical energy. These results is illustrated as OJIP-transients which illustrates the changes in the fluorescence kinetics. These OJIP-transients shows that the stress conditions have a noticeable effect on the photosynthesis of the plants. Furthermore the curves was also plotted as the difference in variable fluorescence. These graphs indicate the physiological stress in the plants as different peaks. These peaks indicate the ineffective transport of electron between photosystem I and photosystem II. Comparisons between the reactions of the different plant species to the stress factors revealed significantly different behaviours. Plants that were grown in more favourable conditions and plants adapted to survive in anthropogenic mine soils showed a higher vitality index.

CONCLUSION

The various stress conditions associated with different anthropogenic soils have a noticeable effect on the chlorophyll fluorescence of various plant species. Therefore chlorophyll fluorescence can be used as an indicator of plant vitality, in order to select successful phytostabilizers for different anthropogenic soils.

Keywords: Physiological stress factors, Phytostabilization, Plant vitality (PI_{ABS}), Potentially toxic trace elements, Remediation.

INFLUENCE OF DIFFERENT STORAGE CONDITIONS AND PERIODS ON QUANTITY AND QUALITY OF *MORINGA OLEIFERA* LAM. SEED OIL

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INTRODUCTION

Moringa oleifera Lam. seed oil can be used as cooking oil and as a fine machine lubricant (Rahman *et al.* 2009). It has also been identified as a potential source of biodiesel by Rashid *et al.* (2008). Commercial oilseeds have a poor reputation due to a widespread perception that lipid-rich seed tend to have limited longevity (Priestley, 1986) and also progressively lose its lipid content (McDonald, 1999) over time. This study aimed to assess the effect of different storage conditions and duration on the quantity and quality of the seed oil.

MATERIALS AND METHODS

Fruits of *Moringa* were harvested from an orchard growing on the Experimental Farm of the University of Pretoria (25˚45'S, 28˚16'E). A twofold experiment was used: 1) Oil extracted from fresh seeds was stored in dark bottles at ambient room temperature. 2) Seeds were stored as follows: Treatments were arranged in a factorial 4 x 2 x 2 scheme experiment with four temperatures (-19°C, 4°C, 20°C and 30°C), two storage periods (6 and 12 months) and two packaging types (paper and aluminium bags). All treatments were stored in triplicate. Both stored oil and oil extracted from stored seeds were analysed, following standard methods of ATSM (2011) and AOAC (2000). The antioxidant activity was determined by DPPH method according to Wu *et al*. (2011). Statistical analyses were performed (SAS 9.4, 2013).

RESULTS AND DISCUSSION

No significant reduction of seed oil content was observed at 6 and 12 months of storage for all treatments. Most of the characteristics of the stored oil were similar to that of oil extracted from seed stored at 30˚C in paper bags. Oil viscosity and density remained relatively unchanged throughout storage. Packaging type had no effect on free fatty acid (FFA) content and iodine number, however, the above significantly decreased as storage period increased. FFA content also increased significantly as the temperature increased. For antioxidant activity, an interaction was found between storage period and temperature. The antioxidant activity of oil extracted from seed stored at 20 □C in both bags, 30□C in | the stored oil, significantly decreased at 12 months of storage.

CONCLUSIONS

Storage temperature and period influenced the quality of *Moringa oleifera* oil. According to this study the quality of the oil can be maintained with minor deterioration, if seeds are stored at temperatures of 4 □C and below. Seed oil content did not decrease after 12 months of storage.

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Keywords: Antioxidant activity, induction time, packaging, temperature

SOUTH AFRICAN PEATLANDS

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INTRODUCTION
Wetlands in South Africa are mostly seasonal and temporarily wet, and comprise less than 15% of the land surface. Less than 10% of these wetlands are peatlands, which are characterized by the unique ability to accumulate and store dead organic matter from wetland vegetation under almost permanent water saturated conditions and low oxygen content. Peat is therefore not only a resource for soil carbon but also fresh water. Hydrological processes play a crucial role in the development and maintenance of this unique wetland type, especially in drier regions. Although peatlands are not common in South Africa, they are under threat. In order to explain the key processes forming peatlands, it is important to understand their spatial distribution in South Africa as well as their valuable contribution to the country's wetland ecological infrastructure.

MATERIAL AND METHODS
The existing peatland eco-region map (2001) was improved using the most recent available spatial data as input layers coupled with defined parameters and thresholds set by peatland experts to update the model. Peatland verification was done using existing spatial peatland points in the national peatland database.

RESULTS AND DISCUSSION
Currently, there are 519 records in the 2001 national peatland database of which 40 sites have detailed profile information and nine peatlands have C^{14} ages recorded that vary from 130 to ± 45 000 years BP. From the wetland and humic soil categories in the ARC-ISCW soil profile database an additional 23 sites could be added to the national peatland database as peatlands. Using the 519 verified peatland points to calculate the overall mapping accuracy, 93% accuracy was attained when both peatland eco-region models (2001 and 2014) were combined. The next phase of verification will include additional peatland sites to compare with the old, new and combined peatland eco-region model products. Contributions to help update the national peatland database with information of known peatland sites are welcomed.

CONCLUSIONS
Peatland protection is important because this unique ecosystem contributes significantly to global biodiversity, regulating hydrological functions, and hosts a third of the Earth's terrestrial carbon. Informed management decisions are needed from both government and the public in order to conserve this valuable natural resource.

ACKNOWLEDGEMENTS
Funding from the Water Research Commission (WRC Project No. K5/2346).

Keywords: wetlands, peatlands, eco-regions

QUANTIFYING THE SOIL QUALITY OF TWO BENCHMARK ECOTOPES IN THE EASTERN CAPE USING THE SOIL MANAGEMENT ASSESSMENT FRAMEWORK (SMAF) FOR STUDYING THE INTERACTIVE EFFECTS OF CONSERVATION AGRICULTURE COMPONENTS

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INTRODUCTION

Soil quality assessment is a significant tool for understanding the management effects of crop and soil practices within agricultural soil systems. The objective of this study is to quantify several soil quality indicators that are sensitive to conservation agriculture (CA) and determine if the Soil Management Assessment Framework (SMAF) could distinguish between the soil quality indicators of the two ecotopes for the purpose of studying Conservation Agriculture (CA) components.

MATERIALS AND METHODS

Two soil ecotopes from the Eastern Cape Region of South Africa, namely the Alice Jozini ecotope and the Phandulwazi Jozini ecotope, were used in this study. In terms of previous land management on both ecotopes, lucerne was grown on the Alice site for at least 5 years and kikuyu grass was grown on the Phandulwazi site for several years prior to the time of sampling. Eight SMAF-scored soil parameters were determined and the data was scored as outlined by Andrews *et al*., (2004) and a combined SQI for each ecotope was computed.

RESULTS AND DISCUSSION

Using SMAF indicator scores, soil organic carbon (SOC) and microbial biomass carbon (MBC) were significantly lower in the Phandulwazi Jozini ecotope than the Alice Jozini ecotope. SMAF-extractable P, pH, bulk density (D_b) and aggregate stability (AGS) indicator scores were significantly lower in the Alice Jozini than in the Phandulwazi Jozini ecotope. The SMAF indicator scores for EC and K were not significantly different across the two sites. Of all the SMAF indicators, D_b scores significantly less across the two sites. The overall Soil Quality Index (SQI) values for the Alice Jozini ecotope and the Phandulwazi Jozini ecotope, which integrated 8 SMAF-scored soil attributes, were found to be 78 and 75% of their optimum capacity respectively. The slight difference in the soil quality of the two ecotopes in this study can be attributed to the different previous land management practices which influenced the SOC differently in these two ecotopes.

CONCLUSION

The results of this preliminary study indicate that the two ecotopes, which receive different amounts of rain, differed in some key soil quality parameters. They are, therefore, going to be used for monitoring the short and long term interactive effects of conservation Agriculture (CA) components on soil quality. The results also showed that SMAF can be a useful and practical tool for monitoring these CA effects.

ACKNOWLEDGEMENTS

Govan Mbeki Research and Development Centre (GMRDC) for funding the research

Keywords: Conservation agriculture (CA). Soil management assessment framework (SMAF); Soil Quality Index (SQI)

INFLUENCE OF TEMPERATURE AND MANGANESE ON THE TOLERANCE OF *CONYZA BONARIENSIS* TOWARDS GLYPHOSATE

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INTRODUCTION

It has been reported that glyphosate-resistant *Conyza canadensis* becomes sensitive at low temperatures (< 12^{0}C). The researchers suggested that if the resistance mechanism is vacuolar sequestration, low temperatures prevent glyphosate being translocate into the vacuole. It has also been reported that tank mixtures with foliar manganese fertilizers decrease glyphosate efficacy. Another study found that the control of velvetleaf decreased when manganese was applied before glyphosate. The aim of the present study is to determine if highly glyphosate-tolerant *Conyza bonariensis* plants would become sensitive at low temperatures, and to assess if there is an interaction between manganese levels and response to glyphosate.

MATERIALS AND METHODS

Temperature experiment: Plants from a highly glyphosate-tolerant population were grown in the greenhouse up to the four leaf stage and then moved to the temperature gradient table. Plants were grown at 5^{0}C, 18^{0}C or 25^{0}C. The glyphosate dosage range was 0, 0.5, 1, 2 and 4 times the recommended rate (2 L/ha Roundup Turbo). At 21 days after treatment the plants were clipped at the soil surface and weighed to obtain fresh mass.

Manganese experiment: Seed from a sensitive and highly tolerant *C. bonariensis* population were planted in seeding trays. Seedlings were transplanted to a hydroponic system in which nutrition was supplied using a standard Hygrotech product as one treatment, and two other treatments in which only the manganese concentration was changed. Plants were treated with glyphosate at the 4-6 leaf stage with 1 and 2 L/ha Roundup Turbo.

RESULTS AND DISCUSSION

Highly glyphosate-tolerant plants did not become susceptible at the low temperature regime, in fact, sensitivity towards glyphosate increased with an increase in temperature. The glyphosate-susceptible biotype showed higher tolerance to glyphosate at the highest manganese level in hydroponic system. However, the difference in tolerance to glyphosate between the manganese levels was not significant.

CONCLUSION

Vacuolar sequestration is probably not the mechanism responsible for either high tolerance or resistance of *C. bonariensis* towards glyphosate, at least for the biotype investigated. Plants did not become less sensitive towards glyphosate at the higher manganese level. Research is ongoing on both aspects.

Keywords: Hydroponic system, weed resistance

A COMPARATIVE STUDY OF SELECTED HORTICULTURAL CHARACTERISTICS OF INDUCED POLYPLOIDS OF *PLECTRANTHUS ESCULENTUS* AND THEIR DIPLOID PROGENITORS.

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INTRODUCTION
Plectranthus esculentus (Family: *Lamiaceae*), or Livingstone potato, is an edible tuberous vegetable which originates in Africa, with central Africa being the center of origin. *P. esculentus* is found throughout the Continent, including the north-eastern regions of South Africa. Although the tubers are edible, limited crop improvement has taken place. To this end a study comprising *in vitro* polyploidisation was carried out with subsequent evaluation of plant morphological characteristics and nutritional value of the induced tetraploids compared with the diploid controls.

MATERIALS AND METHODS
Polyploids were induced using colchicine at various concentrations and exposure times and verified using standard flow cytometric methods. Various morphological and horticultural characteristics of diploid and tetraploid plants were measured, namely: number of stems, plant height, stomatal distribution, chlorophyll content index as well as nutritional value of both leaves and tubers. Potential nematode tolerance was investigated by exposing hardened-off diploid and tetraploid plants to root knot nematodes (*Meloidogyne* spp.) and recording the number of egg masses per root system, number of eggs and J2 individuals per root system. The Rf-value, an indication of resistance/tolerance, was calculated.

RESULTS AND DISCUSSION
Artificially-induced polyploids were produced using colchicine and verified using flow cytometry. Tetraploid plants had more stems per plant which were thicker compared with diploid plants. They also had a lower stomatal distribution compared with the diploids. Tetraploid plant leaves had a higher chlorophyll content index than diploid plants. Tetraploid tubers had a higher starch content compared with the diploids. However, there was no significant difference in elemental content for both the leaves and the tubers when induced tetraploids were compared with the diploids. Further, induced tetraploids appeared to be significantly more tolerant to rootknot nematode, *Meloidogyne* spp., compared with the diploids. Significantly higher number of egg masses per root system and number of eggs and J2 (juvenile stage 2) individuals per root system were detected.

CONCLUSIONS
Artificially-induced tetraploidy of *Plectranthus esculentus* resulted in plants with better nutritional value (starch) and tolerance to rootknot nematode, characteristics crucial for successful commercialization of any crop, especially tuber crops.

Keywords: chromosome doubling, horticultural improvement, Livingstone potato, polyploid, *Meloidogyne*, nematode.

IN VITRO* EVALUATION OF MYCELIAL GROWTH AND SPORE GERMINATION OF *Guignardia citricarpa

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INTRODUCTION

Guignardia citricarpa is the causal agent of Citrus Black Spot (CBS); a phytosanitary disease that causes unsightly lesions on *Citrus spp*., rendering the fruit unfit for export. Thus far, post-harvest control of CBS has been limited to the use of fungicides and sterilization. The aim of this experiment was to evaluate the effect of three different types of media on the *in vitro* mycelial growth and spore germination of *G. citricarpa* in preparation for post-harvest control using phenolic compounds.

MATERIALS AND METHODS

G. citricarpa cultures grown on oatmeal agar were sub-cultured onto oatmeal agar and potato dextrose agar. The Petri dishes were incubated at 25^{o}C in the dark for three weeks and growth was observed daily for characteristic spores and colonies.

RESULTS AND DISCUSSION

In vitro growth of *G. citricarpa* was slow on all three types of media. The mycelia produced were black and surrounded by a yellow halo on oatmeal agar, although no halo was observed around the mycelia on potato dextrose agar. After two weeks of growth, spores were observed under a light microscope. These results were in accordance with the characteristics described by the European and Mediterranean Plant Protection Organization (EPPO). The results indicated that *G. citricarpa* is able to grow on these three different types of media. It is hypothesised that when these growing media are amended with phenolic compounds biologically active in *Citrus spp*. fungal growth will be delayed *in vitro*.

CONCLUSION

CBS can be successfully sub-cultured onto several media and by enhancing phenolic compounds in fruit, biotic control may be achieved. Using phenolic compounds may be a novel way of reducing diseases on citrus fruit post-harvest.

ACKNOWLEDGEMENTS

We would like to thank Elma Carstens from Citrus Research International for supplying the *G. citricarpa* cultures.

Keywords: *Citrus Black Spot, Guignardia citricarpa, Culturing, Oatmeal agar*

QUALITY OF SWEET POTATO VINES AS INFLUENCED BY STORAGE BAG TYPE AND PERIOD

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INTRODUCTION

Sweet potato is established by using stem cuttings, but it is not recommended to re-use vine material due to a build-up of pest and diseases. Healthy vine cuttings are purchased from vine growers. In some instances, because of lack of rain or too wet conditions or constraints with transport, it is not possible to plant sweet potato vines obtained from the vine grower, immediately. Vine cuttings then have to be stored. The objective of this study was to quantify the storage period as well as the best storage bag type (polyethylene or hessian).

MATERIALS AND METHODS

The experiment was conducted in the North West and Gauteng provinces. The treatments consisted of (i) different storage bag types (polyenthylene and hessian); (ii) storage period (2, 4 and 6 days) and (iii) different cultivars (Bophelo, Ndou and Blesbok). The experiment was a 2x3x3 factorial design, laid out as a completely randomised design. The treatments were replicated four times and therefore the experiment had 72 experimental units. Data collection consisted of number of marketable vines, weight loss, and atmospheric conditions.

RESULTS AND DISSCUSSION

After 4 days the vines in the polyethylene bags started to dry out while the vines in the hessian remained firm. In contrast vines in the wetted hessian bags started rotting later on. Hessian allowed better air movement. The results indicate that vines should be stored at room temperature, e.g. in a shed, areas to avoid overheating and drying out. Transportation should be arranged ahead of time to avoid the vines from losing moisture and ultimately drying out. Sufficient moisture is important during storage thus small amounts of water may be applied to the vines to maintain the viability of vines e.g. by wetting the bags with a hose pipe.

CONCLUSION

The best storage type allows better air movement preventing overheating of the vines and enable sufficient moisture to be maintained during the storage period. Proper labelling is important to avoid mixing of cultivars and can also help as a marketing strategy.

Keywords: Blesbok, Bophelo, hessian bags, Ndou, polyenthylene bag, sweet potato vines

WEED SPECTRUM SHIFT IN CONSERVATION AGRICULTURAL SYSTEMS ON TWO SOIL TYPES

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INTRODUCTION

Conservation agriculture (CA) requires careful planning of crop rotations, crop residue management as well as novel approaches to both weed control and pest management. Knowledge of the long-term effect of conventional tillage and CA practices on weed diversity and species composition will provide information necessary for improving weed management in agro-ecosystems. A shift in weed spp. diversity is foreseen and a reduction in weed populations and seed stock will be established over time (Tuesca et al., 2001). In view of CA successes in Brazil and elsewhere the adoption thereof is seen as a key to sustainable agriculture in South Africa (Bolliger et al., 2006; Christoffeleti et al., 2007). The aim of this study was to determine if a weed species shift will occur over a period of four years.

MATERIALS AND METHODS

Two field trials were established, on a sandy (Erfdeel) and a loamy sand textured soil (Buffelsvallei) respectively, during 2008/9 with the aim to compare conventionally produced maize with maize produced in the various conservation agriculture principles. Treatments, as crop systems, consist of mono-cropped conventionally tilled maize (control), and three CA systems namely, mono-cropped maize under no-till, maize – legume rotation under no-till and millet - maize – legume rotation under no-till. On the loamy sand soil, the legume was also substituted with sunflower as a second set of rotations. A randomised complete block layout with four replicates was use at both sites. Weed-surveys were conducted at each locality during the summer and winter periods. The area between the four middle rows of each plot was surveyed.

RESULTS AND DISCUSSION

Loamy sand soil: The annual summer weed spectrum did not differ significantly between seasons, except for Benghal wandering Jew, which increased significantly in the CA systems where crop rotation was done with maize, babala, a legume and/or sunflower. A significant increase in Goose grass was found in maize-millet rotation plots. Annual winter weeds included mostly Starvation scenecio, Cape marigold and White flower Mexican poppy. Winter weeds tended to decrease in the mono-cropped CA system.

Sandy soil: The annual summer weed spectrum consisted of much less weed species compared to the loamy sand soil trial, with Mealie Crotalaria the dominant weed specie as well as Naked crabgrass and Benghal wandering Jew. The highest number of weeds was recorded in the conventional tilled mono-cropped plots. Annual summer weed species decreased significantly in the mono-cropped CA systems. Winter weeds were, however, significantly higher in mono-cropped CA plots and consisted mostly of Starvation scenecio.

CONCLUSION

Due to CA practices the weed spectrum on both the loamy sand and sandy soil shifted to more difficult to control weed species. Winter weed species increased at both localities.

Keywords: conventional tillage; conservation agriculture; crop rotation; weed spectrum

RESPONSE OF THREE SWISS CHARD CULTIVARS (*BETA VULGARIS* L.) TO PLANT SPACING AND HARVESTING FREQUECY

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INTRODUCTION

Swiss chard (*Beta vulgaris* L.), often commonly referred to as spinach, is a leafy vegetable popular in South Africa for its nutritional properties. Little is known about the effects of leaf harvesting frequency and plant spacing on yield parameters of Swiss chard under open field conditions. The main objective of the study was to determine the effect of plant spacing and leaf harvesting frequency on yield of Swiss chard cultivars under open field conditions.

MATERIALS AND METHODS

The study was conducted as a 3 x 4 x 4 factorial experiment arranged in a split-split plot with three treatment factors namely: three cultivars (Fort Hook Giant, Star 1801 and Green Wave) as main plots, four plant spacings (25 x 10, 30 x 15, 35 x 20 and 25 x 25 cm) as subplots and four leaf harvesting frequencies (7, 14, 21 and 25 days after sowing) as sub-sub plots and replicated three times. Two seeds were sown in each hole and later thinned to one plant. The eight middle rows were used for data collection. Two rows for each harvesting frequency were used. Leaf harvesting started from the sixth week after emergence. Harvesting was done continuously at a frequency of 7, 14, 21 and 25 days after sowing and the following parameters were recorded: number of bunches, leaf length, width, leaf yield (fresh biomass), petiole length and mass.

RESULTS AND DISCUSSION

Different yield parameters of Swiss chard were significantly affected by leaf harvesting frequencies. There was a significant increase in leaf fresh biomass and bunch mass with an increase in harvesting frequency. There were no significant differences between yield parameters of Swiss chard cultivars across all plant spacings. The highest yield was obtained with cultivar Star 1801 at harvesting frequency of 25 days after sowing under field conditions. There were no interactions between Swiss chard cultivar and plant spacing.

CONCLUSIONS

Findings of the study demonstrate that Swiss chard cultivars responded differently to harvesting frequencies. They further showed that plant spacing has no effect on yield of Swiss chard under field conditions. The study is still in progress for further evaluation and recommendations.

Keywords: *Beta vulgaris,* leaf harvesting frequency, plant spacing, cultivars, yield

DRIVERS OF CONSUMER PREFERENCE FOR APPLE EATING QUALITY AND APPEARANCE AMONG SOUTH AFRICAN CONSUMERS OF DIFFERENT ETHNIC AND AGE GROUPS

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INTRODUCTION

Domestic apple sales continue to increase while exports to traditional markets such as the EU and United Kingdom are rapidly declining. Earlier studies on consumer preference for apple eating quality and appearance focused on the Western Cape. Therefore, this study aimed to determine the apple quality preferences of Gauteng (GP) and Kwa-Zulu Natal (KZN) consumers of varying ethnic and age groups.

MATERIALS AND METHODS

Nine apple cultivars were used to attain a wide variation in flavour and appearance parameters. Descriptive sensory analysis was carried out using a trained panel. The preference of 579 recruited consumers for eating quality and appearance was assessed on a 9-point hedonic scale. Sensory data were subjected to ANOVA and means compared with Student's t-LSD at a 5% significance level. Principal component analysis was used to project the outcome of descriptive sensory analysis onto consumers' preference dimension. XLSTAT version 2007 was used to perform Pearson's correlations between variables.

RESULTS AND DISCUSSION

The preference of black and older consumers was for sweet taste and older black consumers had a strong aversion for sour taste. The preference of young white GP and young Indian KZN consumers was for positive textural attributes and tolerance for sour taste but these consumers disliked mealiness. Black consumers preferred the appearance of red and green/yellow cultivars. White and Indian consumers preferred green and red apple peel colours, respectively. White GP consumers also preferred pink blush apple peel colour. Young (18-25) and older (26+) consumers grouped together and preferred the appearance of red, pink blush and green/yellow cultivars. However, young consumers also preferred appearance of green 'Granny Smith' which older consumers disliked. Consumers' appearance preferences seem to relate to their taste preferences.

CONCLUSION

The study confirmed that the preference of black and older consumers for apple eating quality is generally driven by sweet taste, while young white and young Indian consumers generally have a predilection for positive textural attributes and tolerate sourness.

Keywords: domestic apple sales, preference, tastes

THE INTERACTIVE ROLE OF LITHOLOGY AND VADOSE ZONE HYDROLOGY

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INTRODUCTION

For large areas of the land, groundwater feeds into rivers, peat wetlands and boreholes. This process is affected by geology, soil, climate, vegetation and topography. These factors control the quantity and quality of the water finally reaching the groundwater. A multi-disciplinary approach is needed to provide a groundwater recharge model.

MATERIAL AND METHODS

Starting with geology and soil, being the dominating factors in the vadose zone, they were combined using ArcGIS into an overlay. Ten catchments were selected to study soil's influence on recharge. Using Land types a classification system was created placing the different catchments into classes based on the dominating variable between recharge, interflow or responsive soil forms.

RESULTS AND DISCUSSION

The catchments are recharge areas and vary between 65.2% - 100.6%, the Interflow areas of the catchments vary between 0% - 33.1% and the responsive areas of the catchments vary between 0% - 21%. The different classes that were created included a recharge only class ($\mathbf{R_c}$), an recharge interflow ($\mathbf{R_c}I_f$), Recharge responsive ($\mathbf{R_c}R_s$) and a recharge interflow responsive class ($\mathbf{R_c}I_fR_s$).

CONCLUSIONS

Land types can be used to determine different classes for potential groundwater recharge and may lead to the classification of 'high' recharge zones for further study and conservation.

***Keywords**:* Catchments, Groundwater, Multi-disciplinary, Recharge.

SPATIAL DATA SETS FOR AGRICULTURE: WHAT DO WE KNOW AND WHERE TO FROM HERE?

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INTRODUCTION

In recent years there has been an increased interest in the use of spatial and remote sensing derived data products in support of agricultural production and water management in South Africa. This paper will review recent research conducted in South Africa. It will summarise results from validation studies investigating the accuracy of derived spatial products, highlight challenges in adopting new technologies and discuss the future of spatial data sets.

RESULTS

For many years now, maps of Normalized Difference Vegetation Index (NDVI) have been utilized to evaluate the growth of crops and vegetation. The high spatial resolution NDVI has been linked successfully to soil maps and nutrient distribution across fields. However, because of cost of capturing NDVI from aerial photography, NDVI images are typically captured one once or twice in a growing season, typically once a complete vegetation cover is achieved.

More recently however, spatial maps derived from a combination of satellite imagery, complex algorithms and field data have been examined in evaluating vegetation or crop growth, water use and nitrogen content. The accuracy of biomass production, crop cover, evapotranspiration and water shortfall (or evapotranspiration deficit) from the Surface Energy balance Algorithm for Land (SEBAL) model has been evaluated in studies funded by the Western Cape Provincial Department of Agriculture, the Water Research Commission and Department of Agriculture Forestry and Fisheries. The potential of weekly SEBAL estimates have been evaluated for crop and water use management and in improving crop forecasts.

CONCLUSION

Results from studies conducted on maize, sugarcane and grape vineyards showed acceptable accuracy of evapotranspiration and crop growth data and the potential of improving crop forecasts. Challenges identified include adoption of a new technology by scientists, consultants and producers and integration of spatial and field based data sets.

Keywords: remote sensing, validation studies

YIELD AND QUALITY OF MUSTARD GREENS AND EDIBLE AMARANTH: COMPARISON OF HYDROPONICS AND AQUAPONICS CULTURE SYSTEMS

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INTRODUCTION

Aquaponics is a biologically-integrated system that combines fish production (aquaculture) with hydroponic vegetable production in a recirculating setup (Rakocy, 1989). Waste products from the aquaculture component serve as inputs for the hydroponic component, which in turn serves a biofiltration function. The interaction of fish and vegetables in aquaponics results in a production system that is more productive than either component alone. The simplicity/efficiency of aquaponics lends itself to year-round production of nutrient-rich foods; the potential for a constant source of income makes it an ideal system for addressing many food and health problems associated with poverty. The goal of this study was to evaluate the productivity and quality of vegetables grown under two soilless culture systems: hydroponics vs aquaponics.

MATERIALS AND METHODS

Two greenhouse-based recirculating systems served as a source of fertigation solution for vegetable crops grown on floating rafts. One system was stocked with Koi fish (*Cyprinus carpio*) while the other was operated as a hydroponics system. In each system, two cultivars of mustard green (*Brassica juncea*; 'Florida Broadleaf' and 'Red Giant') and Amaranth (*Amaranthus* spp. – 'Red Garnet' and 'Green Leaf') were grown. Leaf yield, leaf area, leaf chlorophyll (CHLL) and mineral contents were measured during, or at the end of the crop growth cycle.

RESULTS AND DISCUSSION

Fresh mass yields of both mustard varieties were 60-65% higher in aquaponic culture compared to hydroponics. Total leaf area and *CHLL* were also significantly higher (60-56% and 47-69% respectively) in mustards grown in aquaponic culture. Yields differed between the two varieties of amaranth evaluated. Fresh weight, leaf area and *CHLL* of 'Red Garnet' were significantly higher (14% 8% and 7% respectively) in aquaponic culture. These parameters were similar in both production systems for the 'Green Leaf' amaranthus cultivar.

CONCLUSIONS

In addition to their high resource use efficiencies (of space, water, nutrients), aquaponic systems have the potential to significantly boost productivity of nutrient-rich indigenous vegetables and promote food security. Careful selection of suitable cultivars would further maximize the benefits of production under this system.

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Keywords: Aquaponics, hydroponics, vegetables, amaranthus, mustard green, food security

EFFECT OF FERTILISER AND INOCULATION ON THE NODULATION AND PERFOMANCE OF FOUR DIFFERENT LEGUMES

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INTRODUCTION

Nodules are organs consisting mainly of infected cells of legumes with batteries rizhobioum genus that promote nitrogen fixation. Within the nodules the bacteria assume an endo-symbiotic role, being able to reduce atmospheric nitrogen to ammonia. As ammonia is toxic to plants it is rapidly converted to amide and / or ureide that nourishes the host plant (legume) and contributing to their production (Xavier et al., 2006). This advantage enables the partial and/or total nitrogen replacement of chemical fertilisers. This study aimed to evaluate the effect of nitrogen fertilisation and inoculation on the nodulation and performance of four legumes.

MATERIALS AND METHODS

The experiment was conducted the during 2013/14 summer cropping season at the ARC Grain Crops Research Station, Potchefstroom. The treatments consisted of four legume species namely, cowpea, dry bean, groundnut and soybean. These legumes were either fertilised or inoculated and the combination of both. Unamended control plots were also included as standard checks. The different legumes were fertilised at optimum recommended rates for P and K , while N was only applied to specific treatments to determine the minimum accretion of whether nitrogen will have an influence on nodulation and productivity. The legumes were inoculated with the rhizobium inoculant registered for each respective crop. The sources of N, P and K were limestone ammonium nitrate, superphosphate and potassium chloride, respectively. Treatments were fitted in a randomised complete block design and replicated four times. Data colleted was total number of nodules, viable and non-viable nodules, and seed yield.

RESULTS AND DISCUSSION

The treatment effect showed significant difference in the number of nodules per plant. The highest total number and viable nodules per plant were observed from inoculated plants irrespective of the legume specie. Average total number of nodules obtained from groundnut (48.5) and soybean (42.9) at full flowering, was significantly higher than from drybean (17.4) and cowpea (8.2), while drybean (83.2) and groundnuts (70.6) produced significantly higher total number of nodules than soybean (41.5) and cowpea (6.4), at physiological maturity. The effect of fertiliser application and inoculation as well as their combination did not exert statistically significant effects on crop seed yields. Generally, higher seed yield across crops was achieved with groundnut, when fertilised and innoculated, while fertilised cowpea gave the lowest yield. Average seed yields were 247, 1419, 2761 and 2104 kg ha^{-1} for cowpea, dry bean, groundnut and soybean, respectively.

CONCLUSIONS

The crops studied showed that fertiliser application had a depressive effect on nodulation. When the different crops were inoculated only compared to when in combinations the opposite was true. Nodulation in groundnuts was higher in both samplings, but lower with cowpea. Nonetheless, the response of drybean and soybean was infrequent across the sampling.

Keywords: Fertiliser, inoculants, leguminous plants, nodulation, seed yield

THE POTENTIAL OF HONEYBUSH AS A SUSTAINABLE CROP

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A REVIEW

Honeybush plants of different *Cyclopia* spp. occur naturally in the winter and summer rainfall areas in the Fynbos biome of the south-western part of South Africa, where the species are uniquely adapted to the geography, geology and climate of the region. The honeybush industry, which consists of wild harvesters, farmers, nurserymen, processors and marketers, began in 1999 and is thus one of the newest industries in South Africa. Honeybush is mainly harvested in the wild, which is not sustainable. Currently there are no policies and/or guidelines on wild harvesting although there is legislation in place to control unsustainable harvesting. Unsustainable harvesting may lead to extinction of honeybush in certain areas.

By establishing honeybush plantations, the percentage of the crop harvested from wild plants can be reduced. The aim is to reverse the ratio of wild harvesting to plantation cropping from the current 75:25 to 25:75 in the next 10 years.

The soil criteria to establish honeybush plantations are well drained sandy to sandy loam soil, low pH (< 5.3), low P (<20mg P/kg) and low nematode numbers. Currently there are about 20 commercial farmers and six communities that grow honeybush. The ARC assists the communities with the following aspects: obtaining funding; identifying suitable land; preparing soil; establishing plantations; maintaining plantings; harvesting the crop; and finding buyers for the product. Formal as well as on-farm training is provided.

This talk will focus on the challenges of establishing plantations on farms and communities as well as research done on production, better plant material and product development.

Keywords: honeybush, communities, plantations, research

SEASONAL VARIATION IN ROOTING ABILITY OF FOUR CLONES OF HONEYBUSH (*CYCLOPIA GENISTOIDES)* CUTTINGS

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INTRODUCTION

Currently there are 200 ha of *Cyclopia*. *genistoides* (kustee) and *C. subternata* (vleitee) under cultivation. *C. intermedia* (bergtee) is the predominate species harvested from the wild. Cultivation of honeybush is promoted as it provides greater control over tea quality and increase yields, whilst wild populations are conserved. The aim of this study was to compare the seasonal variation and rooting ability of cuttings taken from four different clones of *C. genistoides* which were either pruned back heavily in the summer of 2013/2014 or left unpruned.

MATERIALS AND METHODS

Four clones of *C. genistoides* were selected from stock plants in Bredasdorp, Western Cape. Two clones (GT 1; GG 53) were cut back heavily in January 2013 whilst GK 3 and GK 5 receive no pruning treatment. Cuttings were taken in April, July, October 2013 and January 2014. The cuttings were soaked in Mancozeb after which the bottom 10cm was dipped in $2g.l^{-1}$ IBA powder (Seradix 2). Cuttings were treated with a rhizobium suspension (Stimuplant $10g.l^{-1}$), three weeks after striking. Cuttings were placed in a bottom heated (18-25°C) misting bed, which were misted 30 seconds hourly, in a shaded tunnel. Cuttings were assessed for rooting percentage, number of primary and secondary roots, total root length and dry mass, three months after striking.

RESULTS AND DISCUSSION

The pruned clones (GT 1; GG 53) both showed significantly higher rooting percentage in the July (84%) and October 2013 (89%) cuttings compared to those collected in April 2013 (63; 56%) and January 2014 (50; 53%). The root dry mass accumulation was also significantly higher in the June (0.25; 0.20g) and October 2013 (0.30; 0.29g) cuttings in comparison to cuttings produced in April 2013 (0.08; 0.11) and January 2014 (0.07; 0.05g). The number of primary roots per cutting in GT 1 were significantly higher in October 2013 (11.7) compared to the other striking times. The numbers of secondary roots per cutting were significantly higher in GT 1 and GG 53 in July 2013 (8.0; 5.6). GG 53 cuttings made in July 2013 produced the highest total root length (229.1mm); however, it was not significantly higher than those produced in October 2013 (225.4mm). The non-pruned clones (GK3 and GK 5) showed opposite results in terms of rooting percentages to the pruned clones in July (30; 62%) and October 2013 (6; 22%). No significant difference between the rooting percentage of the non-pruned clones (GK 3 and 5) in April 2013 (72; 81%) and January 2014 (66; 75%) and pruned clones for the same dates was observed.

CONCLUSION

Pruning back of mother plants in summer assured a significantly higher rooting percentage in cuttings. These cuttings also developed with a root system with a greater surface area, than cuttings from clones which were left unpruned. Further studies will be done on the time of pruning and cutting type.

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Keywords: Bergtee, Kustee, pruned, root dry mass, Vleitee,

THE EFFECT OF *RHIZOBIUM* INOCULATION AND APPLICATION OF *BACILLUS* AS USED IN COMBINATION WITH A NUTRIENT RICH SUBSTRATE ON THE ROOTING PERCENTAGE AND DEVELOPMENT IN HONEYBUSH (*CYCLOPIA* SPP.)

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INTRODUCTION

Honeybush (Cyclopia spp.) is a nitrogen fixing legume endemic to the Eastern and Western Cape of South Africa. The rooting percentages of cuttings are variable and the transplanting success of the cuttings is rated low. This study aims to explain the rooting percentage and root development of Cyclopia spp. Cutting inoculation with rhizobium is routinely used in nursery practices. Rhizocell (Bacillus spp.) stimulates root growth, helps with phosphorus solubilisation and enables plants to overcome salinity. Nutrient rich medium will provide macro and micro elements for the *Bacillus* spp. growth.

MATERIALS AND METHODS

C. genastoides cuttings were made in July 2014 from clonal plants in Bredasdorp, Western Cape, South Africa. All cuttings were soaked in Mancozeb (dithiocarbamate 5g/L) after which the bottom 10cm was dipped in $2g.l^{-1}$ IBA powder (Seradix 2 4-indole-3-butyric acid at 2g/kg). Treatments applied to the cuttings were: the control (TRT 1) which was rooted in a 1:1:1 ratio of sand:peat:polystyrene. TRT 2's cuttings were inoculated with *Rhizobium* and Rhizocell (Lallemand-*Bacillus* spp IT45>$10x10^9$ cfu/g.) and rooted in the same medium as the control. Rhizobium (Stimuplant in a suspension of $10g.l^{-1}$ strain PPRICI3) was applied three weeks after striking. TRT 3 was inoculated with rhizobium in a nutrient rich medium. TRT 4, cuttings were inoculated with *Rhizobium* and Rhizocell and rooted in a nutrient rich medium; TRT 5 was not inoculated with rhizobium or Rhizocell but, the standard medium was used with a topping of native soil from the mother plant collection site. Cuttings were placed in a bottom heated (18-25°C) misting bed, and misted hourly for 30 seconds in a shaded tunnel. After three months the cuttings were assessed for rooting percentage, number of primary and secondary roots, total root length and dry mass. A completely randomised block design was used and analysed with Statistica. Eight cuttings were removed per treatment for assessment, ninety days after striking.

RESULTS AND DISCUSSION

Treatments 2, 3, 4, and 5 showed significantly lower rooting percentages to that of the control (TRT 1 ;75%). Treatment 2, the *Rhizobium* and *Bacillus* spp., rooted in the sand:peat:polystyrene mixture showed rooting percentages of 33%. Cuttings that received only *Rhizobium,* rooted in the medium rich medium, showed rooting of 21%. The cuttings that received both *Rhizobium* and Rhizocell in nutrient rich medium treatment 4, showed rooting of 63%, but remained less than the rooting percentages of the control. The cuttings rooted in standard medium with a topping of native soils (TRT 5), also showed less rooting than the control (54%). A significant difference was also found when comparing the total root length per cutting. TRT 1 (93.2 mm) was found to have the longest root length whilst TRT 2 (4.8 mm) had the shortest root length. A similar trend was seen when comparing the number of primary and secondary roots formed. Lastly, no significant difference was seen between the treatments for the sum of the primary and secondary roots length, and dry mass of the cuttings.

CONCLUSION

A decrease is seen in rooting percentage when cuttings were inoculated with *Rhizobium*. The use of a nutrient rich rooting medium and the application of Rhizocell increased the rooting percentage. Further studies are required on the use of Rhizocell and to establish the most optimum time to apply *Rhizobium* inoculum to the cutting in the nursery.

Keywords: endemic, inoculation, rooting

WATER AND MACRO-NUTRIENT UPTAKE IN SOIL-LESS GROWING SYSTEM IN RELATION TO NUTRIENT SOLUTION CONCENTRATION AND SOLAR RADIATION LEVELS

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INTRODUCTION

In soilless production system fertigation frequency in soilless systems is often determined from the plants water demand which can be estimated from the light intensity. But whereas nutrient uptake is driven by crop demand and growth rate water uptake is driven by the difference in water-potential [Pa] and maintained by transpiration. To simulate crop nutrient demand necessary for model based regulation of fertilizer application the effect of climatic factors on the uptake of macro nutrients need to be quantified.

MATERIAL AND METHODS

In a factorial trial where each treatment combination was replicated four times, tomato plants were grown in a water culture at 5 different nutrient solution concentrations (EC 0.8, 1.6, 2.4, 3.2 and 4.0 $mS.cm^{-1}$), under either no, 20% or 40% shade net during a summer and a winter season. Macro-nutrient and water uptake was determined periodically over 3-hour intervals as well as daily values comprised of uptake during the day and during the night-time. The statistical significance of the results was analysed by the t-test ($p \leq 0.05$) and the data was fitted using nonlinear regression and fitted to Michaelis-Menton plots for nutrient uptake.

RESULTS AND DISCUSSION

The uptake of all the ions increased with an increase in the solar radiation levels and for NO_3^{2-}, K^+ and $H_2PO_4^{2-}$ uptake was also higher at higher nutrient solution concentrations. Mg^{2+} uptake increased with an increase in light intensity but was not affected by the nutrient solution EC. The only macro-nutrient showing a good correlation with water uptake was Ca^{2+} at all nutrient solution concentrations and over the range of solar radiation levels. A correlation was found between the uptake of NO_3^{2-} and SO_4^{2} ions under low solar radiation levels (less than 550 $\mu mol.m^{-2}.s^{-1}$) ($R^2 = 0.95$) but at higher levels the NO_3^{2-} uptake increased at a faster rate than SO_4^{2-}. A similar trend was observed between NO_3^{2-} and K^+ uptake ($R^2 = 0.83$), and K^+ and SO_4^{2-} uptake ($R^2 = 0.83$) correlating fairly well but only at PAR levels lower that 550 $\mu mol.m^{-2}.s^{-1}$. Comparing the night-time water and nutrient uptake again revealed a poor correlation between water and nutrient uptake except for Ca^{2+}. The night-time NO_3^{2-} uptake comprised on average a total of 35% of the total daily NO_3^{2} uptake while that of $H_2PO_4^{2-}$ was as high as 45% of the total daily uptake.

CONCLUSION

Basing crop nutrition on the use of models for transpiration or the use of uptake concentrations (the ratio between nutrient and water uptake) or correlations between nutrient uptake rates is not accurate enough and for a more integrated approach the use of climatic parameters should be included in fertigation models.

Keywords: electrical conductivity (EC), nutrient solution, nutrient uptake, soilless production, solar radiation

AN ANALYSIS OF THE FINANCIAL IMPLICATIONS OF DIFFERENT TILLAGE SYSTEMS WITHIN DIFFERING CROP ROTATIONS IN THE SWARTLAND AREA OF THE WESTERN CAPE, SOUTH AFRICA.

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INTRODUCTION

Conservation agriculture (CA) offers the most holistic sustainable agricultural practice to date. By reducing environmental degradation while concurrently enhancing farm level profitability. Using trial data from Langgewens experimental farm, this study evaluates a comparative analysis of the various CA farming systems over an extended period.

MATERIAL AND METHODS

A systems approach is used to develop a whole-farm budget model to compare the various farming systems. The data used in the whole-farm model was generated through multi-disciplinary group discussions and trial data from Langgewens experimental farm, which also were used to generate and validate the typical farm data used in the model. A multi-period whole-farm budget model is used to evaluate the alternative crop rotation systems. The internal rate of return on capital invested (IRR) is used as a measure of profitability.

RESULTS AND DISCUSSIONS

Three scenarios were simulated. The first scenario aimed to determine the impact of input price inflation. The simulations highlighted the significance of tillage. Under conventional tillage, an increase in input costs results in twice the relative change in the IRR as compared to no-till. The rotation systems appear less sensitive to the inflated prices showing the buffering effect of increased yields generated by the rotations. The second scenario evaluated the implications of lower wheat prices. The simulations showed that all the systems are sensitive to variations in commodity prices. The CWWW and the WMWM systems could sustain a 10% decline in wheat price before becoming unprofitable. Decline in wheat prices of more than 10% rendered all the systems unattractive to investment. The third scenario was designed to determine the impact of continued devaluation of the Rand to the US dollar, which would lead to increased machinery and fuel costs. The WMWM system operates with the lowest capital investment requirement subsequently the expected impact on profitability was less severe when compared to the other systems. The CWWW system performed well under this scenario. It remained the most attractive option even after a 30% rise in machinery and fuel costs.

CONCLUSIONS

The monoculture system is not financially viable. The impact of weed infestations due to herbicide resistant ryegrass is unsustainable. The buffering effect of increased yields derived from diversified crop rotations reduced the farming systems sensitivity to fluctuation in external factors. No-till systems generate a higher expected IRR over an extended period of time.

Keywords: Conservation agriculture, financial evaluation, profitability

RADIOACTIVITY AS A FAMILY CRITERIA FOR ANTHOPOGENIC SOIL CLASSIFICATION : LAND USE ON OLD MINE FOOTPRINTS

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INTRODUCTION

Uranium and other radioactive materials are mined either as an ore mineral or as a by-products of mining. Some industrial activities, especially fertilisers, tend to accumulate radioactive materials. As a result large areas of South African soils have been impacted by radioactive materials, not to mention areas where naturally elevated levels are found. This study aims to promote the inclusion of radioactively polluted soils on a family level for the revised Anthropogenic soils classification.

DISCUSSION

The proposed, revised addition of anthropogenic disturbed soils to the South-African soil classification system is progressing. The classification of Anthrosol materials focuses on the nature and composition of the soils and on the degree and traceability of the human disturbance. Five main soil forms are proposed which includes the Industria (In) form, described as a soil material which has been subjected to chemical pollution to a specified degree. At the soil family level the Industria form is classified into a number of qualifiers based on the type and extent of pollution, however currently no mention is made of radioactivity as a form of pollution. Based on the National Nuclear Regulators (NNR) regulations the possible land use of a radiological polluted area is determined by the degree to which radioactivity is present in the material. As such the presence of elevated radioactivity must be evaluated in order to define a land use capability. The International Atomic Energy Agency and the NNR defines a threshold of 20 milli-Sievert per year as a maximum save dose limit before negative health effects can be seen. This threshold should be included in a definition of a qualifier for the proposed soil forms as livestock production, residence and crop production can be hazardous.

CONCLUSION

The authors propose that a family level qualifier be included into the Industria soil form. Provision should be made to include natural soils that have been polluted as well as anthropogenic material with radioactivity as is the case on rehabilitated mine footprints (specific mines with radioactive ore or waste materials). This qualifier should account for the degree of radioactive pollution and specify the possible land use options based on the observed radioactive dosage.

Keywords: Industria soil form, chemical polluted, International Atomic Energy agency, 20 mSievert /y threshold

THE MOVEMENT, ACCUMULATION AND CONSEQUENCES OF URANIUM IN ANTHROPOGENIC SOILS - LAND USE IMPLICATIONS

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INTRODUCTION

Uranium as an ore mineral has been and will continue to be exploited in South Africa. As a result large areas of South African soils have been impacted by uranium, not to mention areas where naturally elevated levels are found. This study aims to evaluate the geochemical nature of uranium in order to estimate the potential movement, accumulation and finally the land use implications of uranium and radioactivity on the end land user.

MATERIALS AND METHODS

A case study was used where high definition radiometric and geochemical measurements were used to define the movement of uranium in a gold discard dump (potential anthropogenic soils). A 3D geostatistical model was constructed to visualise uranium movement. Legislative criteria regarding radioactivity and land use was used to evaluate potential end land use options including whether or not agricultural or residential land use options are viable.

RESULTS AND DISCUSSION

Results indicated than uranium does mobilise under certain environmental conditions and that transportation occurs in specific pathways. It also proved that uranium tends to accumulate under specific environmental conditions for which natural equivalents can be found. This can be detrimental for specific land uses where anthropogenic activity may remobilise uranium to a bioavailable state. A radiological dose limit of 20 milli Sieverts per annum or 0.2 Becquerel per kilogram or chemicaly, 16mg/kg of soil is considered as the “still safe” threshold. Exceeding this threshold uranium becomes toxic.

CONCLUSIONS

Regulations pertaining to the radiological and chemical toxicity of uranium do exist and needs to form part of agricultural studies prior to the establishment of final end land use options.

Keywords: movement, accumulation, uranium, anthropogenic soils, land use implications

GERMINATION PROPERTIES OF HONEYBUSH SEED

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INTRODUCTION

Cyclopia spp. are leguminous shrubs endemic to the fynbos biome of South Africa. Increased demand for *Cyclopia* (honeybush tea) has put pressure on vulnerable wild populations and necessitated honeybush cultivation programmes. Seed studies are essential as propagation by seed plays an important role in crop sustainability. *Cyclopia* spp. produce dimorphic seed: both green and brown mature seeds per plant. Seed dimorphism has been known to affect germination response in other species. This paper looks at the separate effects of seed age, scarification, and stratification period on germination, with regards to seed colour.

MATERIALS AND METHODS

Seed samples of three *Cyclopia* species were obtained: *C subternata, C. maculata and C. genistoides*. The mixed seed-colour samples were divided by colour: green vs. brown. Three trials per experiment were done in a laboratory setting using a randomised block design. Seeds were suitably pre-treated: scarified in concentrated sulphuric acid (98% H_2SO_4 at 30, 45, 60, 75 and 90 min) or stratified (±2°C in LTIE20 Labcon™ low temperature incubators for 1, 2, 3, 4 and 5 weeks). The seeds were then placed in sterile Petri dishes lined with two, moistened sheets of Grade 292 Munktell™ filter paper. The Petri dishes were placed in individual polyethylene plastic pockets to minimize moisture loss. LTIE20 Labcon™ low temperature incubators were used as germination cabinets. The seeds were incubated at a constant 22°C in the dark, without total light exclusion. Records were taken every 24 hrs for 14 days from the day germination was first observed. All variables measured were subjected to a factorial analysis of variance (ANOVA) to test for significant main effects and interactions at a 5% significance level.

RESULTS AND DISCUSSION

For seed age, harvest year 2011 had an overall germination percentage (GP) of 5.11%, harvest year 2012 had a GP of 3.11% and 2013 had 1.11%. Brown seeds from 2011 had the highest GP at 8.44% while green seeds from 2013 had the lowest GP at 0.44%. For scarification length, the shortest time, 30min, had the highest GP (44.67%) and the longest scarification time, 90min, resulted in the lowest GP (32.44%). For stratification length, the shortest length, 1 week, had the lowest GP (6.22%) while the longest period, 5 weeks, had the highest GP (25.56%). Stratified brown seeds had a GP of 10.93% while stratified green seeds had a GP of 24.53%.

CONCLUSIONS

Seed age, scarification length, stratification period and seed colour significantly affect the GP of the three *Cyclopia* species tested. The predominant colour of a seed sample can indicate how to adapt pre-treatments for best results, but 30min scarification in 98% H_2SO_4 followed by 3-5 weeks stratification is generally recommended.

Keywords: Keywords: germination, honeybush, seed age, seed colour, scarification, stratification

GENETICALLY MODIFIED (GM) MAIZE TECHNOLOGY: PERCEPTIONS, ADOPTION PRACTICES, AND CHALLENGES TO SMALLHOLDERS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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INTRODUCTION

Perception of the characteristics of agricultural technologies influences farmers' adoption decisions. Although South Africa is the only Country in Africa where smallholders cultivate GM Maize, little data exists on smallholder farmers' perceptions and adoption challenges of GM maize technology. This study determined smallholder farmers' GM maize perceptions and adoption challenges.

MATERIALS AND METHODS

Structured questionnaires were administered to 150 smallholder maize farmers in maize growing areas of three District Municipalities of the Eastern Cape Province between October and November 2014. Interviews were conducted in the rural areas where farmers operate. The selection of farmers was based on willingness to participate in the study.

RESULTS AND DISCUSSION

Results indicated that a stacked-gene event with both insecticidal (*Bacillus thuringiensis,* Bt) and herbicide tolerance (Round Up Ready) traits were the most cultivated GM maize types in the Eastern Cape. Seeds of these GM maize types were generally obtained from the Department of Rural Development and Agrarian Reform, and cultivated on small plots (0.5 – 1.0 ha) of communal land. Farmers indicated that they generally sprayed their GM maize plants once per season against cutworms and stalk borers. Farmers also perceived GM maize technology as a high yielding technology which had simplified pest and weed management.

CONCLUSIONS

Although all farmers interviewed indicated that they planted GM and non-GM maize on separate plots of land, the level of awareness of GM maize biosafety regulatory requirements, particularly, refuge plantings with Bt-maize was very low.

Keywords: *Biosafety, Bt maize, questionnaire, refuge, stacked-gene, trait*

RESPONSE OF SOIL MICROBIOLOGICAL PROPERTIES ON RANGELAND MANAGEMENT, COMPARING A SAVANNA AND GRASSLAND BIOME

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INTRODUCTION

Ecosystem structure and function are highly variable, as a result of rangeland management systems. Thus, long-term sustainability of rangeland management systems, whether associated with structural stability or nutrient dynamics, is *inter alia* dependent on the maintenance of soil microbiological properties.

MATERIAL AND METHODS

In this study we investigated the change in soil microbiological and associated properties due to rangeland management, in two different biomes with different climate, vegetation and soil. For this purpose soils were sampled under communal (continuous) and commercial (rotational) grazing systems along a gradient with increasing grazing pressure.

RESULTS AND DISCUSSION

The results revealed that the clayey grassland biome had higher values for all measured microbiological properties compared to the sandy savanna biome, irrespective of the rangeland management practices, indicating that soil texture plays a significant role in microbial communities. Due to the absence of clay in the sandy savanna biome, particulate organic matter proved to be crucial in fulfilling the role of clay. Results further indicated that microbiological properties might be more sensitive to changes in land use compared to chemical or physical properties. Within the clayey grassland biome enzyme activities as well as PLFAs responded more to what was expected, whereas in the sandy savanna biome this was not the case. Decreasing the grazing pressure on a rangeland, such as commercial farmers practicing rotational grazing, can stimulate microbial-mediated nutrient mineralization with positive consequences on plant growth. In this study grazing mainly affected soil microbiological properties through the direct effect of animal trampling as well as urine and dung contributions, and indirectly through its effect on the perennial grass cover, as was evident in the piospheres of the rangeland management systems. There were good correlations between soil microbiological properties and C and N content, with the C/N ratio indicating that the overlying woody *Acacia* vegetation strongly influenced the two indices of organic matter.

CONCLUSIONS

Comparing the two biomes it was interesting to note that the sandy soil of the savanna biome seemed to be more resilient to degradation over the long-term, and less over the short-term, whereas the clayey soil of the grassland biome was more resilient over the short-term, and less over the long-term.

Keywords: bacteria, enzymes, fungi, grazing, PLFA, soil degradation

THE USE OF 3D COMPUTED TOMOGRAPHY SCANS TO EVALUATE BROKEN STONE DEVELOPMENT IN JAPANESE PLUMS

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INTRODUCTION

Both plum and peach cultivars are affected by broken stones, which occur when the expanding mesocarp pulls the endocarp apart before it had hardened completely (Ragland, 1934). Export fruit with broken stones have to be marketed as Class 2 (Organisation for economic co-operation and development, 2002) which leads to significant financial losses. The hypothesis for this study was that differences in the fruit growth patterns as well as differences in the density of the endocarp of a susceptible ('Laetitia') versus a non-susceptible cultivar (Songold'), would explain why stone breakage occurs in Japanese plums and why only some cultivars are susceptible.

MATERIALS AND METHODS

Computed tomography was used to create images of 'Laetitia' and 'Songold' fruit from 29 until 70 days after full bloom (DAFB). The images were used to determine the radial growth of the fruit mesocarps and endocarps. Changes in the density of the stones were expressed as a ratio of the grey-value of a piece of plastic included in every scan to the grey-value determined in different parts of the stone.

RESULTS AND DISCUSSION

The endocarp of 'Songold' was significantly denser than that of 'Laetitia' which might explain why 'Songold' is less susceptible to stone breakage than 'Laetitia'. Broken stones in 'Laetitia' generally occurred near the apical end of the fruit and this part of the fruit showed the most radial growth as well as the lowest endocarp density.

CONCLUSIONS

Since both cultivars were grown in the same environment and subjected to the same cultivation practices, the results of this study suggest that the higher incidence of broken stones in the 'Laetitia' was due to its less dense endocarp.

Keywords: Density, Endocarp, Japanese plums

EFFECT OF TILLAGE AND CROP ROTATION ON SELECTED SOIL QUALITY PARAMETERS AND CROP YIELDS IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

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INTRODUCTION

Minimum soil disturbance, crop rotation, with diverse crops, and stubble retention are important management strategies that will ensure the success of conservation agriculture (CA). Adoption of CA practices will normally increase soil productivity and crop performance, however not instantaneously. The aim of this study was to quantify the effect of soil disturbance and crop rotation on soil C:N, aggregate stability, active carbon and potential mineralisable N (PMN) and resultant crop yields.

MATERIALS AND METHODS

Three crop rotations namely: continuous wheat (WWWW), medic-clover/wheat/medic-clover/wheat (McWMcW) and lupin/wheat/canola/wheat (LWCW) were allocated to main plots and replicated four times at the Langgewens (Moorreesburg) Research Farm. Each main plot was subdivided into four sub-plots allocated to four tillage treatments, namely: zero-till – soil left undisturbed, no-till – soil left undisturbed until planting and then planted with a tined, no-till planter, minimum till – soil scarified March/April and then planted with a no-till planter and conventional tillage – soil scarified late March/early April, then ploughed and planted with a no-till planter. Soil C:N, aggregate stability, active carbon and potential mineralisable N (PMN) as well as wheat and canola yields were recorded.

RESULTS AND DISCUSSION

McWMcW (13.1) and CWLW (14.1) resulted in lower (P=0.05) C:N than WWWW (23.7). Tillage did not influence soil C:N at Langgewens. The percentage stable aggregates in McWMcW (37.7 %) and WCWL (37.5 %) were significantly higher compared to WLWC (30.9 %) and CWLW (28.4 %). Except for CT resulting in lower (P=0.05) aggregate stability, no differences were recorded between ZT, NT and MT. Active C was higher in McWMcW and WWWW than recorded for WCWL. Significantly lower active C was recorded for CT with no differences between other tillage treatments tested. WWWW resulted in lower grain yield than the other systems included in the study. MT and CT produced higher wheat yield compared to ZT. Canola yield for ZT (1.407 kg ha^{-1}) was lower than all other tillage treatments.

CONCLUSIONS

Although minimum soil disturbance is regarded as an important driving force for successful conversion to CA the study shows that advantages are not instantaneous but develop over time. The negative tendency of soil cultivation on aggregate stability and organic C was not reflected in lower crop yields.

Keywords: active C, aggregate stability, C:N, canola, wheat

SOIL CRUSTING PROBLEMS UNDER MICRO-IRRIGATION SYSTEMS: A MINI-REVIEW

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INTRODUCTION

Soil crusting is a widespread problem throughout South Africa, having serious negative impacts. It is *inter alia* serious in high value crop production, such as orchards, under drip and micro sprinkler irrigation systems. The occurrence, causes and consequences of the problem are reviewed, as well as solutions to overcome it.

MATERIALS AND METHODS

Data from various South African research papers on soil crusting and how to overcome it, published in international journals or presented at SSSSA or combined congresses, are reviewed. The author was personally involved in some of these studies. These are augmented by field observations on the occurrence and consequences of the problem.

RESULTS AND DISCUSSION

Field observations and soil collection for research projects have proven the wide occurrence of soil crusting under micro irrigation systems. This was supported by surface sealing of a problem soil under zero energy mist "rain" in the laboratory, giving a final infiltration rate of only 2 mm h^{-1}.

Causes of the problem include inherent susceptibility of soils to dispersion due to unfavourable combinations of clay mineralogy, exchangeable cation ratios and particle size distribution. In the case of micro sprinkler or drip irrigation in orchards, for example, the soil area under the drip of the trees is kept clean of all vegetative growth. Thus, there is a total lack of organic matter that could stabilise the structure of the surface soil layer.

The most obvious consequence of crusting is the poor infiltration of irrigation water, as seen by surface ponding and runoff, resulting in low irrigation water use efficiency. Less visible is the negative impact on aeration and gas exchange. This leads not only to poor root functioning, but also poor, shallow root systems even in soil with no subsurface compaction. Poor aeration also impacts negatively on important soil microbes.

Since it is only a very thin layer at the soil surface that needs to be stabilised against crusting it can easily and economically be overcome by application of small amounts of anionic polyacrylamide (PAM) or other soil conditioner, as was shown already nearly 25 years ago in different South African studies that are quoted internationally.

CONCLUSIONS

Soil crusting is a serious and widespread problem under drip and micro irrigation systems in South Africa, but can be overcome by application of soil conditioners that are being manufactured here in the country.

Keywords: Aeration, crusting, drip, infiltration, PAM

NITROGEN MINERALIZATION IN COMPOST-AMENDED SOILS- BRIDGING THEORY AND FIELD FERTILIZATION

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INTRODUCTION

Nitrogen (N) plays a vital role in plant metabolic processes, and may cause severe economic losses in crop production if deficient. When compost is used to counteract soil impoverishment and supply crop nutrients, it is crucial to understand the dynamics of nitrogenous compounds to optimize N uptake. In the absence of a suitable predictive capability to forecast organic N mineralization, the application of compost to soils with different chemical properties may result in over- or under-fertilization. Whilst under-fertilization may lower crop yield, over-fertilization is linked to the contamination of aquifers and eutrophication. The objectives of this study are (i) to determine the effect of compost application on N mineralization rates in different soils, and (ii) to link this information to *in situ* mineralization using modelling. This will enable the optimization of organic fertilization strategies in commercial sugarcane systems.

MATERIALS AND METHODS

Five major soil groups of Mauritius were amended with three types of compost [filtercake (FC), poultry litter (PL), and poultry manure-thrash (PM)], at total N rates of 140 kg ha^{-1} in a laboratory incubation experiment. As a control treatment, soils were left un-amended. Inorganic N (NH_4^+ and NO_3^-) in amended and un-amended soils was determined periodically over 215 days.

RESULTS AND DISCUSSION

The percentage of organic N mineralized in soils amended with PM ranged from 17% to 125%, from 58% to 105% in PL-amended soils and from 6% to 41% in soils amended with FC. The priming effect may explain N mineralization percentages exceeding 100. With a higher C/N ratio (9.9) than PL and PM, FC resulted in net N immobilization during the first 35 days. In all treatments, the NO_3^- form of N was prevalent, indicating rapid nitrification in these soils. N mineralization rate constants ranged from 0.0011 to 0.0141 day^{-1} in PM-amended soils, from 0.0018 to 0.0063 day^{-1} in PL-amended soils and, from 0.0012 to 0.0053 day^{-1} in FC-amended soils. Lowest rates of N mineralization were noted in clayey soils. A negative correlation between rate constants and soil C/N ratio ($r= -0.92<.0001$) was found.

CONCLUSIONS

Availability of inorganic N from the three composts varies significantly amongst soil groups, and this further underlines the need for a suitable N predictive tool. Results of the incubation study will be used to calibrate and test the Soil Water Balance model which will be applied to determine optimal compost applications under field conditions.

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Keywords: Compost, incubation, mineralization, nitrogen, organic matter

GAMMA IRRADATION OF SWEETPOTATO (IPOMOEA BATATAS) AIMED AT INCREASED NUTRITIONAL QUALITY

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QUANTIFYING THE POTENTIAL OF A NATURAL BIO-STIMULANT UNDER LABORATORY CONDITIONS

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INTRODUCTION

Prior to commercialization the efficacy of natural bio-stimulants needs to be confirmed by means of *In vivo* and *In vitro* screening methods. Screening laboratory and glasshouse testing confirming activity is more cost effective compared to field trials. The aim was to test a commercial registered natural bio-stimulant under laboratory and glasshouse conditions using different bio assays.

MATERIALS AND METHODS

Six bioassays were developed for comparison of natural plant bio-stimulants to an untreated control. In the first assay, bio-stimulants' response towards monoculture yeast cell respiration rate was measured at different concentrations. In a second assay, pea seed respiration rate was evaluated, with a submergible differential respirometer. The third assay involved bio-stimulants' effect on algal growth in a customized nutrient medium, assessing growth using a Klett-meter over a period of 13 days. In the fourth assay seed germination and seedling growth of radish, cabbage, peas and wheat seeds towards different concentrations were evaluated. The last 2 assays were done in the glasshouse applying the bio-stimulant as a foliar application or soil drench on lettuce, beetroot and wheat, measuring its effect on root and aerial parts fresh mass.

RESULTS AND DISCUSSION

Respiration and growth rates of yeast, peas and algae were significantly enhanced with the bio-stimulant at a concentration of 0,5mg/L compared to untreated controls. In the germination paper test the natural bio-stimulant enhanced the root growth of all crops accept for wheat. Lettuce and beetroot fresh mass were also significantly increased under glasshouse conditions after a leaf treatment and soil drench.

CONCLUSION

Enhanced respiration rates of yeast and the growth response of algae and different seeds under laboratory and glasshouse conditions can be a good measure to confirm the efficacy and quality of natural products as bio-stimulants, before commencing to testing then under field conditions.

Keywords: Natural product, bio-stimulant, respiration, germination

EFFECT OF VARYING DEGREES OF PLANT RESIDUE COVER ON ANNUAL MEDIC PASTURE RE-ESTABLISHMENT AND PRODUCTION

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INTRODUCTION

In the southern Cape, farmers have noticed a decrease in annual medic pasture re-establishment under conservation agriculture (CA) practises. Farmers shifted away from medics as a result. This study was done to determine effect of different types and varying degrees of residue cover on the re-establishment and production of annual medic pastures.

MATERIAL AND METHODS

The research was done at the Tygerhoek Experimental farm (Riviersonderend, Southern Cape). The re-establishment and production of medics was measured following wheat (WM), barley (BM) and oats (OM) as well as following on the medic (MM) year, with five different residue cover percentages (100%, 75%, 50%, 25% and 0%, the five treatments). Re-establishment of medics under different treatment residues was determined by dividing the actual medic plant count per square meter (on the treatments plots) with the potential medic plant count per square meter (that specific plot on the farm). Dry mater (DM) production was converted to tons per hectare from grams per square meter. Results were subjected to statistical analysis using Statistica by using the ANOVA and t-tests to determine differences.

RESULTS AND DISCUSSIONS

WM medic re-establishment was significantly greater than that of MM, OM and BM. Medic re-establishment did not differ significantly between 0%, 25%, 50% and 75% residue cover, but re-establishment differences was seen between 0% and 100% residue cover. Re-establishment and DM production showed a positive correlation. It would appear that the type of preceding crop plays a significant role in the re-establishment. This might be due to either allelopathic (cereal residue) or auto toxicity (medic residue), It was interesting to note that there was no significant differences in production between the 0% to the 75% residue cover treatments.

CONCLUSIONS

At least 30% of the soil need to be covered with residues to be classified as CA. Re-establishment is important for future seed reserve build up, thus a 75% residue cover is optimal for re-establishment and production. It would be more optimal of using wheat in rotation with medic for short rotation sequences rather than other cereals.

Keywords: Conservation agriculture, residue cover, medic re-establishment

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INTRODUCTION

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Enhanced respiration rates of yeast and the growth response of algae and different seeds under laboratory and glasshouse conditions can be a good measure to confirm the efficacy and quality of natural products as bio-stimulants, before commencing to testing then under field conditions.

Keywords: Natural product, bio-stimulant, respiration, germination

BLEACHING OF TOPSOILS ON WELL-DRAINED SUBSOILS IN THE WESTERN CAPE AND MPUMALANGA PROVINCES

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INTRODUCTION

Bleaching is commonly observed in topsoil horizons and is primarily regarded to be the result of periodic water saturation resulting in Fe reduction and stripping from soil mineral particles. The South African soil classification system does not recognise bleaching as a topsoil characteristic on well-drained (red or yellow-brown B) profiles (Soil Classification Working Group, 1991). This study aims to investigate the catenal, chemical and physical processes governing the occurrence of these bleached topsoils in the Western Cape and Mpumalanga Highveld.

MATERIALS AND METHODS

Well-drained profiles with bleached and non-bleached topsoils were sampled from the Western Cape (14) and Mpumalanga Highveld (12). For all top and subsoil (B1) horizons, soil colour (Munsell colour chart; Konica Minolta spectrophotometer), particle size, citrate bicarbonate dithionite (CBD) and ammonium oxalate (AAO) extractable Fe and Al were determined. Sampling on the Highveld was conducted along individual catenas with additional auger samples being collected in between profile pits for colour determination.

RESULTS AND DISCUSSION

Colour measurements along the sampled Highveld catenas revealed the presence of bleached orthic A topsoils overlying yellow-brown apedal B horizons. A comparison between perceived colours (visually determined from the Munsell colour chart) and actual colour (measured by a spectrophotometer) exposed the human eye's inability to accurately distinguish between lighter colours. This had a significant influence on profile classification particularly where i) an A/B transition zone was perceived not to be bleached but the actual colours revealed bleaching and thus the presence of an E, and ii) topsoils higher up in the catena, previously classified as non-bleached, had to be reclassified as bleached.

The Fe_{CBD} content did not significantly differ between bleached and non-bleached topsoils, which is regarded to be the result of the limited size of the data set. The Fe_{AAO}/Fe_{CBD} ratio tended to be higher in bleached compared to non-bleached soils, particularly in the Highveld samples. This may indicate a wetter moisture regime in the bleached soils. Western Cape soils tended to have a higher overall Fe content, but proportionally lower amounts of poorly crystalline Fe which may relate to a more eluvial mechanism of bleaching.

CONCLUSION

The human eye is weak at detecting bleached soil colours. Preliminary chemical analysis indicated that the mechanisms for bleaching in the Highveld and Western Cape soils are not

Keywords: Albic properties, ochric, ultisols, value, chroma

APPLICATIONS OF ABSCISIC ACID TO MODULATE GROWTH AND PHYSIOLOGY OF SWEET AND HOT PEPPER TRANSPLANTS

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INTRODUCTION

Small to large commercial vegetable farmers demand high quality containerized transplants that have the ability to enhance field survival and rapid growth after transplanting. A high quality transplant has a balanced root to shoot ratio, is not elongated or spindly, has a vigorous root system and typically has been conditioned or hardened to minimize transplant shock, particularly in stressful environments. Short transplants can also be held past their maturity time, allowing for an extended marketing period. For nurseries, controlling seedling plant size, especially height, is one of the most challenging cultural strategies when growing containerized transplants.

MATERIALS AND METHODS

Our research program has explored the potential of applying abscisic acid (ABA) to increase pepper (*Capsicum annuum* L.) transplant quality through modulation of shoot growth (leaf area, height, biomass), root growth and transplant physiology. We conducted greenhouse studies in southwest Texas to evaluate the impact of ABA on early root and shoot growth parameters, elongation rates, chlorosis, plant water status, and leaf-level photosynthesis and stomatal conductance of sweet (bell) and hot (jalapeno) peppers.

RESULTS AND DISCUSSION

This short review will highlight results from desiccation-recovery studies, rates, frequency and timing of ABA applications and provide new understanding underlying the basis of drought tolerance and growth control (inhibition, promotion) in ABA-treated pepper transplants. Characterizing the differential sensitivity of pepper types to exogenous ABA is critical to maximize its benefits.

ACKNOWLEDGEMENTS

Valent BioSciences, Rio Grande Basin Initiative Program (USDA-NIFA), Speedling Inc., Juan Esquivel and Ezequiel Cardona.

Keywords: S-ABA, *Capsicum annuum,* chlorosis, stand establishment, stem elongation, transplant shock

RELATING THE QUANTITY AND QUALITY OF PROTEIN IN WHET DEVELOPMENT FOR THE SUMMER RAINFALL REGION OF SOUTH AFRICA

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INTRODUCTION

Wheat protein quantity, generally referred to as protein content (%), is an important component for determining grade and end-product attributes such as texture and appearance. However, our hypothesis formulates that acceptable loaf volumes (cm^3) can be obtained through specific combinations and amounts of protein fractions (quality), despite low protein content (quantity). The study aims to determine the relationship between quantity and quality of protein in wheat produced under dryland and irrigated conditions in the summer rainfall region and correlate the results with loaf volume (cm^3).

MATERIALS AND METHODS

Production conditions were simulated through national cultivar field trials of the ARC-Small Grain Institute (ARC-SGI) in 2012 at Bethlehem and Clarens (dryland summer rainfall region) and Upington and Vaalharts (cooler irrigation region). Trial designs for both regions were randomized complete block designs with three replications. Data sets were generated from various milling and baking tests and size-exclusion high-performance liquid-chromatography (SE-HPLC) conducted at ARC-SGI. Trends and correlations between protein quantity (% protein), protein quality (protein fractions) and loaf volume (cm^3) were determined with ANOVA, AMMI and Complete-Correlation in GenStats for Windows edition 15.

RESULTS AND DISCUSSION

The polygenic natures of quantity and quality with environment as primary cause of variation, are evident in numerous cross-over interactions between correlations. Correlation between loaf volume and protein quantity were positive for dryland wheat at Clarens (0.72***) and irrigated wheat at both Upington (0.38**) and Vaalharts (0.69***). There were highly significant differences (*$P \leq 0.001$*) between protein content of cultivars at Clarens, Upington and Vaalharts. Side-by-side comparisons revealed that several cultivars produced acceptable loaf volumes (within a 10% variation of the standard) but with protein content below 12% (Grade 1) at Clarens, Upington and Vaalharts. Protein fractions correlating positively with loaf volume at Vaalharts were percentage soluble α/β and γ-gliadin (larger monomeric proteins) in total soluble protein (0.47***), percentage insoluble α/β and γ-gliadin in total protein (0.46***) and percentage insoluble ω-gliadin in total ω-gliadin (0.35***). Fractions correlating negatively with protein content were percentage soluble albumin and globulin (smaller monomeric proteins) in total soluble protein and in total protein at Clarens (-0.63*** and -0.56***), Upington (-0.53*** and -0.52***) and Vaalharts (-0.61*** and -0.61***).

CONCLUSIONS

Regardless of region more significant correlations occurred between quantity and quality at test localities subjected to high-yielding conditions. These correlations include cross-over interactions and both positive and negative correlations. The first aspect of our hypothesis is endorsed by substantial evidence of acceptable bread quality (loaf volume) obtained from grade 2 and 3 protein content. These findings allow application of protein fractions as more accurate indicators of bread quality.

Keyword: grade, fractions, polygenic nature

SEASONAL DEVELOPMENT OF MICRO CRACKING IN 'FUJI' APPLE PEEL

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INTRODUCTION

Micro cracking in the stem end of 'Fuji' apples causes export apples to be downgraded (personal comm. H Griessel, Tru-Cape). Incidence of this skin disorder ranges between 0 - 50 percent of the orchard, depending on season. According to Maguire et al. (2000) micro cracks are formed during development and growth of the fruit on the tree, as well as during storage. No additional micro cracks appeared during storage, but that the micro cracks only deepened during storage was reported by Knoche and Grimm (2008). A project was launched during 2014 to describe the anatomical development of micro cracking during the season on susceptible ('Raku') and non-susceptible ('Kiku') Fuji apple peel.

MATERIAL AND METHODS

Two 'Fuji' apple cultivars (Kiku and Raku) from commercial orchards in Ceres and a 'Kiku' orchard in Elgin were selected. Fruit were sampled during the season from 28 dafb. Small transverse sections of the peel were cut from the stem end from the fruit and stored in 80% ethanol. Based on appearance, micro cracking on the Scanning electron microscope images was classified according to stage of development: 'no cracking' (0), 'thickening' (1), 'initiation of cracking' (2) and 'cracking' (3).

RESULTS AND DISCUSSION

According to the images, serious micro cracking (1 and 2) in 'Raku' was consistently noticed from 77 dafb, whereas 'Kiku' showed micro cracking (2) only at 91 dafb in Ceres and 126 dafb in Elgin.

CONCLUSION

The anatomical development of micro cracking at the stem end of 'Fuji' indicated that micro cracking is initiated during the first 60 dafb, cracks do not penetrate the epidermis, is cultivar sensitive and area does not seem to play the dominant role in the formation of the cracks.

ACKNOWLEDGEMENTS

Funding for this project was supplied by Ceres Fruit Growers in Ceres.

Keywords: SEM, anatomical study, 'Raku', 'Kiku'

EVALUATION OF MAIZE (*ZEA MAYS L*) GENOTYPES FOR RESISTANCE TO *STRIGA ASIATICA* (L. KUTZE) INFECTION IN MAIZE.

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INTRODUCTION

Striga asiatica, a red flowered root parasitic weed, commonly known as witchweed, causes serious maize yield losses in smallholder farming areas of Zimbabwe. The hypothesis of this study was that the maize genotypes with purple witchweed (*S. hermonthica*) resistance, should also be resistant to *S. asiatica*.

MATERIALS AND METHODS

Seven open pollinated maize genotypes from the International Institute of Tropical Agriculture (IITA) were evaluated for resistance to *S. asiatica* at the University of Zimbabwe during the 2013/ 2014 rainfall season, using two techniques. First, a greenhouse pot experiment using a 2 × 8 factorial in a randomized complete block design (RCBD) was established. Second, a laboratory screening experiment using the agar gel technique was used to determine the capacity of the maize genotypes to stimulate *S. asiatica* seed germination. Analysis of variance was done on the data collected and Fisher's LSD (5%) test was used for treatment comparisons.

RESULTS AND DISCUSSION

The maize genotypes had a significant ($P < 0.05$) impact on *S. asiatica* emergence. The maize genotypes R201, 3, 4, and 16 supported the lowest emerged *S. asiatica* plants. The effect of *S. asiatica* on maize plant height was highly significant ($p < 0.001$). However, the impact of *S. asiatica* on the heights of the maize genotypes 9 and 9022-13 was not significant ($p > 0.05$), suggesting that they tolerated *S. asitica* infection. For the laboratory experiment, significant ($p < 0.05$) maize genotype effects were observed on *S. asiatica* germinating distance from the maize root. This suggested that the maize genotypes differed in terms of root exudates production. The maize genotypes 2, 3 and 9022-13 probably produced low germination stimulants. However, the impact of maize genotypes on the *S. asiatica* seed germination percentage was not significant ($p > 0.05$), with germination percentages ranging from 51.0 to 69.5 %.

CONCLUSION

It was concluded that the maize genotypes 9 and 9022-13 were tolerant to *S. asiatica* infection, under greenhouse conditions and all the maize genotypes were not resistant to *S. asiatica*.

Key words: resistance *Striga asiatica* and witchweed

EFFECT OF DIFFERENT GROWTH MEDIA ON ROOTING OF HONEYBUSH SEMIHARD-WOOD CUTTINGS

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INTRODUCTION

Honeybush (*Cyclopia* spp.) is a shrub of the legume family Fabaceae and grows along the coastal districts of the Eastern and Western Cape provinces of South Africa. The increasing demand for honeybush tea worldwide coincides with consumer demand for health-promoting foods and ingredients and has led to an increasing demand for the. A large amount of the tea is still collected from wild populations, hence vegetative propagation has become necessary due to rapid growth of the industry and demand for more uniform products. This research project was aimed at optimizing propagation and adventitious rooting techniques of stem cuttings. The specific objectives of this study were 1) to evaluate the genetic variation within *C. subternata* clones and 2) to determine the influence of different growth media on rooting of *C. subternata* stem cuttings.

MATERIALS AND METHODS

Four clones of *C. subternata* were grown in a plastic sheet roofed tunnel with 40% shade netting on the sides at ARC Infruitec-Nietvoorbij on six planting dates. Cuttings were set in three growth media [Canadian peat moss, sand and polystyrene balls (1:1:1) (Three mix), Canadian peat moss and sand (2:1) (Peat mix) and pine bark and sand (1:1) (Bark mix)], with three growth regulators (Seradix® B2, Seradix® B3 and Dip & Root™). The experimental design was a factorial experiment arranged in a randomized complete block design with two factors and three replications. Data on cuttings rooted, cuttings survived and root mass were collected after 63 days of plant growth and statistically analysed using a two-way ANOVA of SAS software version 9.2. A probability level at 5% was considered significant for all significant tests ($p \leq 0.05$).

RESULTS AND DISCUSSION

The highest survival and rooting percentage as well as greatest root mass were attained from cuttings grown in Bark mix followed by Three mix. The survival percentage, rooting percentage and root mass were considerably lower in cuttings grown in Peat mix. The survival, rooting and root mass success in Bark mix and Three mix may be due to variable factors interacting within the growth media such as aeration, water holding capacity and nutrient availability. Clone selection SGD7 had significantly the highest survival and rooting percentage as well as root mass, followed by SGD1 and SGD9. Clone SGD6 had significantly the lowest survival, rooting and root mass success.

CONCLUSIONS

Considerable variation in rooting was found amongst the clones of *C. subternata*. Clone SGD7 had more than 80% rooting, SGD1 and SGD9 had 70% rooting and SGD6 had less than 40% rooting. Different growth media significantly affected the rooting success of stem cuttings where the highest rooting success – including survival, rooting and root mass – was obtained on Bark mix followed by Three mix; the lowest rooting success was obtained in Peat mix.

Keywords: Clone, *Cyclopia subternata*, vegetative propagation

EFFECT OF PLANT SPACING ON DETERMINATE TOMATO CULTIVARS GROWN IN A CLOSED HYDROPONIC SYSTEM

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INTRODUCTION

Tomato production in South Africa is mainly in open field conditions. There are no established tomato spacing recommendations under closed hydroponic systems using the gravel-film technique. The study was aimed at determining yield of determinate tomato cultivars at different plant spacing under a shade net structure.

MATERIALS AND METHODS

The study was conducted during September to December 2013 (spring/summer season) and repeated in January to April 2014 (summer/fall season) in a white shadenet structure at the Agricultural Research Council -Vegetable and Ornamental Plant Institute (ARC-VOPI), Roodeplaat. The plantlets were transplanted 35 days after seeding, utilizing a closed (gravel-film technique) hydroponic system. Sixteen treatment combinations were used, namely four plant densities (10, 16, 20 and 25 plants/m^2) combined with four determinate tomato cultivars (Mion, Dynimo, Mariana and Sama). A randomized complete block design with 4 replicates was used. Data were subjected to analysis of variance (ANOVA) using the statistical program *GenStat*® version 11.1. Treatment means were separated using Fisher's protected T-test least significant difference (LSD) at the 5% level of significance.

RESULTS AND DISCUSSION

During spring/summer season, the results showed high total yields on cultivar Dynimo and Mariana, although Mion did not differ significantly from cultivar Mariana. Cultivar Mion and Mariana at a closer plant spacing of 16, 20 or 25 plants/m^2, produced high unmarketable yield due to increases in extra-small sized fruits and incidences of fruit rot. Plants grown at 25 plants/m^2 improved total yield, while marketable yield was improved at 20 or 25 plants/m^2. During the summer/fall season, the results showed no significant difference in total and marketable yield per unit area at plant densities of 10, 16, 20 or 25 plants/m^2 and among the cultivars evaluated. Marketable yield was not affected by cultivar selection during spring/summer and summer/fall seasons.

CONCLUSIONS

Results demonstrate that a plant density of 20 plants/m^2 can improve marketable yield of determinate tomato cultivars during spring/summer season. However, during summer/fall season of 10 plants/m^2 will be more cost effective, with no significant effect on yield. Plant density recommendations are, therefore, 20 plants/m^2 during spring/summer season and 10 plants/m^2 during summer/fall season.

Keyword: Gravel film technique, marketable yield, unmarketable yield

SUITABLE PLANT ORGANS FOR USE AS PROPAGULES FOR *IN VITRO* PROPAGATION OF WILD *CUCUMIS* SPECIES

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INTRODUCTION
Wild watermelon (*Cucumis africanus*) cultivars contain cucurbitacin B (Rimington 1938), which confers auto-allelopathy during germination. Cucurbitacin B is distributed equally in all organs of *C. africanus* plants (Jeffrey 1978). According to this distribution, *C. africanus* may not have suitable propagules for *in vitro* propagation. The objective of this study therefore, was to determine suitable plant propagule for *in vitro* propagation from *C. africanus*.

MATERIAL AND METHODS
Aseptic explants, *viz.* leaves, hypocotyls, cotyledons, nodal bud and shoot-tips from 7-day-old *in vitro* propagated seedlings of *C. africanus*, were cultured in Murashige and Skoog (MS) medium supplemented with 0.0, 0.05, 0.10, 0.25, 0.50 and 0.75 mg/L concentrations of BAP. For rooting, six concentrations, *viz.* 0.0, 0.05, 0.10, 0.25, 0.50 and 0.75 mg/L concentrations of IBA were used. All cultures were incubated in a 12 h light/dark cycle on racks, fitted with cool white fluorescent tubes at 40 $\mu M/m^2/s$ irradiance at 25°C and 50-60% relative humidity.

RESULTS AND DISCUSSION
Regeneration was initiated from all explants tested. The optimum regenerated shoots/explant of 4.38 were achieved from shoot-tip explants, with BAP optimised at 0.44 mg/L. Root regeneration was optimised at 0.31 mg/L IBA. Rooted plantlets were acclimatised and successfully established in sand + compost growing medium under *ex vitro* conditions, where 95-100% plantlets developed into morphologically normal plants.

CONCLUSION
The presence of cucurbitacins did not inhibit shoot regeneration and therefore, shoot-tip explants are considered suitable plant organs for use as propagules for *in vitro* propagation of *C. africanus*.

ACKNOWLEDGEMENT
Funding is supported by Limpopo Agro-food Technology Station, VLIR and the Land Bank of Agriculture.

Keywords: Allelochemicals, alternative crops, Cucurbitaceae, ethnomedicine, growth chamber, mass propagation.

GERMINATION OF CANCER BUSH (*SUTHERLANDIA FRUTESCENS*): GROWTH MEDIA AND TEMPERATURE

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INTRODUCTION

Cancer bush is a perennial shrub and a medicinal plant species that belongs to the Leguminosae family. It is among the 16 commercially important medicinal plants of South Africa with a commercial history and hence, one of the most studied indigenous medicinal plants for both traditional and pharmaceutical use (Moteetee and Van Wyk, 2007; Gibson, 2011). The management of these plants in the wild is not well regulated, the intensive harvesting of these species for their medicinal use has in many places resulted in overexploitation and a serious threat to biodiversity and as such, affecting market supply (Anon, 2003). Therefore, the study aimed at assessing seedling germination and establishment of Cancer bush using different growing media and temperature.

MATERIALS AND METHODS

Seeds were provided by the ARC-VOPI gene bank that was harvested in December 2012. The first trial aimed at investigating the effects of different temperature regimes on germination of seeds. A pleated paper germination method was used to test germination at 15, 20, 25, 30 and 35°C and prior to sowing the paper was moistened with sterile distilled water. Four different growing media were used for the second trial viz; Compost bark, Red top soil, Sand, and a mixture of the 3 in equal proportion (1:1:1, *w/w/w*) were used in seedling trays under glasshouse conditions. The treatments were replicated four times in RCBD and the collected data was subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

No significant differences were observed in total germination percentages and the percentage of diseased seeds was significantly highest at 35°C. Different growing media responded differently in germination percentage. The highest percentage was recorded in compost bark (70 %) followed by sand media as compared to the Red top soil and Mixture. Germination rate was also influenced by media where after 5 and 6 days first seed germination was recorded in compost bark and sand media respectively.

CONCLUSIONS

The results show that *S. frutescens* seeds can be germinated in all temperatures tested without any significant difference in germination percentages. *S. frutescens* seeds germinate better in light (workable) soils than heavy soils and the effect of storage on germination of *S. frutescens* seeds also need to be investigated.

ACKNOWLEDGEMENTS

We are grateful to the ARC's Professional Development Program (PDP) for funding the project

Keywords: Cancer bush, germination, media, temperature

SOUTH AFRICAN HERBICIDE RESISTANCE INITIATIVE (SAHRI): WEBSITE FOR COMMUNICATION ON WEED RESISTANCE ISSUES AND PROMOTION OF 'BEST AGRICULTURAL PRACTICES'

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INTRODUCTION

Particular weed species tend to be associated with certain crop species, therefore, the global distribution of weeds is closely linked to that of the crop 'partner'. Moreover, because of the extensive global distribution network for pesticides, there is significant similarity in the chemicals used for pest and management in a particular crop or cropping system. Therefore, it is not unexpected that the evolution of resistance to pesticides (including herbicides) mirrors their pattern of distribution and use. As a result, South Africa has to cope with its share of herbicide-resistant weeds. We recognise a need for improved interaction between companies and crop producers on this issue in South Africa, and foresee the website contributing to the awareness effort, as well as to refinement of strategies for resistance management.

APPROACH

Bridging the communication gaps between researchers/farmers/company representatives is key to meeting the challenges presented by herbicide-resistant weeds. The website will convey information and knowledge on topical issues related to weed resistance. Knowledge that has been generated both locally and internationally through scientific research and farmer experience will be disseminated in ways that make knowledge relevant for the farming environment. Interactive communication will be stimulated in order that the knowledge and expertise of farmers and company representatives, i.e. those that deal first-hand with weed resistance, and even 'hard to control' weeds, can be drawn into discussions.

One of the website projects seeks to get farmer and company participation in a survey for identifying 'hard to control' weeds on a countrywide basis. Participants will be invited to contribute information and photographs on weeds which they consider particularly problematic. In this way the 'bigger picture' on important weeds in different crop and geographical settings will emerge. Experts can collate and interpret the gathered information with the view to come up with 'best management practices' for dealing with the issues – it may emerge that the issues go beyond weed control *per se*, and can be addressed as such through a team approach involving specialists from diverse fields of expertise.

SAHRI website address: http://www.up.ac.za/south-african-herbicide-resistance-initiative-and-best-agricultural-practices-at-up

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Keywords: Communication, knowledge transfer, herbicide resistance, weed control

DIGESTIVE ENZYMES OF THE BANANA RHIZOME BORER, *COSMPOLITES SORDIDUS*

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INTRODUCTION

Banana weevils (*Cosmopolites sordidus*) are serious pests of banana and plantain. It is important to know the type of enzymes present in the insect gut, as this enables efficient pest management strategies. Banana weevils are sensitive to inhibitors of cysteine proteases known as cystatins. When cystatins are added to the diet of banana weevils, severe developmental delay of the larvae is observed. Although midgut inhibition through the use of cystatins would be a possible approach to reduce weevil damage, the characterization of midgut proteases of *C. sordidus* could enable a targeted weevil reduction strategy.

MATERIALS AND METHODS

Insect guts were dissected from adult banana weevils and used for RNA extraction. Library construction and transcriptome sequencing were done at BGI (Hong Kong) on the Illumina HiSeq 2000 platform using 95 par end reads. *De novo* transcriptome assembly was done using Trinity Assembler. The resulting contigs were screened against the MEROPS protease library using Blastx. Proteins of at least 100 amino acids, e-values $<1e^{-04}$ and with unique sequence identities were selected for further analysis. Alignments were extracted from the Blastx search, and sequences with positives >80% were selected as putative proteases. Furthermore, Signal peptides of the putative proteases were predicted to see if the proteases are secreted, using PrediSi, SignalP and SMART bioinformatics programs. The signal peptides were compared to those of the fully sequenced *Tribolium castaneum* and 37 gut proteases from various insects.

RESULTS AND DISCUSSION

While biochemical analysis of the protease activity in banana weevils showed that cysteine-like proteases are dominant, the characterization of the midgut transcripts shows serine proteases to be the most abundant, followed by metallo- and cysteine proteases. From a total of a 100 putative proteases, only 9 were predicted to be secreted by the presence of upstream signal peptides sequences. *Tribolium castaneum* proteases dominantly possess signal peptide sequences and the same applies to the selected sequences from various insects; only 2 of the 37 selected sequences did not have a signal peptide.

CONCLUSION

Information regarding the protease diversity and abundance can give us insights into possible adaptive evolution and the long term effectiveness of using cystatins as a control measure. The absence of signal peptides in *C. sordidus* suggests that this weevil has a unique mechanism of metabolism.

Keywords: Digestive enzymes, Cystatins, Cosmopolites sordidus, proteases

NITROGEN RESPONSE OF MAIZE SILAGE FOLLOWING RAINFED WINTER COVER CROPS

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INTRODUCTION

Production of maize silage leaves little residue for farmers that wish to practice no-till. In 2003 a cover-crop trial was initiated at Cedara Research Farm (near Pietermaritzburg) to investigate the consequences of winter cover crops in systems where silage maize is grown every summer season. In the 2011/12 and 2012/13 seasons, the plots were split for nitrogen.

MATERIALS AND METHODS

The trial is at Cedara Research Farm near Pietermaritzburg. It consists of 27 main plots (9 treatments and 3 replicates). Split-plots received either zero nitrogen or 120 kg N/ha in January. Winter cover crops were planted in April and were: black oats (var. Saia); black oats and grazing vetch (var. Max); stooling rye (var. Trojan); stooling rye and grazing vetch; grazing vetch; white clover (var. Haifa); white clover and black oats. There were two control plots per replicate (winter weeds were allowed to grow). No-till maize was planted in November. Above-ground dry-matter (DM) yield of the maize and cover crops were measured (harvested in March).

RESULTS AND DISCUSSION

In 2013 (dry winter) cover crops produced much lower yields than in 2012 (wetter winter); in 2013 treatments with stooling rye produced 1.4 to 2.3 t DM/ha (5.8 to 7.7 t DM/ha in 2012) and the grazing vetch produced 1.8 to 2.1 t DM/ha (4.9 t DM/ha in 2012). In 2013, the effect of the N applied to the previous maize crop was significant (P=0.012), but the cover crop by N interaction was not significant.

Maize silage yields showed a significant cover crop x N interaction: Highly significant responses to N were observed for all cover crop treatments other than those with vetch. At zero N, maize silage yield following each of the three cover crop treatments including vetch ranged from 16.8 to 20.8 t DM/ha in 2012 and from 9.6 to 14.1 t DM/ha in 2013, whereas maize yield in the other cover crop treatments ranged from 8.1 to 9.8 t DM t/ha in 2012 and 5.6 to 8.8 t DM/ha in 2013. In contrast, at 120 N, maize yields ranged from 16.5 to 19.7 t DM /ha in 2012 and 12.3 to 15.5 t DM /ha in 2013.

CONCLUSIONS

The use of vetch as a cover crop, either alone, or planted with a temperate grass, can allow N fertilizer savings, even if grown in winter without supplementary irrigation. In both years, above-ground N uptake for the vetch treatment at 0 N was similar to that of the control at 120 kg N/ha. The vetch-grass mixtures, however, had much smaller effects on above-ground N uptake.

***Keywords**:* black oats; stooling rye; grazing vetch; legume

HERITABILITY AND GENETIC GAIN OF GRAIN YIELD AND SOME AGRONOMIC TRAITS IN EARLY MATURING MAIZE HYBRIDS

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INTRODUCTION

Production of maize does not match the demand in Africa because there are no suitable varieties that fit in short seasons. The objectives of the study were to determine the genetic gain, genetic variation and heritability for yield potential and the role of secondary traits in early maturing maize hybrids.

MATHERIALS AND METHODS

Fifty maize hybrids were evaluated at three sites, in KwaZulu-Natal, South Africa. The experiments were laid out as 5 x 10 alpha lattice designs with two replications at all sites. They were managed following standard cultural practices for maize, in South Africa. The analysis of variance for all traits was performed using GenStat 14th edition. The path coefficient analysis was performed in SAS version 9.3 to determine the direct and indirect effects of secondary traits on yield.

RESULTS AND DISCUSSION

Genetic gain for grain yield of 18% was reflected by the top five hybrids indicating a significant improvement in performance of the hybrids. The top five experimental hybrids have the potential to be advanced the following season. Significant genetic variation was observed indicating opportunities for further improvement of the hybrids. Grain yield was highly heritable (75%) across sites implying that direct selection of maize hybrids for grain yield would be effective. Heritability for secondary traits ranged from low (3%) to high (79%), indicating the need to identify agronomic traits which should be targeted to improve yield of the hybrids. The number of ears and ear prolificacy had a highly significant (P=0.001) positive correlation with grain yield. Similarly regression results indicated that ear prolificacy and number of ears were the highest contributors to grain yield improvement.

CONCLUSIONS

The study was successful in identifying five productive maize hybrids. Further genetic gains will be obtained by exploiting the large genetic variation. Selection will be effective because heritability was large for yield. Ultimately ear prolificacy, which displayed the highest direct effects on yield, will be emphasized to enhance yield potential of early maturing hybrids.

***Keywords**:* correlation, early maturing hybrids, genetic gain, heritability, path coefficient analysis.

THE EFFECT OF SOIL NUTRIENT DEFICIENCIES ON THE SEEDLING EMERGENCE OF MAIZE SEED PRODUCED IN SUCH SOILS

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INTRODUCTION

In rural areas where seed is held back, the soil in which the mother plant was grown, might have been deficient in one or more nutrient element. How will this affect the germination of seed if it was to be sown back into the soil deficient in those elements? To answer this question, seed harvested from the long term maize fertilizer trial at the Hatfield Experimental Farm was used in simulating such a practice.

MATERIALS AND METHODS

Soil was collected in 2014 from the maize fertilizer trial plots. The plots have been allocated to the same specific fertilizer treatment from year to year since 1939. The treatments are combinations of N, P and K (N, P, K, NP, NK, PK, NPK) as well as the same treatments but with three years of compost added (W, WN, WP, WK, WNP, WNK, WPK, WNPK) in 2003 – 2005. The control (0 treatment) has not received any fertilizer or compost since 1939. Each treatment is replicated four times and the layout is a randomized complete block design. Statistical analysis was done with SAS and the 5% level of probability (Tukey) was used to distinguish between treatment means.

The soil from the plots were kept separate, sieved and placed in 500 ml pots. Seed harvested from the corresponding fertilizer treatment were sown into the pots (3 per pot) and germination monitored until no further seedlings emerged. This was carried out in a glasshouse with an air temperature of about 30°C.

RESULTS AND DISCUSSION

Pots with WNPK treated soil achieved the highest emergence percentage (97%), and was only statistically similar to the emergence at NPK (89%) ($P<0.05$). The plots receiving only one nutrient element (N or P or K) had the lowest emergence percentage (19 – 28%) and were significant lower than where at least two of the nutrient elements were present (NP, NK, PK, 44 – 50%). The emergence percentage in W treated soils tended to be higher, although not significantly so, than their counterparts receiving only inorganic fertilizers.

CONCLUSIONS

Nutrient deficiencies have a negative effect on the emergence percentage of maize seedlings from seed originating from the poor soil. Looking at the three main macro nutrients, the more of them that are left out in fertilization, the more severe the effect. Compost application can have a positive impact.

Keywords: nitrogen, phosphorus, potassium, compost

VARIATION IN ACID PHOSPHATASE ACTIVITY IN ORGANS OF TWO INDIGENOUS SOUTH AFRICAN LEGUMES, *ASPALATHUS* AND *CYCLOPIA* SPECIES

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INTRODUCTION

The Cape Fynbos is ideal for measuring intracellular acid phosphatase activity (APase) because of its low pH and P. P is remobilized from less active to younger tissues in plants through intracellular APase. We assessed APase activity and P concentration in *Cyclopia*, *Aspalathus* and *Leucadendron* species of the Cape fynbos.

MATERIALS AND METHODS

Five *Cyclopia genistoides*, *Aspalathus aspalathoides* and *Leucadendron strictum* plants, each four years were collected from Koksrivier 30° 41' 27″ S, 19° 40' 43″ E, Kanetberg 33° 55' 55″ S, 21° 01' 50″ E and Kleinberg 33° 47' 39″ S, 20° 26' 24″ E. Plants were separated into leaves, stems and roots (n = 5) and assayed for APase activity as described by Liu *et al*. (2004). Absorbance was read at 405 nm on a UV-Visible spectrophotometer. Plant subsamples were oven-dried, ground and analysed for P according to Giron (1973).

RESULTS AND DISCUSSION

At all sites, APase activity was much higher in organs of the legumes compared to non-legume. Of the two legumes sampled at Koksrivier, leaf enzyme activity was highest in *Cyclopia genistoides*, whilst *Aspalathus aspalathoides* exhibited the highest enzyme activity in stems. At both Kleinberg and Kanetberg, *Cyclopia subternata* and *Cyclopia longifolia* showed the highest APase activity in leaves, followed by stems, and lowest in roots. P concentration closely mirrored enzyme activity in organs of all test species from each site. APase activity positively correlated with P concentration in organs of all the test *Cyclopia* and *Leucadendron* species, indicating that intracellular APase activity is directly linked to P nutrition in these species. Tissue APase activity in *C. genistoides* (r = 0.911*), *A. aspalathoides* (r = 0.868*) and *A. caledonensis* (r = 0.957*) was also significantly correlated with percentage N derived from fixation, suggesting that APase activity could be directly or indirectly linked to symbiotic functioning in these Fynbos legumes, possibly via increased P supply to sites of N_2 fixation.

CONCLUSIONS

Intracellular APase activity is involved in P nutrition of *Cyclopia*, and also seemed related to enhanced symbiotic functioning in *Cyclopia*, as evidenced by the significant correlation between APase activity and %N derived from fixation. APase activity also correlated positively with P in *Leucadendron strictum* whilst the test *Aspalathus* species showed not relationship between APase activity and organ P concentration.

Keywords: APase activity; Cape Fynbos; Kanetberg; Koksrivier; P nutrition

NITROGEN, PHOSPHORUS AND POTASSIUM AVAILABILITY IN WINEREY SOLID WASTE COMPOSTS

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INTRODUCTION

Increased wine production in South Africa has resulted in a significant increase in winery solid waste (WSW) generation. Indiscriminate dumping of WSW may cause bad odour and contaminate natural agro-ecosystems. The use of WSW in composting may be an alternative strategy of handling WSW. Studies on the quantification of nutrients mineralised following application of WSW composts on agricultural soils are very scanty. This study was therefore initiated to assess the nutrient mineralisation pattern and nutrient release potential of WSW composts following soil amendment.

MATERIALS AND METHODS

Winery solid waste materials namely, wine filter materials (FM), grape marc (berry stalks, skins and seeds) and chopped grapevine pruning canes were composted in heaps through a thermophilic process. The FM were mixed with the grape marc and grapevine pruning canes at five rates (10%, 25%, 50%, 75% and 100%) to produce five composts herein designated as C10FM, C25FM, C50FM, C75FM and C100FM, respectively. The composts were subjected to chemical analyses at curing; and subsequently used in a laboratory incubation study using two soil types (sandy and sandy loam). The composts were mixed with 1.2 kg soil at a rate equivalent to 200 kg N/ha, transferred into plastic pots and placed into an incubator. Concentration of nutrients mineralised from compost amended soils was estimated at 7, 14, 21, 28, 35 and 42 days after incubation. Data collected was analysed using Statistix 8.1 computer program.

RESULTS AND DISCUSSION

The mineralisation of NH_4-N was significantly ($P<0.05$) increased following application of all composts, except C75FM. The amount of K mineralised significantly increased with the percent content of FM in composts. The increased NH_4-N and K mineralisation observed during the study is associated with the low compost C:N ratio and high level of K in these composts, respectively. The difference in the amount of NO_3-N and P mineralised among the various composts was however, not significant. The concentrations of NO_3-N, Bray-1 P and K mineralised in the two soils differed significantly while a significant compost type x incubation period x soil type interaction effects were observed on NH_4-N and K mineralised. The mineralisation of NO_3-N, P and K was higher under sandy loam soil than under sandy soil. The highest amounts of NH_4-N (413 mg/kg) and exchangeable K (3020 mg/kg) were obtained at 21 day after incubation from C100FM treatment under sandy loam soil. The C100FM treatment under sandy loam soil gave the highest amounts of NO_3-N and Bray-1 P of 112 mg/kg and 5.97 mg/kg obtained at 21 and 14 days after incubation, respectively.

CONCLUSIONS

The study showed that WSW compost could serve as a potential good source of ammonium N and K fertiliser for use on crop field.

Keywords: winery solid waste, compost, nitrogen, phosphorus, potassium

EFFECT OF ORCHARD SLOPE, HARVEST TIME AND RIPENING TEMPERATURE ON DE-SYNCHRONIZATION OF 'HASS' AVOCADO FRUIT SKIN COLOUR CHANGE

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INTRODUCTION

'Hass' avocado fruit are characterized by a change in skin colour from green to purple black after harvesting, as fruit ripens and softens. Recently, markets importing South African 'Hass' avocado fruits have reported a lack of skin colour change to purple/black during ripening. The aim of this research was to investigate pre- and postharvest factors leading to 'Hass' skin colour becoming de-synchronized from softening during ripening.

METHODS AND MATERIALS

'Hass' avocado fruit were harvested during early-, mid- and late-season from two blocks with a slope in the Kiepersol area, and were transported to the ARC – ITSC postharvest laboratory. Fruit from the top and bottom of the slope were stored separately to determine whether temperature differences across the slope contributed to fruit colouring. At the laboratory, fruit were sorted and graded and stored at 5.5°C for up to 28 days. After withdrawal from cold storage, fruit were ripened at 16, 21 or 25°C, and during ripening fruit were evaluated for firmness, skin colour (L, C, hue, a and b), external and internal damage (chilling damage) as well as for pathological disorders (stem-end rot and anthracnose).

RESULTS AND DISCUSSION

'Hass' avocado fruit harvested from the lower parts of the slope showed significantly higher de-synchronized colouring. Furthermore, lower ripening temperature (16 and 21°C) significantly affected colouring of 'Hass' avocado fruit when compared with higher ripening temperature (25°C). In the case where fruit showed de-synchronized colouring, the L, chroma and hue slightly decreased. During 'Hass' ripening, all colour parameters (L, chroma and hue) were expected to decrease (Cox et al., 2004). In addition, colour de-synchronization was mainly associated with lower slope fruit which further showed higher internal and external cold damage.

Keywords: Avocado fruit (*Persea americana*); Fruit firmness; Ripening temperature; Days to ripening

LEAFY VEGETABLES PHYTOCHEMICAL CONTENTS: EMPHASIS ON TOTAL ANTIOXIDANTS AND CARBOHYDRATES

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INTRODUCTION

Vegetables are an important source of health-beneficial phytochemicals. However, the available literature emphasizes commercially available leafy vegetables while there are a number of underutilized traditional leafy vegetables that can be effective in human health. Traditional leafy vegetables are currently immediately available and consumed in rural areas / poor communities due to information gap between traditional and exotic leafy vegetables. However, due to modernization of agriculture, the use of these crops has substantially decreased, and their consumption pattern is not fully understood. Scientific research and commercialisation of underutilized leafy vegetables can aid in the issues of food security and malnutrition. This report aims to look at the growth stage leaf preference for indigenous leafy vegetables, using commercial vegetables as reference crops, and promotion of the cultivation of indigenous crops to address the problem of food security and malnutrition.

MATERIALS AND METHODS

Brassica oleracea (green cabbage) and *Brassica oleracea var. capitata f. rubra* (red cabbage) were used as reference crops for *Amaranthus hybridus,* a traditional leafy vegetable, for investigating total antioxidant and carbohydrate content. Data was collected weekly for six weeks from a controlled facility, where the experiment was done on pots in a RCBD. Samples were collected, freeze dried, ground and stored at -74^{o}C to prevent any enzymatic activity during the laboratory analysis. Spectrophotometric determination of total antioxidants' capacity was conducted using FRAP and DPPH assays, and total soluble sugars were measured according to Liu et al. (1999). Data was analyzed using statistical software GenStat version 14.1..

RESULTS AND DISCUSSION

The results showed that green and red cabbage had high progressive accumulation of carbohydrates and initial high contents of antioxidants that decreased during their developmental stages, while *Amaranthus hybridus* showed initial high contents of carbohydrates and progressive accumulation of antioxidant capacity. There were no significant differences in total antioxidants between the investigated leafy vegetables. The findings are in agreement with Tesfay et al. (unpublished work 2013), who reported that indigenous vegetables have high antioxidant contents during their plant growth.

CONCLUSION

This experiment confirms the taste preference for young amaranthus leaf over consumption of older leaves. Traditional leafy vegetables are cheap and easy to grow while also showing health benefits.

Keywords: Indigenous leafy vegetables, antioxidants, carbohydrates

YIELD AND PROFITABILITY OF AMARANTH (*Amaranthus cruentus* L.) PRODUCTION UNDER VARIOUS NITROGEN SOURCES AND APPLICATION RATES

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INTRODUCTION

Amaranthus cruentus L. is the most commonly used African leafy vegetable by rural communities in South Africa and its consumption is also increasing in urban and peri-urban areas. Inorganic fertilizer, especially nitrogen (N) is the major form of soil nutrient supplement used to increase yield and nutritional content of vegetable crops. However, inorganic nutrient sources are expensive and often inaccessible to resource poor farmers (Okorogbona & Adebisi, 2012). Therefore, for sustainable production of Amaranth in smallholder farming and homestead gardens, easily, accessible and cheap alternative fertilizer sources are required. The objective of the study was to evaluate the effect of supplemental application of different fertilizer sources and rates on yield of amaranth and further to determine the costs, returns and efficiency of resource under such conditions.

MATERIALS AND METHODS

A field experiment was conducted in the 2013/2014 summer season at the ARC-Roodeplaat, VOPI. Six fertilizer sources; i.e, cattle kraal manure (CKM, 1.89% N), poultry manure (PMN, 2.43% N), inorganic N (LAN, 28% N), commercial organic (6% N), kraal manure + inorganic N and poultry manure + inorganic N), were used. Fertilizer sources were applied at five rates (0-Control, 60, 120, 180, 240 kg N ha^{-1}) in a randomized complete block design. Fresh and dry mass of marketable yield (leaf), stem, and total dry mass (leaves and stems) were determined. Analyses of variance (ANOVA) for yield parameters were conducted using SAS (SAS, 2002). Enterprise budgetary analysis was used to analyse the data, gross margins and break-even points for each fertilizer application rate were determined.

RESULTS AND DISCUSSION

When compared to the control treatment, applying 60 kg N ha^{-1} significantly (p=0.05) improved LFM by 10.6% whereas 120 kg N ha^{-1} and 180 kg N ha^{-1} both improved marketable LFM by35%. This implies that applying 120 kg N ha^{-1} could be enough for the production of acceptable marketable LFM. When combinations of poultry manure and inorganic N sources were used; the optimum rate was 120 kg N ha^{-1}. On average combination of manure (Organic) and inorganic N sources improved marketable LFM by 14.9% (19.5 t ha^{-1}) when compared with the marketable LFM of the single fertilizer sources (16.6 t ha^{-1}) therefore; this can be used as a cheap source in an integrated soil management farming system, especially if manure is freely available. In terms of the economic analysis, gross margins were about R168 000 for 60 kg N ha^{-1} and R171 000 for 120 kg N ha^{-1}. Rates of return were 3.74 and 4.81 respectively which indicates that application of 120 kg N ha^{-1} is sustainable and economically viable.

CONCLUSION

Applying a combination of manure with inorganic fertilizer revealed to be a promising combination. In terms of cost involved, there are lower costs incurred with this strategy and it also improves Amaranth productivity. With low transportation costs of fertilisers, farmers stand to gain more if manure is freely available.

ACKNOWLEDGEMENTS

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Keywords: Amaranth, fertilizer, manure, organic, yield, gross margins

THE INFLUENCE OF SEWAGE SLUDGE TREATMENT PROCESSES ON PHOSPHORUS TRANSFORMATION IN BIOLOGICALLY vs. IRON TREATED SLUDGE

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INTRODUCTION

Phosphorus (P) dynamics in sludge amended soils has been one of the complex issues in the scientific community because sludge treatment processes and post treatment drying methods influence the forms and crop availability of P. The aging of sludge is expected to reduce soluble P (KCl extractable) as well as Plant available P ($NaHCO_3$ extractable). Calcium bound P (Ca-P) is expected to increase in biological phosphorus removed (BPR) sludge due to the presence of calcium and phosphate. The aim of this study was to investigate P transformation in BPR vs. chemically treated sludge (Fe-trt).

MATERIALS AND METHODS

The treatments were incubated at 40°C for 28 days and wetted every third day. Sampling was done at days 0 and 27 to investigate P transformation using a modified sequential P extraction Method developed by Tiessen and Moir (1993). Other samples were taken at day 0, 9, 18 and 27 so that the sludge could be analyzed using a Scanning Electron Microscope (SEM) with the assistance of Energy Dispersive X-rays (EDX) to generate elemental maps and understand the chemical composition of P in the sludge.

RESULTS AND DISCUSSION

BPR sludge resulted in higher KCl extractable and $NaHCO_3$ extractable P in comparison to Fe-trt sludge. Aging the sludge resulted in the reduction of KCl extractable P by approximately 50 % in BPR sludge. Ca-P increased by 27% and 12% in BPR and Fe-trt sludge respectively, over time. Elemental maps indicated that P distribution coincide with that of Fe and Ca, which suggests that P exists in the form of iron phosphate and calcium phosphate in sludge granules in both sludge types.

CONCLUSIONS

BPR sludge has more KCl and $NaHCO_3$ extractable P than Fe-trt sludge. Sludge is considered as a fertilizer source, but aging the sludge reduces the latter fractions significantly hence farmers need to know the age of the sludge before purchasing it. The increase in the 1M HCl fraction in aged sludge is attributed to the presence of calcium and phosphate in the sludge which formed insoluble calcium phosphate compounds which is not preferable because it is not plant available.

Keywords: amended soils, sludge treatment

YIELD, OIL AND PROTEIN CONTENT OF SELECTED GROUNDNUT CULTIVARS IN EASTERN CAPE PROVINCE OF SOUTH AFRICA

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INTRODUCTION
Performance of groundnut (*Arachis hypogaea L.*) cultivars, like most crops, may differ significantly under varying environmental and climatic conditions. Climate in the Eastern Cape differs from region to region and is characterized by abiotic stresses such as drought, extreme temperatures and high soil acidity, which could restrict plant growth and result in poor crop yields. Lack of studies on adaptability of commercial groundnut cultivars in the province necessitated a study aimed at identifying best suited cultivars under different climatic conditions of two local municipalities in the OR Tambo District. The specific objective of the study was to determine crop yield, seed oil and seed protein content in response to provenance

MATERIALS AND METHDS
A study to evaluate performance of nine groundnut cultivars namely: Akwa, Kwarts, SA Juweel, ICGV-SM-95714, Anel, ICGV-SM-90087, Harts, Nyanda and Mwenje was planted at two trial sites, Mthatha and Lusikisiki. Plots measuring 4m x 3.6m were planted with five rows of groundnuts, each with an inter-row spacing of 90cm, intra-row spacing of 7cm and a planting depth of 6 cm. The following parameters were measured, seed yield, pop formation, and average seed per pod, oil and protein content. The experiment was arranged in a Randomized Complete Block Design (RCBD) and replicated three times. The data was subjected to Genstat Version 14.1 for statistical.

RESULTS AND DISCUSION
Kwarts produced the highest seed yield (1155 kg ha^{-1}) in Mthatha, while at Lusikisiki it produced the lowest yield of 630 kg ha^{-1}. The highest seed yield in Lusikisiki was recorded from Anel (936 kg ha^{-1}) which produced low yield (692 kg ha^{-1}) in Mthatha. Kwarts, Harts and ICGV-SM 95714 produced high oil contents of 52.7%, 47.4% and 40.03%, respectively. Nyanda and Anel gave low protein quantities at 10.80 and 10.85 mg/g, respectively, and ICGV-SM-90087 yielded the highest at 11.85 mg/g followed by Kwarts (11.75 mg/g).

CONCLUSIONS
There was a site difference in genotypes performance. Kwarts, Nyanda Mwenje and ICGV-SM 95714 should be planted under the climatic conditions of Mthatha. Anel, Nyanda, Harts, ICGV-SM 90087 and Akwa should be planted under climatic conditions of Lusikisiki.

Key words: Climate, genotypes, performance

AN ASSESSMENT OF SUITABILITY OF SEABED DERIVED PODZOLIC SOILS AND AQUAFER WATER SOURCE FOR SUSTAINABLE CROPPING

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INTRODUCTION

One of the major causes of soil degradation is the effects of inappropriate farming practises which cause soils to become saline and sodic or both. The purpose of this investigation was to assess the long term suitability of a unique situation of Podzolic soils derived from old sea beds and shells when using in *situ* aquifer water for irrigation of vegetables.

MATERIALS AND METHODS

A detailed soil, water and crop survey which included the analysis of soil, water and vegetable crop plant samples was performed. Orthodox methods of soil surveying were applied. The Taxonomic Soil Classification System for South Africa (1991) was applied to classify soils. Soil samples from each diagnostic soil horizon were analysed in detail. Irrigation water samples were analysed for essential parameters to determine the irrigation suitability. Plant samples were analysed to test for response of crops to the soil and irrigation water. A three year old developed land was used to assist with interpretation of results. 31 different soil and management parameters were used to estimate the soils' potentials for long term cropping.

RESULTS AND DISCUSSION

The soil survey revealed that, in the long term, Witfontein, Fernwood, Houwhoek and Pinegrove were medium potential soils. Low potential soil included Shallow phases of soils mentioned above as well as Groenkop, Cartref, Mispah and Kroonstad. In virgin soils all nutrients are low but in three year cultivated soil, nutrients were excessive with low (0.5%) organic matter. Clay contents varied between 2 and 5%. All virgin soils had high infiltration rates while old cultivated soils infiltration was low. Irrigation water analysis was found to be saline with a potential of becoming sodic. The Langelier index indicated that water was aggressive and corrosive due to super saturated Calcium bicarbonate and high pH. Analysis of drainage water showed high values of applied nutrients, a build-up of salinity and sodicity as a result of calcium bicarbonate imbalance and calcium precipitation. Plant analyses showed applied nutrients were excessive. Sodium, chlorine and sulphates were very high. All trace elements were low as was calcium as a result of precipitation of calcium in the soil and irrigation water.

CONCLUSIONS

Only soils with medium potential should attract high capital investment in the long term and the low potential soils should be phased out or developed for other use. Since the irrigation water source is saline has high pH, aggressive and corrosive, appropriate water treatment should be applied before application. Plant nutrients should be applied as required avoiding excessive applications to their requirements. Organic matter needs to be progressively increased to 3%. Soils need to be drained. Vertical tine implement cultivation is required to reduce subsoil compaction and improve soil structure in combination with applied soil organic matter.

Keywords: Soil classification, water quality, soil salinity, water salinity, plant nutrition

THE INFLUENCE OF SOIL TYPES ON PASTURE PRODUCTION AND NUTRITION IN THE SOUTHERN CAPE, SOUTH AFRICA

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INTRODUCTION

The aim of this study was to classify and map the spatial distribution of soils on the Outeniqua Research Farm, assess soil chemical and physical characteristics, pasture dry matter (DM) yield and quality and soil group yield potentials.

MATERIALS AND METHODS

The orthodox method of soil surveying was applied. The Taxonomic Soil Classification System for South Africa (1991) was applied to classify soils. All soil profiles were described in detail which included measurement of rooting depth. Soil association groups were created to form soil mapping units. Soil boundaries demarcated and areas were quantified using GIS mapping techniques. Representative soil samples and plant samples, corresponding to the most dominant soil groups, were analysed for all essential parameters. Pasture yields (kg (DM)/ha) and % DM were calculated for pastures grown on each soil group.

RESULTS AND DISCUSSION

An estimate of different soil group production potentials were 13.2, 11, 16.1, 9.4, 19.5 (tons/DM/ha/growth cycle) for Katspruit, Estcourt, Witfontein, Glenrosa and Witbank respectively. Main physical limitations of all soils were soil compaction, poor drainage and high sand fraction (80.1%) in the Orthic horizon. High water tables were evident in Katspruit and Estcourt groups. Root penetration in Witbank averaged 80cm and 40cm in all other soils groups. Soil organic matter in Orthic horizons range from 2.48% to 5.15%. Soil chemical analyses showed imbalances of acidity, P, K, Ca and Mg and toxic amounts of Al in Podzol B horizon of Witfontein. The average Ca/P and K/(Ca+Mg) expressions in pastures was 1.29 and 4.01, respectively, indicating base nutrient and P imbalances. The DM contents of pastures measured 12% to 43% with an average of 24.2%.

CONCLUSIONS

Differences in yield potentials for pastures are influenced by soil group and compared favourably with actual performance. Remedial procedures to correct levels and balance of P, N, K, Ca, Mg and trace elements in soils and pastures would probably improve pasture quality and DM yields. Soil tillage methods that conserve soil organic matter, improve soil structure, reduce soil compaction and increase infiltration rates need to be applied. Soil water drains need to be installed in Estcourt and Katspruit groups.

Keywords: Soil classification, soil potentials, soil quality, pasture production, pasture nutrition,

NUTRITIONAL VALUE AND ROOT GROWTH OF JUTE MELLOW TO WATER AVAILABILITY AND NITROGEN FERTILIZATION

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INTRODUCTION

Jute mallow (*Corchorus olitorius L.*) is an erect annual indigenous leafy vegetable crop classified under the *Tiliaceae* family. It grows well in the tropical and subtropical regions with an annual rainfall range of 600 mm – 2000 mm and temperatures of 15ºC to 38ºC. Jute mallow exhibits therapeutic functions and is nutritionally rich in phyto-chemicals, such as vitamins, phenolics and acts as a source of micronutrients. Despite all these benefits, it is the least studied leafy vegetable with regards to cultural practices that affect root growth and nutritional value. The aim of this study is to investigate the interactive effect of planting density with (1) Water availability and (2) Nitrogen fertilization, on edible fresh biomass (leaves and young tender stems) of Jute mallow, and (3) Root growth response to water and nitrogen fertilization

MATERIAL AND METHODS

Two separate trials were established under rain-shelters at the Agricultural Research Council Roodeplaat experimental site, each trial was a two factorial experiment arranged in a randomized complete block design with three replicates. The irrigation trial consisted of three irrigation levels: Irrigating to fill the profile to field capacity (FC), irrigating to 80% of the plant available water (PAW), and irrigating to 60% of the PAW. Irrigation was applied every fifth day and soil water content was measured a day before irrigation using a neutron probe. The fertilizer trial consisted of three Nitrogen fertilization (LAN) rates: 0, 75, and 150 kg N ha^{-1}. Each fertilizer and irrigation trial was tested under three planting densities, namely: 100 000, 167 000 and 330 000 plants ha^{-1}. Composite raw edible fresh biomass (leave and young tender stems) samples were taken for nutritional content analysis. Destructive and non-destructive root samples were taken in each trial to measure root growth response to water and nitrogen fertilization. Data was analysed using SAS software for Windows v9.3 (Statistical Analysis System Inc., 2002) and the treatment means were compared using Tukey's test at $P < 0.05$ significant level.

RESULTS AND DISCUSSION

The highest population density of 330 000 plants ha^{-1} gave the highest total fresh and dry biomass (leaves and all stems) under water and nutrient non-limiting conditions. However, 167 000 plants.ha^{-1} produced higher edible fresh biomass in contrast to 330 000 plants.ha^{-1}. In addition, high nutritional value (Fe, Zn and K) was attained under 167 000 plant.ha^{-1} using 80%PAW. Full water application increased the root diameter and root dry weight while decreasing root volume. Although nitrogen application rate of 150 kg.ha^{-1},significantly improved root volume and root diameter but nitrogen generally did not affect nutritional value of Jute mallow.

CONCLUSION

The results show that stress irrigation could be applied by leaving room for rain without compromising Jute mallow yield, while saving irrigation water and minimizing nitrate leaching due to an increase in root volume and depth which increased the PAW. The highest nutritional value is attained under 167 000 plant.ha^{-1} using 80%PAW.

Keywords: *Biomass, Irrigation, Planting density*

YIELD AND NODULATION OF INTERCROPPED AMARANTHUS CRUENTUS L AND VIGNA UNGUICULATA L WALP AS AFFECTED BY N FERTILIZER APPLICATION

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INTRODUCTION

Nitrogen is one of the primary nutrients necessary for vegetable production systems, because of its role in increasing yield and quality. To supply N, inorganic sources are commonly utilised, even though their costs are high (Smil, 2002). According to the Food and Agriculture Organisation (FAO), N fertiliser use has increased 7-fold from 1960 to 2000 (Tilman et al., 2002). The incorporation of N-fixing legume crops to intercropping farming systems provide an affordable option for smallholder farmers who cannot purchase or have access to inorganic commercial fertilisers. Therefore, the aim of the study was to test the effect of N in an intercrop system using cowpea and amaranth as test crops.

MATERIALS AND METHODS

This experiments was conducted at the ARC Roodeplaat, Vegetable and Ornamental Plant Institute, Pretoria, summer 2013/2014. Amaranth and cowpea were row-intercropped at 30 cm between plants and rows respectively. Factorial design including three row-intercropping arrangements ($100_{Amaranth}$; $50_{Amaranth}$:50_{Cowpea}; 100_{Cowpea}) and four N fertiliser (0, 75, 150 and 225 kg N ha^{-1} $season^{-1}$) rate treatment combinations were assigned in a completely randomised block design, with three replications. Total biomass (fresh and dry), marketable seasonal yield, leaf area and nodulation were determined.

RESULTS AND DISCUSSION

Yield of both crops increased as a function of the amount nitrogen fertiliser applied. The yield was not significantly influenced by treatment interactions between the intercropping arrangement and N fertiliser applied. Results showed that highest yield was obtained from $50_{Amaranth}$:50_{Cowpea} treatment, though not significantly different from sole cowpea and amaranth treatments. In terms of biomass yield, either fresh or dry, the highest cumulative yield was shown at 150 N $kg.ha^{-1}$. The nodule number and mass were highest at 100_{Cowpea} with no N fertilizer. In terms of intercropping combinations, more nodule number was shown at $50_{Amaranth}$:$50_{Cowpea,}$ with the mass being highest at the control.

CONCLUSIONS

In conclusion, N application reduced nodulation, however increased yield of amaranth and cowpea in an intercrop and as sole crops. Amaranth/cowpea intercropping was beneficial as it performed better than the

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Keywords: Intercropping, fertilisation, inoculation, amaranth, cowpea.

PHENOLIC CONTENT OF AFRICAN GINGER (*SIPHONOCHILUS AETHIOPICUS)* CULTIVATED UNDER DIFFERENT GROWTH CONDITIONS

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INTRODUCTION
African ginger (*Siphonochilus aethiopicus)* is a major medicinal plant with commercial economic value and a history of traditional and modern use in southern Africa (Van Wyk, 2008). Plant derived products have been traditionally used for the treatment of coughs, cold, asthma, headaches and malaria. Due to the increasing interest in the food industry and health care, the improvement and assessment of natural antioxidants from medicinal plant material is crucial. Although antioxidant therapy has an enormous impact in the treatment of many diseases, there is no data on the antioxidant capacity of African ginger organs. This study evaluated total phenolic composition for assessment of their contribution to the antioxidant capacity of African ginger.

MATERIALS AND METHODS
African ginger rhizomes were collected from farmer's fields in Mpumalanga, Western Cape; Eastern Cape, Limpopo and KwaZulu Natal provinces. Rhizomes from W. Cape, E.Cape and Mpumalanga were cultivated under commercial field. Row-to-row and intra-row spacings were 20 and 20 cm, respectively. Five plants were randomly dug up from the field and pooled to make one replicate sample. The plants were separated into leaves, roots and rhizomes and oven dried (50 ^{o}C) for 72 hours before being milled (0.45 mm). Total phenolic content was determined by the Folin-Ciocalteu method and expressed as gallic acid equivalents (GAE), derived from a standard curve. Absorbance was measured in triplicate for all samples at 765 nm using a spectrophotometer. Data was subjected to ANOVA and analyzed using Statistica software.

RESULTS AND DISCUSSION
The data revealed significant differences among African ginger rhizomes collected from different regions of South Africa and cultivated under field conditions. Generally the phenolic content in the leaves were significantly higher in plants from Mpumalanga (57.37±0.00 mgGAE/g). The phenolic content in the rhizomes was slightly higher in plants from Limpopo and Mpumalanga compared to those from the Eastern Cape, Western Cape and Kwazulu-Natal. The differences in phenolic content of the roots, however, were not statistically significant for plants from Mpumalanga (54.54±20.40 mgGAE/g), KZN (56.68±6.92 mgGAE/g) and E. Cape (51.25±15.04 mgGAE/g) compared to plants from the W. Cape (14.55±0.48 mgGAE/g) and those that were collected from Limpopo (32.75±7.08). Roots, in general, exhibited a higher phenolic content compared to rhizomes and leaves irrespective of cultivation systems. The results are in accordance with that reported earlier that medicinal plants are potential sources of natural antioxidants.

CONCLUSION
Our results suggest that the high total phenolic content recorded in different plant organs of African ginger have the potential for antioxidant activity and radical scavenging activity.

Keywords: *Anti-oxidant activity, Medicinal plants, Phenolic content, Plant extracts*

GLUFOSINATE EFFICIENCY ON RYEGRASS AS AFFECTED BY TEMPERATURE

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INTRODUCTION

Glufosinate ammonium (GA) is a non-selective post emergent herbicide used effectively as an alternative for glyphosate and paraquat on the control of annual and perennial grasses in vineyards and orchards (Coetzer et al. 2001). Higher ambient temperatures can increase efficacy of herbicides (Matzenbacher et al. 2014).The objective of the study was to determine glufosinate efficacy on ryegrass as affected by temperature.

MATERIALS AND METHODS

Two glasshouse studies were conducted to determine the effect of temperature on GA efficacy. The experimental factors for the first trial were glasshouse temperature (15/20 and 10/15 ºC night/day) and herbicide rate (0, 2.5, 5, 7.5 and 10 L ha^{-1} of glufosinate ammonium 200 g a.i. L^{-1}). The design was a 2 X 5 factorial arranged in a randomized complete block with four replicates. The experimental factors for the second trial were herbicide rate (0, 2.5, 5, 7.5 and 10 L ha^{-1} of glufosinate ammonium 200 g a.i. L^{-1}) and 4 growth temperatures (1) 15/20 ºC night/day for the whole duration of the trial, 2) 15/20 ºC from seeding to spraying date and then moved to 20/25 ºC night/day from spraying date to evaluation date, 3) 20/25 ºC from seeding date to spraying date and then 15/20 ^{0}C from spraying date to evaluation date and 4) 20/25 ºC for the whole duration of the trial. Seedlings in both trials were evaluated six weeks after spraying and the percentage control were calculated.

RESULTS AND DISCUSSION

In the first trial a significant interaction occurred between temperature and GA efficacy. GA at all but the highest dosage rate was significantly more efficient at the lower temperature than at the high temperature. The efficacy of GA was intermediate where the plants were moved between temperatures after spraying. Efficacy of GA was greater but not significantly so when plants were moved to the cooler temperature after spraying than *vice versa.*

CONCLUSION

The efficacy of GA on ryegrass is significantly higher at cooler than warmer temperatures. It appears as if temperature after spraying plays a bigger role on efficacy than temperature before spraying.

Keywords: glufosinate ammonium efficacy, non-selective herbicide, ryegrass, temperature

COMPARISON OF THE EFFECTS OF ORGANIC FERTILIZERS ON THE GROWTH AND LEAF NUTRIENT CONCENTRATIONS OF *MACADAMIA INTEGRIFOLIA* UNDER SUB-TROPICAL ENVIRONMENT OF SOUTH AFRICA.

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INTRODUCTION

South African soils in general are low in organic matter content. Incorporating organic base fertilizers into the soil could be beneficial by enhancing soil structure and texture and improving soil organic matter content. Organic matter in soil improves water infiltration and enhances soil water retention. As the organic materials break down both macro and micronutrients are released and become available for plant uptake. Declining soil fertility, high cost of inorganic fertilizers and desire to conserve the environment has directed the attention of smallholder farmers towards organic base fertilizers. The objective of this study was to assess the growth responses and leaf nutrient concentrations of *Macadamia Integrifolia* trees to different organic base fertilizers.

MATERIALS AND METHODS

A field experiment was carried out for three consecutive years (2012–2014) at the Institute for Tropical and Subtropical Crops in Nelspruit, South Africa, to establish the effect of different organic base fertilizers on the growth and leaf nutrient concentrations of macadamia plants. Sixty plants, uniform in growth and in as good physiological condition as possible were selected and fed with different organic base fertilizers. The treatments consisted of Vermicompost, Cattle manure, Chicken manure and Control (without fertilizer) laid in a completely randomized block design with five replicates.

RESULTS AND DISCUSSION

The application of organic fertilizers induced significantly the growth of macadamia trees. In all the three years, plant heights were significantly higher ($p<0.01$) on macadamia plants grown on soil treated with Vermicompost (2.07m) followed by those grown on soil amended with cattle (1.84m) and chicken manure (1.80m). The lowest plant heights were observed on the macadamia plants grown on soil without fertilizers. Except for control, there was no significant different on stem diameter among the three organic base fertilizers. Plants fertilized with Vermicompost had significantly higher nitrogen (1.50%), phosphorus (0.09%) and manganese (924mgkg^{-1}) content than those fertilized with animal manures. Trees grown on soil without fertilizers had significantly low value of all nutrient elements except for zinc.

CONCLUSIONS

The study has concluded that that the application of organic base fertilizers especially Vermicompost enhances the growth and leaf nutrient concentrations of macadamia plants.

ACKNOWLEDGEMENTS

Funding was provided by the ARC-ITSC (Grant number 571026).

Keywords: organic base fertilizer, leaf nutrient, macadamia, sub-tropical environment.

IMPROVING PHOSPHORUS AVAILABILITY USING BIOCHAR

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INTRODUCTION

Inadequate soil moisture and poor soil fertility are some of the most challenging factors that limit crop production. Phosphorus (P) is one of the limiting nutrients in North West Province of South Africa soils and its deficiency results in reduced nutrient uptake, hence reduced plant growth and yields. This study was conducted to determine the adsorption of P in selected soils in North West Province in the absence or presence of biochar.

MATERIAL AND METHODS

The batch equilibration laboratory experiment was conducted using soils collected (0-15 cm) from Rustenburg and Mafikeng with the pH level 6.34 and 4.07. The soil was analysed for physical and chemical properties, while biochar was analysed for chemical properties. The soil (2 g) was amended with biochar at rates of 0, 0.002 and 0.004 g. Samples were equilibrated with 5ml of 0.01M KCl solution containing seven P (KH_2PO_4) concentrations ranging from 0 to 30 mg/L in a shaker for 24hrs at temperatures of 15, 25 and 35 °C. Samples were centrifuged at 10 000 rpm for 30min then filtered. The experimental layout was a completely randomised design (CRD) with a factorial treatment structure and three replications. The amount of P adsorbed was calculated from the difference between the amount of P added in concentrations and the remaining concentration in solution.

RESULTS AND DISCUSSION

The location had significant effects ($P < 0.001$) on phosphorus adsorption. Rustenburg soil had significantly ($P < 0.001$) higher final concentration of P in solution after equilibrium (1.25 mg/L) as compared to Mafikeng. The higher adsorption rate at Rustenburg might be attributed to the soil physical properties such as higher clay percentage. The application rate of biochar at both locations significantly ($P < 0.05$) affected P adsorption. The higher application rate of biochar significantly ($P < 0.05$) reduced amount of P sorption compared to the other treatment. The higher phosphate concentration significantly ($P < 0.05$) affected available soil P. P sorption increased with the increasing P application in both locations. Langmuir equation was best fitted in the P sorption data.

CONCLUSION

Application of biochar improved P availability in both locations of high P-sorbing soils, which will in turn reduce the amount of fertilizer P necessary to optimize yields in these soils.

***Keywords**:* adsorption, biochar, phosphate

VOLATILE ORGANIC COMPOUNDS FROM GERMINATING SEEDS OF CYCLOPIA SPECIES AS AFFECTED BY TEMPERATURE

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INTRODUCTION

Metabolic changes in seeds during imbibition and germination liberate metabolites known as volatile organic compounds (VOCs). VOCs are related to the amount of organic substances present in the seeds and act by either inducing or inhibiting seed dormancy. Internal seed control mechanisms responsible for triggering germination vary as a result of the mother plant altering resource allocation during seed development. Abiotic factors such as temperature (thermodormancy) can affect seed organic substances. *Cyclopia* (honeybush) is a herbal tea legume endemic to the Western and Eastern Cape Provinces of South Africa. *Cyclopia* species have a great economic value but present horticultural problems; a dearth of detailed information on seed physiology and germination characteristics hampers production and cultivation. The objective of this study was to determine VOCs from germinated *Cyclopia* seeds at different temperatures in relation to seed dormancy.

MATERIALS AND METHODS

VOCs from seeds of *C. subternata* and *C. genistoides,* germinated at different temperatures, were detected using headspace solid-phase micro extraction (HS-SPME) and gas chromatography-mass spectrometry (GC-MS). Seeds germinating on moistened double filter paper in Petri dishes were incubated in a growth chamber and put inside GC-MS vials for analysis. Vial headspace was sampled using a SPME grey fibre (divinylbenzene/carboxen/polydimethylsiloxane) conditioned in the GC injection port at 240 °C for 30 minutes. VOCs were identified by matching mass spectrometric fragmentation patterns corresponding to various peaks with those present in the Wiley 275 library mass spectral database.

RESULTS AND DISCUSSION

Seeds of both *Cyclopia* species liberated a number of alcohols, esters, ketones, aldehydes, carboxylic acids, hydrocarbons and other chemical classes that are known either to inhibit or induce seed germination depending on seed age, genetic profile and extrinsic variables such as temperature. Generally, *C. genistoides* released more compounds than *C. subternata*. Similar compounds were detected in both species. A majority of compounds emitted were fungal volatiles with known inhibitory effects on plant pathogens, and diverse roles as sources of mycodiesel, mycofumigation and semiochemicals. Non-germinating but fully imbibed seeds also evolved volatiles, indicating active seed metabolism.

CONCLUSIONS

The levels of VOC emissions from *Cyclopia* seeds were found to be temperature dependent and varied quantitatively and qualitatively. Volatiles associated with inhibitory or inductor properties in plants may thus be expected to impact on seed dormancy in *Cyclopia* species.

Keywords: *Cyclopia*, germination, temperature, volatile organic compounds

THE CONTRIBUTION OF MANGANESE OXIDES TO REDOX BUFFERING IN SELECTED SOILS OF THE SOUTH AFRICAN HIGHVELD

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INTRODUCTION:
Certain hydric soils lack the redoximorphic features that are commonly expressed in saturated or seasonally saturated soils. An Eexamples is are the lack of mottles in the dolomitic soils of an area in Centurion, but the expression of this feature in a hydric soil nearby in the Halfway House granites. This indicates possible redox poise in the dolomite-derived soils. Differences in redox buffering is are generally attributed to the amount / presence of electron acceptors (e.g. Mn^{4+}, Mn^{3+} and Fe^{3+}), contrasting mineralogy, texture and CEC as well as more transient properties like acidity and alkalinity. The aim of the study was to investigate the role Mn oxides play in redox buffering of soils of different geologies.

MATERIALS AND METHODS:
Samples were collected and subjected to the following: 1) air dried 2) placed in a cold room at 5°C to maintain field moisture 3) subjected to chemical extractions which included hydroxylamine (which is selective for dissolution of Mn oxides), acid ammonium oxalate (to determine amorphous Al, Fe and Mn) and dithionite-citrate (to determine total Al, Fe and Mn). Samples were analysed by ICP-AES for Al, Fe, Mn and metals co-precipitated with manganese oxides. Redox experiments, i.e. manganese electron demand (MED) and total electron demand (TED) were also conducted on all samples.

RESULTS AND DISCUSSION:
The reducible Mn (Mn^{4+} and Mn^{3+}) concentration was highest in the dolomite derived soil. The dolerite and vertic soils had considerably higher concentrations of reducible Mn, although not as high as the dolomitic soil. Soils derived from quartzite and granite had lower concentrations of reducible Mn. This is expected due to the mineralogy difference between the soils with dolomite derived soils having a much higher Mn content. Field observations show that redoximorphic features are expressed in the quartzite and granite soils (low reducible Mn) and not expressed in the dolomite soil (high reducible Mn). Results from chemical redox experiments indicated that the dolomite soil had a higher MED than the dolerite soil with the other soils having negligible MED. All samples showed a TED, however a similar trend to MED was seen, with the dolomite soil having the highest TED, followed by the dolerite, then the vertic and lastly the quartzite and granite.

CONCLUSIONS:
The dolomite derived soil had appreciably more reducible Mn than soils derived from the other geologies sampled. Furthermore, both TED and MED tests suggested that the dolomite soil had an inherently stronger oxidising (electron accepting) tendency than the other soils. This links the absence of redoximorphic features to the presence of high levels of Mn^{4+} and Mn^{3+} in these soils. Redoximorphic features are important criteria in wetland delineation which has broader implications for urban development especially in Gauteng where manganiferous soils are more commonly found.

Keywords: *Manganese; redoximorphic features; redox buffering.*

CHEMICAL COMPOSITION OF BABY SPINACH (*SPINACIA OLERACEA* L.) AS AFFECTED BY NITROGEN, PHOSPHORUS AND POTASSIUM NUTRITION

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Introduction
Spinach (*Spinacia oleracea* L.) is an edible flowering plant in the family Amaranthaceae (LeStrange et al., 1999). Baby spinach is considered to be one of the most nutritious vegetables, as it is both rich in phytochemicals and minerals. Growing baby spinach is a fairly new concept that has grown in popularity in recent years because of its high nutritional value. Baby spinach is known to be rich in those nutrients that are essential for normal physiological functioning, but also has high levels of phytochemicals which are believed to help prevent chronic health illnesses such as cancer and heart disease, as well as other health complications associated with ageing (Hedges & Lister, 2007; Mehta & Belemkar, 2014). The purpose of the study was thus to investigate and quantify the variations in bioactive compounds such antioxidants, flavonoids, total phenols and carotenoids together with that of the mineral content (magnesium, zinc, iron and selenium) in baby spinach when grown under a specific mineral nutrition regime during cultivation in a protected environment.
Materials and methods
Three nitrogen (N), phosphorus (P), and potassium (K) parallel trials were conducted on spinach grown under protected environment. Treatments consisted of 0, 45, 75, 105, 120 kg·ha^{-1} N and P; and 0, 63, 85, 106, 127, 148 kg·ha^{-1} K in a randomized complete block design (RCBD) with 5 treatments for N or P and 6 treatment for K replicated 4 times. The optimum rates of N, P and K were then used to formulate a fourth trial of a combined NPK treatment in the following ratios: 0 (control), 30:30:40, 45:45:60, 60:60:70, 75:75:90 kg·ha^{-1}, arranged in a RCBD with three replicates. Fertilizer sources used were limestone ammonium nitrate (LAN, N=28%) for the N trial, superphosphate (P=83%) for the P trial and potassium chloride (K=50%) for the K trial. N, P and K fertilizers were supplied as side dressed applications in the form of granules at two weeks after sowing. Analysis of the bioactive compounds was conducted using reversed-phase high-performance liquid chromatography (HPLC) hence minerals were analysed using AOAC method and data was subjected to analysis of variance (ANOVA) using the SAS version .
Results and Discussion
Total phenols, total antioxidants activity, total flavonoids and vitamin C increased with an increase in N, P and K concentrations, reaching maxima at 45 kg·ha^{-1} N, 75 kg·ha^{-1} P and 85 kg·ha^{-1} K. However, these treatments did not have a significant effect on the uptake and accumulation of minerals such as magnesium, iron, zinc and selenium. Where NPK fertilizers were applied, the treatment combination of 45:45:60 kg·ha^{-1} NPK improved concentrations of total phenols, total carotenoids, total antioxidants activity and total flavonoids.
Conclusions
Based on the findings of the study, in order to optimise bioactive compounds in baby spinach, application of 45 kg·ha^{-1} N, 75 kg·ha^{-1} P and 85 kg·ha^{-1} K is recommended if applied as single elements, but a treatment combination of NPK (45:45:60 kg·ha^{-1} NPK) is recommended. The application of N, P and K did not have any significant effect on selected minerals in baby spinach.

Keywords: baby spinach, bioactive compounds, chemical composition

VIABILITY OF SEED PRODUCED BY GRASSES GROWN IN MINE TAILING MATERIALS

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INTRODUCTION

The adverse properties of mine tailing materials, such as extreme pH conditions, provide hostile growth conditions for vegetation and can compromise the viability of offspring seed. The hypothesis is that seed can become sterile once exposed to hostile growing conditions, for example low pH due to the oxidation of pyrite in gold mine tailing materials.

MATERIALS AND METHODS

The viability of the offspring seed was determined through a pot trial study and additional germination testing. Seed were harvested from grasses established in eight different mine tailing materials and were sown and replicated in a red soil. The germination results were statistically correlated with the soil analyses from the mine tailing materials, which indicated several significant correlations.

RESULTS AND DISCUSSION

According to the Repeated Measures ANOVA statistical analysis, there was a significant influence of the mine tailing materials, in which the parent grass were grown, as a variable on the germination of the progeny seed batches from *Cenchrus ciliaris*, *Chloris gayana*, and *Digitaria eriantha*, indicating that the environmental factors as attributed by the mine tailing materials and experienced by the maternal plant, did indeed influence the germination of progeny seed. *Chloris gayana* seed had poor germination percentages, especially seed harvested from grass grown in gold tailings. Seed harvested from *Eragrostis. curvula* grown in various mine tailings, had excellent germination percentages. From these results it is evident that certain grass species are more susceptible to sterility when exposed to the hostile conditions of mine tailing materials.

CONCLUSIONS

The viability of seed is vulnerable to and threatened by the adverse properties of mine tailing materials. The pH is potentially the greatest determining property of mine tailing materials with regard to seed production and viability. In terms viability of offspring seed, certain grass species are more suitable for sustainable rehabilitation of specific mine tailing materials.

ACKNOWLEDGEMENTS

The financial support by Advance Seed is greatly appreciated

Key words: mine waste, mine tailings, pH, seed viability, sustainable rehabilitation.

ADDITIONAL IRRIGATION AT HIGH AIR TEMPERATURES REDUCES SUNBURN IN 'GOLDEN DELICIOUS' APPLE

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INTRODUCTION

High irradiance and extreme fruit surface temperatures (46 to 49 ºC) induce sunburn in apples and pears. Sunburnt fruit are not suitable for export, resulting in loss of earnings for the growers. Up to 50% of the total yield may be unmarketable due to sunburn (Wand et al; 2006). The aim of this research was to examine the effects of pulsing irrigation, used as a sunburn control measure, on soil water status, canopy environment, leaf ecophysiology, vegetative growth and fruit quality of 'Golden Delicious' apple.

MATERIALS AND METHODS

Experiments were conducted during the 2013-14 season in a 'Golden Delicious' orchard at Meulrivier farm, Greyton, South Africa (Lat.: 34°06'S; Long.: 19°47'E). The orchard was planted in 1998 on M793 rootstock at a spacing of 4 x 1.5 m and an N S row orientation. Treatments consisted of a control irrigated according to the scheduling of the farm using microsprinklers and three treatments that received normal irrigation plus pulsing at 25, 37 and 75 L h^{-1} when ambient air temperatures reached 30 °C with a cycle of 5 min on and 20 min off. The system switched off at ambient temperatures <30 °C. Soil volumetric water content (upper 30 cm) was continuously measured. Leaf gas exchange was measured before the beginning of the experiment at 84 days after full bloom (DAFB), and at 102 and 116 DAFB. A representative scaffold branch was strip picked at commercial harvest on both sides of the tree providing samples of >100 fruit per tree for assessment of sunburn incidence and severity, and green colour intensity. Fruit size, weight and internal quality were measured on a 20-fruit subsample. Vegetative growth was measured by weighing one-year-old water shoots removed during winter pruning.

RESULTS AND DISCUSSION

Soil volumetric water content was increased by pulsing irrigation. Pulsing irrigation reduced canopy maximum temperature and increased relative humidity. Stem water potential was increased and there was a positive effect on photosynthesis. Even though leaf and fruit surface temperature were not affected, sunburn incidence and severity was reduced by irrigation pulsing. Vegetative growth was significantly increased and could be the reason for the decrease in sunburn. A negative effect on fruit colour and total soluble solids was also observed.

CONCLUSIONS

Pulsing irrigation reduced the occurrence of sunburn and had beneficial effects on net photosynthesis, soil and plant water status. It also modified the microclimatic environment inside the tree canopy.

***Keywords**:* pulsing irrigation, canopy environment and sunburn

INFLUENCE OF NEW WHEAT RUST RACES ON BREEDING FOR RUST RESISTANCE

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INTRODUCTION

Stripe, leaf and stem rust are serious wheat diseases and are responsible for significant wheat yield losses. Wheat rusts can be chemically controlled but due to high costs of chemical applications and the negative impact on the environment, genetic resistance is a more sustainable method for rust control. The emergence of new rust races is a challenge when breeding for rust resistance and has led to the adoption of gene pyramiding to enhance durability of wheat rust resistance.

MATERIALS AND METHODS

Annual rust surveys are conducted to identify the distribution of rust races in the different wheat producing areas as well as to identify the presence of new races. Rust infected samples are collected from the different areas and these samples are pathotyped at Small Grain Institute (SGI) by characterizing their virulence using a differential set containing specific rust resistance genes. Crossing blocks are annually implemented to incorporate rust resistance genes into spring and winter wheat lines. Gene donors for these crossing combinations are selected according to rust races that are present in South Africa.

RESULTS AND DISCUSSION

Over the last 10 years, 10 new rust races were identified in South Africa. This includes four races for stem rust, five races for leaf rust and one race for stripe rust. Several important rust resistance genes that were used in the past were found to be virulent to these races. The rust pre-breeding program at SGI actively breeds for wheat rust resistance using race specific resistance combined with non-race specific resistance. Various gene combinations are explored in the program and several lines with effective rust resistance have been developed.

CONCLUSIONS

Rust surveys are essential in identifying the distribution of rust races and to identify new races that could pose a serious threat to wheat production. Breeding for wheat rust resistance is a continuous initiative that explores new sources of rust resistance and gene combinations. Several wheat lines with effective rust resistance have been developed and are available to breeding programs in South Africa.

ACKNOWLEDGEMENTS

The authors acknowledge the Winter Cereal Trust for funding and CIMMYT for germplasm.

Keywords: Stripe rust, Leaf rust, Stem rust, Durable rust resistance

BUILDING A SUSTAINABLE MEDICINAL PLANT VALUE CHAIN. A CASE OF *SIPHONOCHILUS AETHIOPICUS* (AFRICAN GINGER) AND *HYPOXIS HEMEROCALLIDEA* (AFRICAN POTATO)

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INTRODUCTION

Wiersum *et al*1[1] reports that the intensive harvesting of wild medicinal plants due to increasing use has in many cases resulted in overexploitation. Alternative options for relieving human pressure on wild medicinal plants are needed and cultivation on a commercial scale is ideal in maintaining and creating financial viability. In order to achieve this, developing a sustainable value chain is crucial.

MATERIALS AND METHODS

Value chain analysis is used to identify key activities within the supply and market chain of the two medicinal plants. The study uses this approach because it is intended to provide a systematic knowledge of the flow of goods and services from their origin to their final destination. A cross-sectional research design was implemented and data was collected from a sampling unit of producers, processors, traders and consumers of African potato and African ginger. Data is quantitative and qualitative and tabular analysis was done to interpret data with the use of Statistical Package for Social Sciences (SPSS).

RESULTS AND DISCUSSION

The study maps out a clear market chain for African ginger and African potato linkages between processors, processes and activities. The value chain for both medicinal plants includes the processed and raw products which are sold in informal and formal markets. The chain has key players such as hawkers, small traders, processors, input suppliers and end users (consumers). There are a few processing industries for the two medicinal plants and they use very small amounts of the raw product. The market at the end users point is significantly large, but consumers' purchase more of the raw product and other products that are prescribed by their traditional healers. Processing facilities are required in the rural areas where most of the producers are located.

CONCLUSION

The results of this study show a possibility of developing African potato and African ginger into commercially viable products that can be adopted by smallholder farmers. Proper structures in the supply chain should be instigated and this can be aided by an increase in the productivity of these medicinal plants.

Keywords: Medicinal plants; African Ginger; African Potato; Value chain analysis

EFFECTS OF NITROGEN FERTILIZATION ON GROWTH, YIELD AND QUALITY OF

BANA AS A BIOMASS CROP.

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INTRODUCTION

High yielding perennial tropical grasses like bana grass (*Hybrid Pennisetum*) have potential for lignocellulosic biomass production. However, there is paucity of information to guide its production as a biomass crop in South Africa. This study was aimed at characterizing growth performance, yield and chemical composition of bana grass.

MATERIALS AND METHODS

An experiment was established as a randomized complete block design (RCBD) with three blocks. Each plot measured 8 m x 5 m and inter-and intra-row spacing was 1 m x 0.5 m. Six nitrogen levels 0, 75, 150, 225, 300 and 375 kg N ha^{-1} were applied in two equal split applications, one at the beginning of the season in early December and the other at the end of January. Canopy height, leaf area index (LAI) and light interception (LI) was measured, bi-weekly, for each plot. Yield was estimated at the end of the growing season by harvesting herbage in four 2 m^2 quadrats from each plot. Harvested herbage was weighed and sub-sampled for dry matter (DM) determination. Ten representative tillers were hand-separated into leaf and stem components. All sampled materials were oven-dried at 70ºC to constant weight and later analysed for ash, nitrogen (N), neutral detergent fiber (NDF), acid detergent fiber (ADF) and gross energy (GE).

RESULTS AND DISCUSSION

Canopy height, LAI, LI and DM yield increased significantly (p<0.0001) with N fertilization. End of season DM yield was 8.00, 15.25, 20.54, 24.36, 27.39 and 30.00 t $DMha^{-1}$ when bana was fertilized at the rate of 0, 75, 150, 225, 300 and 375 kg N ha^{-1}, respectively. The ADF for composite, stem and leaf increased significantly (p<0.0001) with N fertilization and ranged from 403.5- 512, 468.4-544.1 and 395.7-500.3 g kg^{-1}DM, respectively. The respective NDF ranges were 599.2-727.5, 614.6-750.4 and 599.4-672.3 g kg^{-1}DM. The average N content for the composite samples was 3.50, 4.10, 4.60, 6.30, 7.60, and 9.30 g kg^{-1}DM for 0, 75, 150, 225, 300 and 375 kg N ha^{-1} respectively. The corresponding N values for leaf were 4.90, 7.60, 8.10, 8.80, 9.30 and 9.70 g kg^{-1} DM and for stem 2.70, 3.30, 3.70, 5.90, 6.30 and 7.80 g kg^{-1} DM. Ash content decreased significantly (p<0.0001) with N fertilization and ranged from 45.5-85.5, 42.5-76.5 and 33.5 - 80.5 g kg^{-1} DM for composite, stem and leaf, respectively. Average GE content increased curvilineal (p<0.001) with N application and ranged from 16.26-16.34,15.57-16.10 and 14.70-15.93 MJ kg^{-1}DM, for composite, stem and leaf, respectively.

CONCLUSION

Nitrogen fertilization increased biomass and lignocellulose content of bana. The ranges of ash, N and energy contents of bana indicate that species has potential as a biomass crop. The produced biomass could be used for bioenergy and/or chemical production.

Keywords: bioenergy, lignocellulose material, Pennisetum.

THE EFFECT OF BACTERIAL BASED BIO-FERTILISERS AND CYTOKININ ON THE EMERGENCE OF SUNFLOWER AT SUPRA-OPTIMAL TEMPERATURES

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INTRODUCTION

Subsurface sunflower (*Helianthus annuus* L.) seedling growth often deteriorates on sandy textured soils due to supra-optimal temperature levels leading to poor emergence and sub- optimum plant population densities. It has been shown that seedling growth is enhanced by the application of plant growth-promoting rhizobacteria and cytokinin. The possibility therefor exists that the poor emergence problem might be remedied through the use these applicants. The objective of this investigation was to determine if commercially available bacterial based bio-fertilisers and cytokinin can enhance the seedling vigour of subsurface sunflower seedlings in controlled ambient temperatures ranging from non-limiting to supra-optimal and in unregulated field conditions.

MATERIALS AND METHODS

Untreated sunflower seed and seed treated with cytokinin and four bacterial based bio-fertilisers were planted 25 mm deep in wet sand in a temperature controlled environment. A series of day time ambient temperatures, varying from not limiting to supra-optimal, were applied for 7 days and the emergence of seedlings recorded. The procedure were repeated in a field trial under uncontrolled conditions at three planting dates. A randomised complete block design was used for the trial layout. Seedling vigour as presented by the emergence index, (index of the rate and percentage emergence), were calculated and compared for the different seed treatments, ambient temperature regimes and planting dates through an analyses of variance.

RESULTS

The seedling vigour as affected by cytokinin and the bio-fertilisers, was inconsistent over a range of temperatures. However, considering only the supra-optimal temperatures where heat stress usually supresses emergence, two of the four bio-fertilisers (Biozone 125 S, B-Rus and Landbac) and (Arise Liquid) resulted in equal or higher emergence indices and/or emergence percentages than the untreated control.

CONCLUSION

The results suggest that there are conditions where bacterial based bio-fertiliser and cytokinin can alleviate the damaging effect of supra-optimal temperatures on the emergence of sunflower. However, the effect of these applicants on various cultivars and soil conditions require more investigation.

Keywords: Plant growth-promoting rhizobacteria, seedling vigour.

DEVELOPING A SANITATION MODEL TO REDUCE POSTHARVEST DECAY OF POTATO TUBERS

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INTRODUCTION

Postharvest soft rot of potato tubers caused by *Pectobacterium carotovorum* subsp. *carotovorum* (*Pcc*) is a serious disease causing severe losses of potatoes during storage. Consumer demands for more natural and less toxic alternative sanitizers has led the industry into developing different fresh produce sanitizers, as well as preventative methods for soft rot. The aim of this study was to determine the efficacy of existing and new sanitation products/protocols to assist in developing an integrated sanitation protocol that would successfully and safely reduce post-harvest decay of potatoes.

MATERIALS AND METHODS

Chemicals were first tested *in vitro* to determine their efficacy and dosage response against Pcc bacteria. Chemicals included: HTH®, SporeKill®, Product B [biological product from Cool Ideas], Product C [registered sanitizer from TAT] and Product D [registered sanitizer from Agchem Africa]. Chemicals were then tested in a postharvest potato wash experiment on cultivars Mondial and Fianna tubers using a commercial potato washing machine. Tubers were artificially damaged using a table fork to create wounds as entry point for bacteria and inoculated by immersion in liquid inoculum of Pcc. Treated tubers were air-dried, packaged in potato bags, incubated at room temperature and evaluated overtime for visual signs of rotting. Three replicates of ten tubers were used per treatment.

RESULTS AND DISCUSSION

Tubers of cv. Mondial showed to be highly susceptible to soft rot (100% soft rot incidence at day 35) compared to tubers of cv. Fianna (46% soft rot incidence). According to Visser (2012:85) cv. Mondial is a very susceptible cultivar to soft rot and blackleg. Treating Pcc infected tubers with post-harvest sanitizers had a significant effect ($p=0.001$) in reducing soft rot. Product C and SporeKill® were the most effective chemicals in the control of Pcc, and reduced soft rot incidence by 43% and 17% on cv. Mondial potatoes and by 23% and 30% on cv. Fianna potatoes, respectively.

CONCLUSIONS

Pectobacterium tolerant potato cultivar (Fianna) can reduce soft rot incidence. Applying an effective postharvest sanitizer during potato wash can further reduce the incidence by up to 43%. The combination of Pcc tolerant cultivar and an effective post-harvest treatment can therefore potentially reduce post-harvest soft rot incidence by more than 70%.

ACKNOWLEDGEMENT

Potato South Africa and Agricultural Research Council are acknowledged for funding of this work.

Keywords: *Dickeya*, inoculation, *Pectobacterium* (Pcc), soft rot

A SIMPLE TECHNIQUE TO EVALUATE THE EFFECT OF A DEFINED PERIOD OF WATER STRESS ON POTATO VARIETIES

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INTRODUCTION

South Africa is a country with limited water resources. The development of potato varieties with improved drought tolerance is therefore important. This study focused on the development of an inexpensive but reliable method to evaluate the effect of periods of water stress on potato breeding lines developed in the local potato breeding program.

MATERIALS AND METHODS

A greenhouse pot experiment was conducted during April/May 2014. Well sprouted seed tubers of 11 potato varieties were planted in plastic pots filled with a mixture of topsoil, sand, vermiculite and 3:2:1(25) fertiliser. The trial layout was a split-plot design, with two irrigation treatments (adequate and a stressed irrigation). The water stress was induced by withholding water during tuber initiation. As soon as Up-to-Date (drought susceptible) showed symptoms of water stress (wilting), irrigation was resumed. Plants were evaluated with regards to plant height, tuber yield, and tuber number, cooking type, tuber flesh colour, tuber flesh disintegration, discoloration, crisp colour and specific gravity.

RESULTS AND DISCUSSION.

Mondial had significant higher plant height in both the irrigated and stressed treatment. Mondial also had significant higher fresh tuber yield, followed by BP1 and Pentland Dell. However, BP1 initiated the highest number of tubers, followed by Mnandi and Pentland Dell, and this was also significant. The tuber cooking type, flesh colour, flesh disintegration, and flesh discoloration (after cooking darkening) were not significantly different between adequate and stress irrigation. Contrary to the expected, the tuber chip colour and specific gravity did not differ significantly between the treatments. Traits such as tuber growth cracks, malformation and internal brown spot (IBS) are important factors in water management. This was not displayed in this study probably due to the stage of growth when stress was applied. It is important that the technique employed should also initiate these symptoms to be effective as a reliable screening tool.

CONCLUSION

As expected, the plant height, potato yield and potato tuber weight varied amongst varieties, but the quality traits, i.e. cooking, fry colour and specific gravity were not influenced significantly by the induced moisture stress. This screening technique should be refined to also induce tuber malformation, growth cracking and IBS.

Keywords: Potato, Water stress

GROWTH AND YIELD RESPONSE OF KENAF *(HIBISCUS CANNABINUS* L) CULTIVARS TO NITROGEN REGIMES UNDER DRYLAND CONDITION

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INTRODUCTION

Kenaf (*Hibiscus cannabin's* L), responds well to added fertilizers depending on the soil nutrient status, cropping history and other environmental and management factors. Sufficient nitrogen fertilization will enhance growth and bast fibre production. High levels of nitrogen may promote the uptake of other essential nutrients, but can also have a negative effect on fibre content. The economic balance between these factors needs to be determined. Although it is important to grow strong healthy plants, the main aim is to produce a large amount of good quality fibre. Therefore, the objective for this study is to determine minimum N fertilization rate that produce optimum Kenaf yield under rainfed conditions.

MATERIAL AND METHODS

The study was conducted under varied climate and rainfall condition at Winterton (KZN) and Rustenburg (NW) during 2013/2014 growing season. The trials were laid in split-plot design with main plot being cultivar: Elal 1 and Raz 2 and sub plot being nitrogen level (0, 40, 80, 120, 160 kgN ha^{-1}). The application of nitrogen fertilizer was split into two, 60% of required nitrogen was applied four weeks after planting and 40% 8 weeks after planting. Plants were harvested manually at flowering stage (Duke and Ducellier, 1993). A sample dry stem yield ($kg.ha^{-1}$) of one meter stalk was put into an oven to dry for 5 days at 60 ^{o}C. Then fibre yield(%)The weight of bast in the above ground dried stalk divided by dry stalk mass x100 fibre quality was measure in terms of reed length, bundle breaking tenacity and elongation at break.

RESULTS AND DISCUSSION

There were significant differences ($P \leq 0.05$) observed in fresh biomass, green stem, dry stem yield and fibre yield of cultivars as influenced by nitrogen, cultivars and cultivar x nitrogen interactions. Kenaf yield tends to increase with increase in nitrogen regimes for both cultivars and localities. At Rustenburg, Elal 1 (322 t ha^{-1}) and Raz 2 (304 t ha^{-1}) obtained the highest fresh biomass yield with 160 kg Nha^{-1}. These yields were respectively 80% and 77% higher than when 0 kgN ha^{-1} was applied. Similarly, dry stem yield was higher when 120 and 160 kgN ha^{-1} was applied compare to lower N-regimes. Fibre yield varied significantly under nitrogen regimes ($P \leq 0.05$) at both localities. At Winterton, Elal 1 obtained the highest fibre yield of 16 t ha^{-1} with 160 kgN ha^{-1} application and also, Raz 2 yielded the highest at Rustenburg with 19 t ha^{-1} at the same N-regime .

CONCLUSION

The minimum nitrogen application rates to produce optimum Kenaf fibre yield were observed to be 120 kgN ha^{-1} and 160 kgN ha^{-1} at both Winterton and Rustenburg localities and cultivars.

Keywords: Kenaf, Nitrogen regimes. Elal 1, Raz 2

QUANTIFYING SUGARCANE CULTIVAR DIFFERENCES AND GENOTYPE X ENVIRONMENT INTERACTIONS FOR STALK PHENOLOGY TRAITS

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INTRODUCTION

The Canegro sugarcane model uses cultivar coefficients to simulate the effects of genotype, environment and management on crop performance. The current coefficients in the Canegro model are limited to data from the cultivar NCo376 and estimates for a wider range of cultivars are not available for key growth parameters. The primary objective of this study was to quantify the cultivar coefficient values for some tillering and stalk elongation traits for a diverse range of sugarcane cultivars. An additional objective was to determine the stability and heritability of these traits across environments and crop stages to determine their potential contribution to future model-assisted breeding.

MATERIAL AND METHODS

Three cultivar trials were established at three separate sites on SASRI research farms; Amatikulu (AK), Pongola (PG) and Bruynshill (BH). The same set of 12 cultivars was tested at the three sites. The trials were planted in randomized block designs with four replications and harvested for two crops. The cultivar traits peak tiller population (PTP), thermal time to peak tiller population (TTPP), final population (FPOP), tiller survival percentage (TSP) and stalk elongation rate (SER) were derived from measurements of stalk population and stalk height at two-week intervals together with relevant temperature data from automatic weather stations. Cultivar rankings across sites and across crops within sites were evaluated for stability. The data was analysed using GENSTAT to estimate the variance components and broad-sense heritability for each trait.

RESULTS

The highly significant ($p<0.001$) effect of cultivar (C) was larger than the cultivar x ratoon (C x R) and cultivar x site (C x S) effects for all traits studied. Mean trait values for most traits differed significantly between sites and ratoons within sites. Cultivars generally showed consistent rankings for PTP, TTPP, TSP, and SER across sites for individual crops. Cultivars also showed consistent rankings across ratoons within a site for PTP, FPOP, SER and TTPP. This suggests that grouping of cultivars into low, moderate, and high range values for these traits may be a possibility. In contrast; cultivar rankings were different across ratoons for TSP. This means that TSP cannot be adequately represented with plant crop values only. Broad sense heritability estimates were 64, 67, 80, 92, and 92% for TTPP, TSP, PTP, FPOP and SER, respectively. The traits PTP, FPOP and SER are therefore largely genetically controlled and can be selected for in a breeding program.

CONCLUSION

The relatively stable rankings of cultivars across sites and crops suggest that some traits can be quantified per cultivar by single-site and single-crop experiments in future. The cultivar coefficient values determined here will help refine the crop model's ability to simulate cultivar growth differences across environments. The range of values for these traits will also contribute to model-wise exploration of genotype x environment interactions and future model-assisted breeding efforts for sugarcane.

Keywords: cultivar, genetic traits, heritability, sugarcane

EVALUATING RAINWATER HARVESTING AND CONSERVATION TECHNIQUES ON THE TOWOOMBA/ARCADIA ECOTOPE

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INTRODUCTION

In the semi-arid areas of the Sub-Saharan Africa water and soil fertility are the main factors limiting dryland crop production. These areas are characterized by low and poor rainfall distribution. This limited rainwater is mostly lost through runoff and evaporation, which result in low soil moisture availability and possible crop failure. Therefore, techniques that reduce these water losses are important for improving dryland crop production and rainwater productivity (RWP). The objectives of this study were to determine the effectiveness of the rainwater harvesting and conservation techniques (RWH&C) to increase plant water availability (PAW) and maize grain yield as compared to conventional practices (CON) for small-scale farmers working under these conditions.

MATERIALS AND METHODS

A field trial was conducted at the Towoomba Research Station during the 2008/09 and 2009/10 growing seasons. The experiment was conducted as a randomized complete block design with five tillage treatments [1. Conventional (CON), 2. No-till (NT), 3. Daling plough (DAL), 4. In-field rainwater harvesting (IRWH) and 5. Mechanized basins (MB)] and replicated four times. Maize was used as the indicator crop at 18 000 plants ha^{-1}. A total of 40 neutron water meter access tubes (2 access tubes per treatment) were installed to a depth of 1100 mm in order to measure the soil water content (SWC) at four depths (150, 450, 750 and 1050 mm). The other parameters used were PAW, RWP and grain yield. Data was analysed with Genstat 14.0 and treatment means were separated using Fisher's LSD test at P = 0.05.

RESULTS AND DISCUSSION

PAW during the 2008/09 growing season for the IRWH, MB, and DAL were significantly different from CON, with no significant difference during the 2009/10 growing season. The SWC of the RWH&C techniques was higher than CON. The IRWH treatment produced 23 and 50% significantly more biomass than the NT treatment, with during the 2008/09 and 2009/10 growing seasons, respectively. IRWH grain yield was only significantly different from the NT treatment. IRWH induced 26 and 56% more grain yield during 2008/09 to 2009/10 respectively, than the NT treatment. IRWH produced 22% higher RWP than CON.

CONCLUSION

The results revealed that rainwater harvesting techniques significantly increased SWC, maize grain yield and RWP when compared to CON treatment.

Keywords: Plant available water, Rainwater harvesting, maize, yield.

THE USE OF WIKWIO FOR IDENTIFICATION OF WEEDS IN SOUTH AFRICA

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INTRODUCTION

The WIKWIO (Weed Identification and Knowledge in the Western Indian Ocean) project aims to strengthen science and technology orientation to achieve food security by enhancing agricultural productivity in the Southern African region. Agricultural productivity is hampered by many factors, one important among them being weeds. WIKWIO aims to enhance the capacities of researchers, reinforce the institutional capabilities of the National Agricultural Research System (NARS) and universities, empower extension services and improve their quality of service, through a participatory, technology-facilitated platform.

MATERIAL AND METHODS

WIKWIO will deploy appropriate ICT solutions to build a multi-stakeholder community of researchers, extension services, civil society and farmers around an ICT knowledge base of weeds. The WIKWIO portal exists out of a participatory platform and the IDAO (Identification Assistée par Ordinateur - weed identification assisted by computer) identification system. The specific objective of the WIKWIO project is to build and use a network of STI (science and technology program I) knowledge and weed management methods of weed infestations, which will consolidate existing information and facilitate the sharing of scientific and technological acquisitions. This work is to create a database as complete as possible, on weeds in the geographical area concerned. All the documents and information related to the weed species (descriptions, photos, drawings and scans) will be prepared and integrated into the WIKWIO website. Furthermore, it will develop a collaborative platform for exchange of information on weeds between stakeholders: researchers, agronomists, extension officers and farmers.

RESULTS AND DISCUSSION

A project website has been launched to disseminate project description and scientific information on the crop weeds in Island States of the Western Indian Ocean and South East Africa. It will provide space for collaborative work between project partners through several tools such as forums, a mailing list, document repository and access to the knowledge database on weed species. Existing knowledge on weed identification and control for the selected weed species is gathered in the WIKWIO knowledge base.

CONCLUSIONS

By using the WIKWIO portal, weed scientists, botanists, extension officers, students, lecturers and farmers will be able to identify unknown weeds and broaden their knowledge on weeds, not only occurring in their respective field/crop, but also in other crops and other parts of the world.

Keywords: IDAO identification system, weed knowledge, WIKWIO portal

USE OF STRUVITE FROM SOURCE-SEPARATED URINE AS A PHOSPHATE FERTILIZER

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INTRODUCTION

The major concern regarding future supply of Phosphorus (P) is the possible exhaustion of the currently known and commercially available reserves of P. At the rate known reserves of P are being mined an estimated complete depletion will occur within a century. Continued population growth puts an extra pressure on future P requirements. Waste recycling for P recovery is among the more promising answers due to the ubiquitous occurrence of waste. Struvite a product of source-separated urine was assessed for its ability as a P fertilizer using maize (Zea mays) as a test crop.

MATERIALS AND METHODS

The study evaluated the solubility of struvite in water, its nutrient release potential by incubating soils with varying amount of struvite, and its effectiveness as a P fertilizer in a glasshouse study using superphosphate as a reference P source. Three soils of contrasting physico-chemical properties were used, Inanda (Ia), Sepane(Se) and Catref(Cf) for the study. A 22 day incubation study was conducted at 25^0C and 50% water holding capacity to measure extractable P, exchangeable bases and pH at various sampling dates. Sorption isotherms were linearized using the Freundlich equation; P affinity, external P requirements and sorption maxima of the soils were extrapolated from the linear equations. Pot experiment was done under glasshouse conditions with maximum temperatures of 26^0C and minimum temperatures of 16^0C using 2kg of soil and it was harvested after 6weeks, P in the plant tissue and soil was then analysed at a local testing station (CEDARA).

RESULTS AND DISCUSSION

In the incubation overall solution P increased with increasing struvite application rates in all three soils. The highest amount of P was recorded in Ia›Cf›Se maximum P concentration of 54mgkg^{-1} on day 22 in Ia. Struvite showed appreciable water solubility at low rates resulting in increased pH, solubility was lower with increasing application rate and showed very little effect on pH. Adsorption parameters K_f values followed the trend; Ia > Se > Cf , whereas the trend for EPR was in the order Se > Ia > Cf. The greatest response in the pot experiment was at half the recommended rate of struvite application with Cf›Se›Ia. Except in Se soil; there was no significant difference ($p < 0.05$) between superphosphate and struvite, with regards to P concentration in the soil, P uptake of plant and dry matter weight of the plant.

CONCLUSIONS

Struvite can be as effective as superphosphate except in Se where it was outperformed. In closing the nutrient loop using struvite from source separated urine gives a justifiable solution to P shortages which are looming in the near future.

Keywords : Struvite, phosphorus fertilizer

QUANTIFYING THE IMPACT OF OFF-ROAD DRIVING ON ROOT DISTRIBUTION IN SOILS IN THE MAKULEKE CONTRACTUAL PARK, SOUTH AFRICA

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INTRODUCTION

ImageJ software was used to determine the effects of vehicle traffic on root development/root distribution below tracks at the following tyre pressures: 80, 160, 240 and 320 kPa. As expected, root area fractions under the tracks was reduced statistically significantly at all sites and all tyre pressures, compared with the control values.

MATERIALS AND METHODS

The study was conducted in the Makuleke Contractual Park, Kruger National Park. The method used was a combination of the Profile Wall Method (Bohm 1979) and Photographic Image Analysis by making use of ImageJ Software (Rasband 2011). Soil profiles were excavated under each track representing tyre pressures of 80, 160, 240 or 320 kPa and controls, respectively. All in triplicate. Digital photographs of the exposed roots were taken and analysed using the computer software ImageJ. Area fractions were determined and recorded as percentage root density. ANOVA (SPSS V.19.0®) was performed to compare the average root area fractions across the five tyre pressures ($p = 0.05$). Pair-wise comparisons, Least Significant Differences (LSD), were performed *post hoc* to determine between which tyre pressures the statistically significant differences occurred.

RESULTS AND DISCUSSION

Site 1: the differences between the control and the four tyre pressures are statistically highly significant in the order 80 kPa>160 kPa>240 kPa>320 kPa. There is a curvilinear negative relationship between tyre pressure used and root area fractions across the control and four tyre pressures. *Site 2:* a linear decrease in root fraction occurs with increased tyre pressure at Site 2. The statistically significant differences between the root area fractions for the different tyre pressures were 80 kPa>160 kPa>320 kPa>240 kPa. *Site 3:* a linear decrease in root area fraction occurs, as in the case of Site 2. The significant differences between the root area fractions for the different tyre pressures were 160 kPa>80 kPa>240 kPa=320 kPa.

CONCLUSION

Results indicated that root penetration, and therefore, root area distribution was drastically reduced as tyre pressure increased. This reaffirm previous research showing that higher tyre pressures cause higher sub-soil compaction than lower tyre pressures (SASTA 2001). Driving at low tyre pressures should be stipulated as a prerequisite when off-road guidelines are developed. The roots limited to the top 15 cm of the soil profiles for all three sites correlates well with the soil depth of 7 to 25 cm where severe crusting due to the vehicular traffic occurs. This crusting has serious long lasting effects like inhibiting root growth (Laker & Vanassche 2001), germination and seedling emergence, the latter especially of small-seeded plants like grasses, and thus water- and nutrient uptake.

Keywords: ImageJ, root area distribution, root area fraction, soil compaction, tyre pressure

EFFECT OF SMART FRESH ON SHELF-LIFE AND QUALITY OF FUERTE AVOCADO HARVESTED AT DIFFERENT MATURITY STAGES

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INTRODUCTION

The South African avocado industry is export oriented and aimed primarily at the European markets. Controlled atmosphere (CA) is the most common post-harvest treatment for S.A. shipments. However, soft landing, grey pulp vascular bundles remains the main limitations. 1-Methylcyclopropene (Smartfresh) is starting to play a more important role as an alternative. 1-MCP applications is primarily used to reduce the risk of soft landings that occur in the country of import and to also reduce the incidence of ethylene associated physiological disorders, primarily diffuse mesocarp discoloration also known as greypulp or internal chilling injury. Generally, avocados are harvested over a long period and therefore, the efficacy of 1-MCP at different fruit maturities is an important factor from a commercial perspective. Thus this study aims to evaluate the effects of 1-MCP on quality Fuerte avocados harvested at different maturities.

MATERIALS AND METHODS

Fuerte fruits were obtained from ZZ2-Bertie van Zyl farms at Politsi. Fruits were harvested from three different grooves with high, moderate and low moisture content. Prior to 1-MCP treatment, fruits were dipped into a chronos fungicide suspension. Fruits were treated with 500ppb for 16 hours using sealed 200l plastic drums. Both treated and untreated fruits were either directly at a ripening room or stored at 6°C 4 weeks before placed at a ripening. Days to ripening, incidence of vascular browning, grey pulp, anthracnose, stem-end rot, lenticel damage and seed sprout was recorded.

Results and discussion

1-MCP delayed fruit ripening on both cooled and non-cooled treatments regardless of fruit maturity. However, cooled treatments ripened more rapidly than the non-cooled treatments. Cooling increased the incidence of grey pulp. The incidence of vascular browning and lenticel damage was high on cooled 1-MCP treatments at all fruit maturities. 1-MCP increased the incidence of seed sprout at all harvesting maturities. There was no treatment effect on incidence of anthracnose and stem-rot.

Conclusion

The study shows that 1-MCP has potential to extend the shelf life (delayed ripening) of avocado. However, application of 1-MCP had no positive effect on physiological disorders and post-harvest diseases.

Keywords: 1-Methylcyclopropene, Avocado, Cold storage, Harvesting time, Fruit quality

GROWTH AND YIELD RESPONSES OF COMMERCIAL SUGARCANE CULTIVARS TO MULCHING IN THE COASTAL RAINFED REGION

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INTRODUCTION

Mulching of sugarcane is defined as the physical removal and spreading of green and dead leaf material from the previous crop over the next ratoon crop. This practice has been shown to have substantial impacts on sugarcane growth. Recently, there have been industry reports of reduced growth vigour, establishment, and yields of certain cultivars through residue blankets. However, no quantitative information exists on the reaction of popular commercial cultivars to mulching in the rain-fed regions. The objective of this study was to evaluate the population dynamics, cane yield and quality responses of sugarcane cultivars to mulching in the rain-fed region of South Africa.

MATERIALS AND METHODS

A field trial was established in 2008 at Empangeni in the rain-fed region. The trial comprised of eight of the most popular sugarcane cultivars in the coastal region. The trial was planted as a 2 x 8 factorial strip-plot with four replicates, with burning vs. mulching as the main plots and cultivars as sub-plots. The trial was evaluated over a period of three summer crops (1st, 2nd, and 3rd ratoon) and one winter crop (5th ratoon).The impact of mulching on stalk population, stalk heights and soil water content was evaluated during each growing season. Cane yields (YCANE), estimated recoverable crystal percentage (ERC) and ERC yields (YERC) were determined at each harvest. A combined analysis of variance was conducted to evaluate main and interaction effects of cultivar, mulching, and ratoon.

RESULTS AND DISCUSSION

Mulching significantly ($p<0.05$) improved cane and ERC yields of most cultivars across all four ratoons. Cane yield improvements ranged from 7% (N41) in the summer ratoon to as high as 85% (N45) in the winter ratoon. The ERC% ranged from 20% improvement for cultivar N47 to an 11% reduction for cultivar NCo376. Cultivar N47 had the highest improvement (up to 74%) in TERC for the drier summer ratoons, while cultivar N39 had the greatest improvement (up to 92%) in the winter ratoon. The improvements in cane and ERC yields were attributed to the higher soil water content prevalent under the residue blanket. There were no significant differences in stalk population between burn and mulch treatments in the summer ratoons, however, most cultivars had significantly improved stalk populations when mulched in the winter ratoon. Stalk heights and mass were generally improved for most cultivars in all four ratoons with mulching. All cultivars showed reduced emergence and tillering due to mulching both in winter and summer ratoons. This was attributed to lower soil temperatures measured under the residue blanket during crop establishment.

CONCLUSIONS

The results showed that mulching was beneficial for sugarcane production, regardless of the cultivar and ratooning season. This agronomic practice can thus be recommended for all current commercial cultivars along the coastal rainfed region of South Africa in order to improve production.

Keywords: *cultivar, sugarcane, mulching*

WATER FOOTPRINT OF GROWING VEGETABLES IN SELECTED SMALLHOLDER IRRIGATION SCHEMES IN SOUTH AFRICA

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INTRODUCTION

There is widespread ignorance, improper measurement and monitoring of water use in smallholder irrigation schemes in South Africa, where irrigated vegetable production is a major farming activity. More so, the full impact of vegetable production on water resources within the irrigation schemes remains unknown. The need to better manage existing water resources has been recognised which has led to the promotion of water footprinting.

MATERIALS AND METHODS

The water accounting and impact assessment method which follows the framework by Hoekstra & Chapagain (2011) was used to estimate water footprints (WF) of five vegetable crops produced at the Tugela Ferry (TFIS), Thabina (TIS) and Zanyokwe (ZIS) smallholder irrigation schemes in South Africa. Evapotranspiration was calculated using the CROPWAT model. The distinction between green and blue water evapotranspiration was based on precipitation and irrigation data. The study focused on nitrogen (N) as the critical pollutant in the grey water footprint calculations. The N values used were based on application rates obtained from responsible local extension officers. The water footprint of vegetable consumption was estimated by aggregating the water footprints and yields of different farmers within the same scheme.

RESULTS AND DISCUSSION

The TIS had the highest water footprint, followed by TFIS whilst ZIS had the lowest. Green beans had the highest water footprint; 3535.7 m^3/ton in TIS, 2753 m^3/ton in TFIS and 2407.6 m^3/ton in ZIS. Cabbage had the lowest water footprint. The highest water footprint for growing cabbage was 254.5 m^3/ton in TFIS, 223.1 m^3/ton in TIS and the lowest was 217.8 m^3/ton in ZIS. Green beans had the highest grey water footprint i.e. 373 m^3/ton and the lowest was cabbage with 37 m^3/ton. Values for potato, spinach and tomatoes were 156 m^3/ton, 214 m^3/ton and 132 m^3/ton, respectively.

CONCLUSION

The highest WF was found in TIS followed by TFIS, whilst ZIS had the lowest. There were large differences in WF among the crops and the irrigation schemes that were caused by a number of factors, mainly weather and production practices. More water was used in crop production within irrigation schemes studied in SA compared to other countries as evidenced by the high WF observed in this study. This could be an indicator that the yield is not proportional to the drop of water hence a need to increase crop output Or to increase irrigation efficiency and optimise conditions (soil, management) to increase WUE.

ACKNOWLEDGEMENTS

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***Keywords**:* Smallholder Irrigation Scheme, Water footprint, Consumption, Evapotranspiration

CAN WE USE GENERIC NITROGEN MINERALIZATION FOR SLUDGE RECOMMENDATION TO AGRICULTURAL LANDS?

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INTRODUCTION

The expected rate of Nitrogen mineralization is key, to recommend sludge application rates to agricultural lands. Nitrogen mineralization from sludge amended soils is influenced by a combination of biotic and abiotic factors. Despite this, the use of a single annual N mineralization rate across sites and agro-ecological zones is a common practice around the world. The aim of the study was to model error in assuming a constant rate of sludge mineralization across sites in South Africa using the SWB-Sci model. To achieve the stated aim, the following hypotheses were tested: under dryland cropping cumulative annual N mineralization in sludge amended soils: 1) will vary significantly across agro-ecological zones but not within an agro-ecological zone, 2) will not vary significantly between and within seasons at a specific site, and 3) will not vary significantly across soil textures within a site.

MATERIALS AND METHODS

Scenario simulations were run using the SWB-Sci model for four major soil textural classes (clay, clay loam, sandy clay loam and sandy loam), using long-term weather data for five major agro-ecological zones in South Africa. Statistical analyses were done on model simulated mineralization values for factorial combinations of 5 zones, 3 sites and 4 soil textures.

RESULTS AND DISCUSSION

It was apparent from model simulations that N mineralization from sludge was predicted to vary significantly across the 5 major South African agro-ecological zones with highest mean decomposition rate recorded in the super-humid zone (38.5%) and lowest in the arid zone (21%). Cumulative annual N mineralization varied significantly between sites within an agro-ecological zone, but remained mostly similar across years within a site, except for anomalous low rainfall seasons. Cumulative annual N mineralization did not change significantly across soil textures and between seasons within a site. Cumulative annual N mineralization was, however, significantly influenced within seasons in the humid and super-humid zones, but not in the arid and semi-arid zones of South Africa.

CONCLUSIONS

A single annual N release value cannot be used to represent N mineralization from sludge across agro-ecological zones as well as across sites within the zone. However, a single annual N release value could be used across soil textures within a site.

ACKNOWLEDGEMENTS

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Keywords: Agro-ecological zones, modelling, N-mineralization, sewage sludge, soil texture, SWB-Sci

GROWTH AND DEVELOPMENT OF AVOCADO FRUIT GROWN IN THE COOL SUBTROPICAL AREA OF KWAZULU-NATAL

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INTRODUCTION

The growth pattern of avocado fruit is arguably said to follow a single sigmoidal growth pattern. Harvest time of the fruit is difficult to determine as the fruit lack obvious physical indication of maturity. Harvesting mature avocado fruit is of high importance as such fruit are met with higher consumer acceptability than slightly immature fruit.

MATERIALS AND METHODS

During the 2014 season, 'Fuerte' and 'Hass' avocado fruit's diameter were monitored and some were harvested from Bounty Farm (Latitude: 29°28´S; Longitude: 30°161´E) and Everdon Estates (Latitude: 29°45'S, Longitude: 30°25'E) in KZN province of South Africa for maturity analysis. Everdon Estates well irrigation system compared with Bounty Farm that is solely dependent on rainfall for water intake. A total of 160 fruit from the two farms each were picked at random on every harvesting day. Fruit mass, diameter and respiration were recorded and mesocarp moisture content (MC), dry matter (DM) and oil content were determined.

RESULTS AND DISCUSSION

Although there were significant differences between production locations and harvest dates in both 'Fuerte' and 'Hass' avocado fruit, the trends in MC and diameter were fairly consistent throughout the entire period of study. The oil content of 'Fuerte' avocado from both production locations were present in high concentration but the trend was not consistent trends. The oil content of 'Hass' avocado fruit from both production locations was lower than that of 'Fuerte' fruit at the initial stage of the fruit growth but oil content of 'Hass' increased - inconsistently - over the entire harvesting period. All parameters from both cultivars showed significant differences during the harvesting dates ($P < 0.001$). There were significant interactions between the two factors for MC, DM, oil content, respiration and fruit mass while there was no interaction with fruit diameter.

CONCLUSION

The growth of avocado fruit appeared to follow a single sigmoidal growth pattern except for 'Fuerte' fruit from Everdon Estates which showed a tendency of a re-growth suggesting a double sigmoidal growth pattern. Therefore, an extended period of study is suggested. The MC appeared to be a better indicator for determining avocado fruit maturity.

ACKNOWLEDGEMENTS

We acknowledge the provision of experimental fruit by Bounty Farm and Everdon Estates.

Keywords: Avocado, fruit growth pattern, maturity parameter

PASTURE INTERCROPPING FOR DRY LAND AGRO-PASTORAL SUBSISTENCE SYSTEMS.

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INTRODUCTION

Semi-arid agropastoral subsistence farmers depend on overgrazed communal land and conventional tillage systems that have degraded 75% of the land area whilst achieving very poor water use efficiencies (WUE) (Rockström, 2000). In response to these challenges a perennial pasture intercropping (PI) method (Seis, 2006) was tested for subsistence farmers with the primary objective being to understand water use dynamics and assess yields responses.

METHODS AND MATERIAL

Vigna unguiculata (C), *Sorghum bicolor* (S) and established *Eragrostis cervula* pasture (P) were assessed as a monocrop (S, C, P) and intercrop (SC, CP, SP and SCP). All treatments were rain-fed nutrient non-limiting. Crop growth parameters, soil moisture measurements, meteorological data and microclimate variables were measured.

RESULTS & DISCUSSION

C achieved the highest yields, whilst CP and SP had a 35% and 72% yield. Productivity was increased 5 times when CP was compared to P. There was a 5 times greater WUE with CP versus P. In terms of soil water balance gains, PI showed a more than 10% increase in the soil moisture relative to C, S and CS. SC and C lowered the vapour pressure deficit (VPD) and temperature (T) values most significantly. T and radiation had the most positive correlation on VPD whilst the crop development stage had the strongest negative correlation. PI with a C4 crop is not suggested. CP added significantly to the overall pasture productivity, making this a very attractive dry-land pasture management option. The soil water balance gained significantly from the benefits of reduced run-off, evaporation and increased infiltration.

CONCLUSION

CP has a significant benefit with regard to pasture production and water use efficiency whilst promoting and demonstrating the scope of PI with other legumes.

ACKNOWLEDGEMENTS

Thanks to National Research Fund, Conservation Food & Health fund, DAAD and the University of Pretoria.

Keywords: agropastoral, Intercropping, pasture, reclamation, water use efficiency

HUMAN HEALTH RISK ASSESSMENT OF HEAVY METALS INTAKE VIA CASSAVA CONSUMPTION FROM CRUDE OIL IMPACTED SOILS WITH AND WITHOUT PALM BUNCH ASH AMENDMENT

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INTRODUCTION

The pollution of lands and waters of the Niger Delta region of Nigeria by crude oil has been one of the woes befalling the people of the region since the discovery of crude oil in the region. Oil spillage has been a regular occurrence with resultant environmental degradation (Onuh*et al.*, 2008). Palm bunch ash has over time been used to improve soil fertility, cheap source of potassium (K_2O). However, it is a common practice ash and other locally available manure be added to crude oil impacted soils three to four months before the commencement of planting season. This study was conducted to assess the level of contamination of soil and the level of accumulation of the contaminants in cassava tuber. The study also examined the reclaiming efficiency of palm bunch ash used by the people on soil impacted with crude oil.

MATERIALS AND METHODS

The study was conducted in three different locations of farmland in around the Ikot Ada Udo Village. Soil samples were collected in triplicate, oven dried, crushed, and sieved using a 2 mm mesh size sieve and then stored in the labled polythene sampling bags at room temperature prior to analysis A local cassava cultivar was grown. The tubers were collected from each study site, dried and then ground into powder and kept at room temperature for further analysis. 1g soil and cassava tuber samples were digested for heavy metal analysis. Heavy metal concentrations in the filtrate of the digested samples were determined using atomic absorption spectrophotometer (AAS).The Hakanson potential ecological risk (PER) method was employed in assessing the level of contamination of the studied soils. Soil to plant metal transfer was computed as transfer factor (TF). For the assessment of health risks through consumption of cassava produce by the local inhabitants, the Daily Intake of Metal (DIM), Health Risk Index (HRI), and the Target Hazard Quotient (THQ) were evaluated.

RESULTS AND DISCUSSION

Contamination factor, enrichment factor, and geo-accumulation index values suggested that the contaminated soils (with and without palm bunch amendment) were highly enriched with Fe, Pb, Cu, and Cr. Daily intake of metal, health risk index, and target hazard quotient values pointed to high health risk for people consuming cassava products from these soils. The calculated percentage risk showed a positive influence of palm bunch ash on the metals concentrations. Percentage risk followed the trend: Fe>Cd>Zn>Cr>Cu>Pb>Ni.

CONCLUSION

Crude oil spillage on agricultural lands in the Niger Delta has led to the build-up of ample heavy metals in the soil. The study revealed that Ikot Ada Udo soil is not agriculturally viable as it is highly enriched with Fe, Pb, Mn, Cr, Cu, Zn, Ni, and Cd. Cassava plants grown on this soil accumulates reasonable amount of these metals. However, the practice of addition of palm bunch ash to the soil as a soil reclaiming agent by the local farmers does not reduce the heavy metals concentrations to health risk free level. People consuming cassava products gotten from these lands are of high health risk. A total clean-up of the agricultural lands in Ikot Ada Udo community of Akwalbom State, Nigeria is therefore recommended.

Keywords: Keywords: oil spilage, heavy metal, health

KENAF TOLERANCE TO VARIOUS POST EMERGENCE HERBICIDES REGISTERED FOR OTHER CROPS GROWN IN SOUTH AFRICA.

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INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is one of the fibre crops on a commercial scale in South Africa. However, there are no herbicides registered for use in this crop. The purpose of this study was to determine the tolerance of kenaf to one pre-emergence and five post-emergence herbicides compared to manual weed control under irrigated and dryland cropping systems.

MATERIAL AND METHODS

The experimental design was factorial experiment laid out in random complete block design (RCBD) with seven replicates. The experiment consisted of herbicides: MSAM, Basagram, 2,4,-DB, Fusilate, Frontier, hand-hoeing and control. Control plots in this experiment were not weeded. Kenaf, *Hibiscus cannabinus* cultivar Elal2 was used as test. Measurements that were taken included plant height, herbicide damage, weed control efficiency, fresh plant weight, dried plant weight, and dried root weight. The data were subjected to analysis of variance (ANOVA) to determine the statistical likelihood of damage to plants from the herbicides.

RESULTS AND DISCUSSION

Plants on dry land performed differently under different post emergent herbicides. It is worth to note that 2,4, DB and Basagram had detrimental effect on kenaf at six leaf stage (two weeks after planting). Whilst Basagram killed both weeds and Kenaf, few plants survived on 2,4, DB plots. Other post emergent herbicides applied, such as Frontier, Fusilate, and MSMA retarded kenaf growth, but kenaf plants recouped after few days. Kenaf on weed free plot had higher plant height compared to other treatments but did not significantly differ from the kenaf treated with Frontier, Fusilate and control plots

CONCLUSION

Based on the findings the majority of the herbicides can be included in further field trials on *Hibiscus cannabinus* L. with the exception of Basagram which caused substantial injury to the kenaf plants.

***Keywords**:* Kenaf, herbicides, pre-emergence, post-emergence, weeds

GEOTEXTILES - APPLICATIONS FOR SOIL CONSERVATION

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INTRODUCTION

Geotextiles are any type of material that can be placed on the soil surface, and may be either synthetic or natural. Synthetic geotextiles can be made of nylon, plastic or similar materials and may be reinforced with wire. However, they degrade slowly. Natural materials include hemp, coconut fibre or other plant materials, such as crop residue, branches or mulch, but some of these disintegrate too rapidly to be effective in slope stabilization. The benefits of geotextiles include: Intercepting raindrops and lessening their impact on bare soil; Reducing the speed and amount of runoff water flowing on the soil surface and; Creating micropockets that retain moisture for vegetation to re-establish.

MATERIAL AND METHODS

A series of rainfall simulator tests at ARC-ISCW was followed by a series of field trials in four provinces of South Africa to evaluate locally-produced natural geotextiles under natural conditions. The trials ran over four seasons. In addition, information was obtained from partner trials in a number of countries where other locally-produced materials were also evaluated.

RESULTS AND DISCUSSION

Results showed that average runoff under the palm mats decreased by between 38% and 70%, compared to bare soil. Sediment removed under the mats decreased by between 38% and 89%, using three combinations of slope, mat density and mesh size. Splash erosion at Roodeplaat decreased by between 62% and 68%, while re-vegetation at Ladybrand and Mabula increased by between 38% and 58%, with organic carbon content and topsoil accumulation also increasing under the mats.

Results from the other participating countries, where a reduction in runoff of between 25% and 95% was recorded, confirm that there is much potential to use organic, bio-degradable, easy to manufacture geotextiles in soil erosion control. In many susceptible areas of South Africa, this offers an excellent opportunity to combine employment opportunities with enhanced environmental protection.

CONCLUSIONS

Geotextiles (either alone or in combination) are especially useful on steeper slopes (>30%), where water flow velocity may be reduced from 2 m s^{-1} to <0.1 m s^{-1} when a covering is applied. Synthetic geotextiles can be expensive, ranging from R40 to R100 m^{-2}, excluding transport and labour costs to install. In contrast, many other commonly occurring materials may be used, with little or no associated costs. These include woven palm leaf mats, branches or twig bundles, maize stalks, rice straw and bamboo. The only requirements are that the materials are stable, relatively flexible, can be fixed to the soil surface and are bio-degradable.

Keywords: Biotextiles, Soil conservation, Water erosion

DEVELOPMENT AND EVALUATION OF CULTIVARS IN THE SOUTH AFRICAN MACADAMIA INDUSTRY

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INTRODUCTION

The macadamia was introduced into South Africa in the 1930's, initially as seedling trees. It was only in the 1960's that the successful development of vegetative propagation protocols allowed importation of superior selections made in Australia and Hawaii. Much of the early evaluations were conducted by the University of Kwa-Zulu Natal, but in 1993 the macadamia industry allocated funding for a series of trials across the three main macadamia growing regions. The results of these trials and the implications for the local industry will be discussed.

METHODS AND MATERIALS

Four trials were planted on an 8 x 4m spacing in the Hazyview, Tzaneen and Levubu areas (two sites in Levubu). All sites were irrigated and annual fertilisation was carried out based on leaf and soil analyses. No pruning or tree shaping was conducted. Data collected on an annual basis included yield (wet in shell - WIS), total and sound kernel recovery, analysis of factors contributing to unsound kernel, kernel size, percentage whole kernel and the percentage of grade 1 kernel. Cultivars included Australian selections A4 and A16, Hawaiian selections HAES 294, HAES 344, HAES 660, HAES 695, HAES 741, HAES 788, HAES 789, HAES 790, HAES 791, HAES 800, HAES 814, HAES 816, HAES 863 and a South African selection, namely Nelmak 2.

RESULTS AND DISCUSSION

Only the Hazyview site is discussed in this presentation. Cumulative WIS yield over a 12 year period ranged from 39 kg/tree to 105 kg/tree, while kernel recovery ranged from 7.75 kg/tree to 22 kg/tree. This large variation can be ascribed to the fact that many of these cultivars originated from seeds collected in the wild or from trees which themselves were grown from seed collected in the wild – ie: all are first or second generation trees. Some of the differences are also due to the fact that some trees are pure *Macadamia integrifolia*, while others are hybrid of *Macadamia integrifolia* and *Macadamia tetraphylla*. Significantly, the hybrids comprise 4 of the top 5 yielding cultivars. The South African industry is currently based on cultivars in these trials. In Australia, a breeding program at Hidden Valley Plantations has resulted in cultivars that are three generations removed from the wild type. These cultivars have cumulative yields up to 40 kg/tree of sound kernel over 10 years – double the yield of the current South African cultivars. This highlights the importance of a dedicated breeding and selection program. While South Africa has access to the newer Australian cultivars, the industry has noted the need for new cultivars and is currently engaged in establishing new evaluation trials.

CONCLUSIONS

South Africa is currently the biggest producer of macadamia in the world. However, the industry is based on old cultivars only one to two generations removed from the wild type. Research in Australia indicates that each new generation offers the potential for significant increases in yield. This indicates the critical need for a local breeding and evaluation program.

Keywords: regions, vegetative propagation

THE USE OF RADIO FREQUENCY IDENTITY TAGS (RFID) IN THE ELECTRONIC TRACKING OF SEEDLING TRAYS

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INTRODUCTION

Nursery economies of scale point towards a larger operation for sustainability which in turn requires more accurate seedling tray documentation and traceability. An added factor is the high cost of seed, hence mistakes can prove to be expensive. The painted colour coding of seedling trays can suffice for large standard orders, however a new cost effective and more efficient system is available. Barcode technology is out-dated and the location of the barcode needs to be discovered before the data can be collected. Radio Frequency Identification (RFID) is the name for a set of techniques used for the identification and tracking of various items.

METHODS AND MATERIALS

Research was done on the various tag types: Passive and active, and their use in the agricultural industry. The tags were subjected to extreme nursery conditions of heat and humidity; and thereafter, the optimal scanning range was determined. Tests were conducted on the robustness of the scanners and their use in nursery conditions. The tags are attached at the seed planting stage and removed at dispatch and further research is required on what information is required on the RFID tags.

RESULTS AND DISCUSSION

It was found that prices of RFID tags are decreasing, while the price of scanners are increasing. The system can efficiently monitor the tracking of seedling trays in the nursery as well as record traceability (seed source, pesticides uses, sowing dates) and the cost of installation is now affordable to most nurseries using expensive seed.

CONCLUSION

The use of the RFID tags might in future might be a cost saving benefit to the producer.

Keywords: : RFID, seedling trays, electronic tracking

THE EFFECT OF CULTURAL PRACTICES ON THE EFFICACY OF AVIGLYCINE IN THE INHIBITION OF NATURAL FLOWERING IN QUEEN PINEAPPLE IN SOUTH AFRICA

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INTRODUCTION

Cultural practices and the manipulation of the crop cycle by farmers determine the constant supply of pineapples to the fresh market. The ideal is to supply pineapples every week and at such volumes that an over production does not occur. This is mainly achieved by artificial flower induction by growth regulators such as ethepon at a specific time. When flowers differentiate naturally and out of sequence, controlled harvesting cannot take place and can lead to the overproduction of pineapples and consequent lower market prices. Natural flower differentiation is a severe problem during the drier, winter months leading to an overproduction in December - January of the following year. It is mainly induced by low temperatures and short day length, but drought and cultural practices can also play a role. Several methods to reduce natural flowering have been investigated over the past 4 years, of which the application of aviglycene, an ethylene inhibitor, gave the best results. This method is very costly and several trials were done to find more cost effective application rates. Results were sometimes inconsistent when applied at different farmers and trials were therefore carried out at different farmers to determine if cultural practices will have an influence on the efficacy of natural flower inhibition.

MATERIAL AND METHODS

Eight treatments were applied at four different farms to evaluate the effect of dosage of aviglycine, as well as the additive effect of urea and/or Photon under the cultural practices applied by each farmer, on flower inhibition.

RESULTS AND DISCUSSION

Different results were found at each farm indicating the importance of cultural practices on the efficacy of aviglycine. Plant size and plant age at application, as well as fertilizer programs have an influence on the efficacy of aviglycine. If farmers want to apply aviglycine for natural flower inhibition, cultural practices should be taken in consideration when the application rate of aviglycine is determined.

CONCLUSION

Cultural practices do play an important role in the efficacy of aviglycine. Planting time, sucker size and fertilizer programs determine plant size at application, which in turn determine aviglycine dosage.

Keywords: *Plant size, fertilizer, photoperiod*

AN ECONOMIC CONVERSION TOOL FOR SUGARCANE RESEARCH RESULTS: PRELIMINARY EVALUATIONS

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INTRODUCTION

Results from sugarcane field trials are conventionally presented in yield terms, yet economic considerations of treatment differences may be more important to growers. The availability of a user-friendly tool to convert conventional trial data into economic terms would enable researchers to rapidly perform such calculations. This paper outlines the initial stages of development and a preliminary evaluation of such a tool at SASRI, using cultivar evaluation trials as case studies.

MATERIAL AND METHODS

The approach to development involved calculating a partial margin (PM) associated with different cultivars in a trial. An MS Excel-based tool was developed to account for all agronomic factors that vary between cultivars that could influence profitability, while those that are the same across cultivars were excluded from calculations. For example, sugarcane production costs relating to weed control (cultivar differences in canopy closure), harvesting (cane yield differences), loading, and transport were accounted for, while fertiliser costs (same across cultivars) were not. A series of linked spreadsheets were populated at the plot level with relevant trial data such as cane yield, recoverable value percentage (RV), and lodging ratings through simple copy and paste actions. The tool then calculated the PM associated with each plot in the trial. Data from nine cultivar trials were analysed using the tool and relative cultivar rankings for PM and RV yield were compared. The potential of the tool for sensitivity analyses was evaluated by varying transport distances to the sugar mill, and evaluating cultivar PMs with increasing distances.

RESULTS AND DISCUSSION

In seven out of nine trial datasets, cultivar rankings for PM were different to rankings for RV yield. High RV yielding cultivars were not necessarily more profitable in most trial datasets. In general PM was correlated to RV yield (R^2 values ranging from 0.55 to 0.99), however, the strength of the correlation was dependant on the presence of lodging in the trial. Trials that lodged showed poorer correlations between PM and RV yield, and larger differences in rankings for the two traits. High sucrose, low cane yielding cultivars generally showed improved rankings for PM compared to their rankings for RV yield. Such cultivars also became more profitable when transport distances to the mill were increased incrementally in trials where lodging was experienced. In trials with no lodging, no changes in PM rankings were observed when transport distances were increased. The benefits and drawbacks of a tailor-made tool for specific trial types vs. a generic tool with wider applications are also discussed.

CONCLUSIONS

The tool was able to evaluate the economics of different cultivars in current cane payment schemes based on their performances in trials. Results were intuitively correct, and corresponded to expert knowledge of sugarcane production economics. The sensitivity of the harvesting and transport aspects of the calculator to lodging differences emphasised the importance of this trait on sugarcane economics. The tool will be developed further to include other routine experiment types such as foliar sprays and crop nutrition trials.

Keywords: Economics, partial margin, sugarcane, trial

SOIL ORGANIC MATTER: CONSTANT, VARIABLE AND UNKNOWN

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INTRODUCTION

Soil organic matter (SOM) is a mixture of various organic compounds. It is often difficult to extract and analyse. Simple conversion factors from easily determined soil organic carbon to (SOC) are often used. Most commonly the van Bemmellen factor (1.724) based on 60% carbon content in SOM, or suggested Weil and Brady the less accurate value of 2 are used. Assuming that SOM would affect the soil particle density we have attempted to estimate the SOM/SOC ratio from density measurements.

MATERIALS AND METHODS

The study was conducted in the Mvoti river catchment measuring some 300km^2 located in the Midlands area of KwaZulu-Natal, South Africa. A combination of forestry/grassland and cultivated areas were selected for soil carbon inventory. A range of soil samples from 48 profiles selected throughout the catchment, sampled at depths of 2.5, 7.5, 12.5, 17.5, 30, 40, 50, 75 and 100cm for particle density and SOC determination.

RESULTS AND DISCUSSION

Assuming a simple mixture, $\rho_s = (1-C_{om})\cdot\rho_m + C_{om}\cdot\rho_{om}$

Where ρ_s is soil particle density (Mg/m^3), ρm – average density of mineral fraction, ρom density of SOM and C_{om} is the organic matter content, %$_{wt}$.

Expecting a constant average SOM/SOC ratio, the slope k of the linear relationship for ρ_s *vs Corg, where C org is t*:he organic carbon content, %$_{wt}$. $k = 0.01\cdot(\rho_{om}-\rho_m)\cdot C_{om}/C_{org}$

The k value was estimated between -0.045 and -0.049 (R^2 = 0.86 and 0.87 for grasslands and forestry respectively), and -0.042 (R^2 = 0.55) for cultivated maize crop rotation fields. Assuming ρom = 0.25 Mg/cm^3, the SOM/SOC ratio was calculated as 2.25. The SOM in the studied soils is not likely to contain more that 44.5%$_{wt}$ carbon and is related to the type of OM inputs. The correction of value may be significant for understanding the soil organic matter composition.

CONCLUSIONS

It is concluded that the SOC content in SOM may be well predicted from ρ_s .and C_{org} determinations. Such corrections to van Bemmelen factor may help with modelling OM dynamics and significantly reduce the cost of soil carbon accounting and audit.

ACKNOWLEDGEMENTS

The NRF funding through DST/NRF Green Landscapes programme is gratefully acknowledged.

***Keywords**:* Soil carbon, soil organic matter, soil properties

ALLELOPATHIC EFFECTS OF LANTANA (*LANTANA CAMARA* L.) ON TOMATO (*LYCOPERSICON ESCULENTUS* L.) AND LETTUCE (*LACTUCA SATIVA* L.)

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INTRODUCTION

Lantana camara leaves are known to be allelopathic to some arable weeds. However, the effect of these residues on tomato and lettuce has not been evaluated. The aim of the study was to evaluate the allelopathic effects of dry *L. camara* residues on germination and emergence of tomato and Lettuce.

MATERIALS AND METHODS

The study was carried out at the University of Zimbabwe. The laboratory seed germination assay was carried out using 1, 2, 3, 4, 5 % w/v *L. camara* aqueous extracts and distilled water as the control. In the greenhouse experiment, tomato and lettuce seeds were grown separately in pots with soil mixed with 0, 10, 20, 30, 40, 50g of *L. camara* residues. Both experiments were laid out in Randomised Complete Block Design with six replications. The data were analysed using regression analysis and analysis of variance. Mean separation was done using least significance differences at 5 % significance level.

RESULTS AND DISCUSSION

The aqueous extracts had an inhibitory effect on the germination, plumule and radicle growth of tomato and lettuce. The parameters were significantly ($p< 0.05$) reduced linearly as the concentration of *L. camara* leaf extracts increased. This suggests that the aqeous leaf extracts of *L. camara* have allelochemicals that suppress the germination and initial root growth of the tomato and lettuce. The emergence and dry matter of the tomato and lettuce plants were not significantly ($p > 0.05$) reduced with the increase in *L. camara* leaf biomass. From the study, the allelopathic effects of *L. camara* on tomato and lettuce in the soil were not clearly expressed but had an inhibitory effect with the use of aqueous extracts.

CONCLUSION

It can be concluded that *L. camara* leaf extracts suppress the germination of lettuce and tomato but incorporating their biomass in red soils has no inhibitory effect on the emergence of tomato and lettuce. Therefore *L. camara* residues can be used to suppress weeds in tomato and lettuce.

Keywords: Emergence, Germination, Allelopathy, Aqueous Extracts

CALIBRATION OF SAP FLOW TECHNIQUES USING THE STEM PERFUSION METHOD

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INTRODUCTION

The most generally accepted methods for achieving accurate estimates of whole-tree water use are the stem sap flow techniques. However, it is widely acknowledged that these methods often tend to over or underestimate sap flow and consequently it is necessary to perform species specific calibration when using these techniques. The aim of this study was therefore to calibrate the most appropriate sap flow techniques in citrus species using the stem perfusion method, in order to determine water use of citrus orchards as part of a Water Research Commission solicited a project.

MATERIALS AND METHODS

Sap flow techniques (compensation heat pulse (CHPM) and heat ratio method (HRM)) were calibrated on four citrus species using the stem perfusion method. Stems of approximately 25 cm in length were used, which were connected to a column of water. This column was placed under pressure (<100 kPa) to force water through the stem, and the water moving through the stem was collected and the mass recorded every 10 minutes using an electronic balance. Heat pulse velocities were determined every 10 min using locally manufactured probes. Safranin was added to the perfusion solution to determine the area of conducting sapwood.

RESULTS AND DISCUSSION

Preliminary results showed that sap flux density was underestimated in all citrus stems using both the CHPM and HRM, even when wounding was taken into account. Overall, CHPM underestimated transpiration by 70% while the HRM underestimated transpiration by 42%, especially at high flow rates. Despite this underestimation there was a fairly good correlation between sap flux densities using the HRM and CHPM and that determined gravimetrically, which allowed the determination of empirical correction factors. This underestimation could be explained by the variation in sapwood conducting tissue in the stems and the properties of the xylem vessels, i.e. both vessel size and the spacing between groups of vessels.

CONCLUSION

The consistent underestimation of sap flux density by the two sap flow techniques confirms the need to calibrate the techniques in each new species in which measurements are to be made. However, the calibration coefficients varied between species and among different stems of same species which makes it difficult to determine a single calibration coefficient for citrus.

ACKNOWLEDGEMENTS

Funding is provided by Water Research Commission, Citrus Research International and the Citrus Academy.

Keywords: compensation heat pulse, heat ratio method, water use

PRODUCTION POTENTIAL AND METAL TRACE ELEMENT CONCENTRATIONS OF TWO CEREALS ON DIFFERENT MINE TAILINGS

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INTRODUCTION

Mine tailing dams are very prone to erosion and must be stabilized according to the legislation, in order to prevent water and dust pollution onto the surrounding farm and suburbs. Using vegetation is one of the most common and effective rehabilitation methods. Stability is very important due to the extreme dry northwest winds. This project was developed from a combination of several demands from different parts of the mining industry and communities to find alternative land use options after mine closure. The main objectives of this project were to determine the growth potential of two cereals as well as the metal trace element transfer from various growth mediums onto the seed of the cereals.

MATERIALS AND METHODS

Nine different mine tailings materials i.e. gold, platinum, coal, andalusite, fluorspar, kimberlite and gypsum were used as growth mediums. *Avian sativa* (oat) and *Triticum aestivum* (wheat) were used in 50 liter pot trails where composite samples were taken from each growth medium for analyses. The pots along with the cash crops were kept in controlled conditions with micro irrigation systems. There were four to six replicas of each with three plants per pot. Ammonium Nitrate solution were used to determined available / solubility of selective metal trace elements Co, Ni, Al, Mn, Fe with ICP-MS in soils and total aqua regia acid digestion of plant tissue material. A sandy loam was used as a control growth medium. The amount of ears and grains on each plant were used as production potential.

RESULTS AND DISCUSSION

The data showed that oats have higher concentrations of metal trace elements than the wheat. In the case of Nickel the transfer factor from growth medium to plant (TFF) was >1 for the oat which is an indication that the concentration for Nickel was higher than in the growth medium self. Furthermore wheat showed a higher TFF than oat for copper and the TFF was high for both crops (>1).

CONCLUSION

Production (number and mass of grain) were the highest for the gypsum and coal growth medium. There can thus be concluded that the trace metal absorption in crops depend mainly on the composition of the tailing materials as well as the plant species. A way forward is to determine the toxic risk factor for the two crops.

Keywords: pollution from mine tailings, alternative land use, metal trace elements, Avian sativa, Triticum aestivum

THE EVALUATION OF DIFFERENT FORMULATIONS OF MICRONUTRIENTS ON FOLIAR UPTAKE

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INTRODUCTION
Perennial fruit crops like citrus can benefit from foliar nutrition since deep roots can deplete the soil and soil amendments are not easily applied without damaging roots (Abd-Allah, 2006). Increases in production costs are urging farmers to be more cost effective in supplying their crops with the necessary micronutrients. Different formulations (amino acid, chelate or inorganic complexes) for micronutrients exist, and when used as foliar sprays, more information is needed on: i) the most effective and cost effective formulation for uptake in citrus, ii) the optimal concentrations for each formulation and iii) the influence of contact time between the micronutrient and citrus leaves.

MATERIALS AND METHODS
Potted Valencia 'Midknight' trees in a greenhouse at the University of Pretoria were used to evaluate the absorption of foliar applied micronutrients. Formulations, concentrations and sampling times for foliar applied Cu, Mn, Zn and Fe were evaluated. Five concentrations, 0.5, 1, 2, 4 and 8 times the recommended concentration from FSSA (2003), were applied foliarly. Treated leaves and the leaves directly above and below the treated leaf were sampled at predetermined times. Four replications with a control treatment were used in a split-split plot design in completely randomized block design. The waxy layer and residues on the leaves were removed. Plant material was oven-dried, digested and Cu, Mn, Zn and Fe concentrations were determined.

RESULTS AND DISCUSSION
For the Mn, Cu and Fe treatments, the SO_4^{2-} formulations had the highest concentrations in the leaves, while the EDTA formulations had concentrations in the same range as the control. Fe content of the leaves increased with time and application concentration. Zn content of the leaves was the highest with ZnO applied at 8x. Zn content of the leaves was higher when Zn-Amino acid was applied than $ZnSO_4$

CONCLUSIONS
The most effective formulation and concentration, as a multiple of the FSSA (2003) recommended concentration, in parenthesis are: Cu: $CuSO_4$ (8x); Mn: $MnSO_4$ (8x); Zn: Zn-Amino acid (8x); Fe: $FeSO_4$ (4x). The optimal sampling times after application for the different elements were: Cu – 24 hr, Mn & Zn – 96 hr, Fe – 192 hr. Transport of the applied elements occurred to the leaf directly above and below the treated leaf.

ACKNOWLEDGEMENTS
CRI, Zinchem and NRF for funding.

Keywords: Micronutrients, foliar uptake, Citrus, formulation.

EFFECT OF MANAGEMENT PRACTICES UNDER COWPEA-MAIZE CROPPING SYSTEMS IN SOUTH AFRICA: MAIZE YIELD CASE STUDY

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INTRODUCTION

Maize is the most important cereal crop in sub-Saharan Africa, high yielding and an easy to process crop. Crop rotation involving grain legumes is a viable management option that helps increase maize yield and can substitute the unproductive fallow system traditionally used for soil fertility maintenance.

MATERIALS AND METHODS

The study was conducted at Potchefstroom, Taung and Rustenburg in the North West province of South Africa during 2011/12 and 2012/13 planting seasons. The experiment comprised of three cropping systems which were cowpea-maize rotation, mono-cropped maize and cowpea-maize intercropping (50:50 rows). The two rates of nitrogen fertilizer were applied, in kg ha^{-1}, at each site (0 and 95 at Potchefstroom, 0 and 92 at Rustenburg, 0 and 113.5 at Taung). The experimental design was 3 x 3 x 2 factorial experiment laid out in randomized complete block design with three replications. The experiment was conducted to investigate the effect of cropping system, site, and nitrogen fertilization on maize yield. The measured yield parameters were maize ear length, ear mass, kernel number per ear, hundred seed mass and grain yield harvested from an area of 12 m^2 per plot.

RESULTS AND DISCUSSION

Cropping system, Nitrogen fertilizer and site had significant effect ($P < 0.05$) on maize yield. Cowpea-maize rotation and mono-cropped maize had significantly ($P < 0.05$) higher ear mass, kernel number per ear and grain yield than cowpea-maize intercropping. The longer ear length, higher ear mass, kernel number per ear and grain yield under the rotational cropping system may have been attributed to the improved soil structure by the previous cowpea. Maize applied with nitrogen fertilizer had significantly ($P < 0.05$) longer ear length, higher ear mass, kernel number, seed mass and grain yield than maize without nitrogen fertilizer application. The higher yield parameters under maize applied with nitrogen fertilizer may be attributed to fertility of soil due to improved soil organic matter. Maize ear mass and grain yield were significantly ($P < 0.05$) affected by the interaction effect of cropping system x site x nitrogen fertilization. Maize planted at Potchefstroom had significantly ($P < 0.05$) higher kernel number per ear and grain yield than other sites.

CONCLUSIONS

In this study, cropping system played a vital role in terms of maize growth and yield. The interaction effect of cropping system x site x nitrogen fertilizer on maize ear mass and grain yield contributed significantly towards yield improvement in this study.

Keywords: Monocropping, nitrogen fertilizer, rotation, site

EVALUATING PLANT YIELD RESPONSE AND POTASSIUM REMOVAL EFFICIENCY AS AFFECTED BY DIFFERENT RATES OF POTASSIUM FERTILIZER APPLICATION

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INTRODUCTION

Improved understanding of soil potassium variables and availability is important and challenges are to improve the understanding of the effect of soil potassium availability on crop growth. In the past potassium was often not considered a nutrient of concern (Williams and Raupach 1983) and as a result Bell et al. (1995) showed that soil potassium was not being managed in a sustainable manner. The aim of this study was to examine the effect of different rates of applied potassium on plant uptake and yield, using *Amaranthus tricolor* L. as a test crop.

MATERIALS AND METHODS

A field trial was conducted during the summer of 2013/14 at the ARC-Roodeplaat Research Station, north-east of Pretoria, South Africa. The selected soil was categorized as a Bainsvlei form (Soil classification, 1991). A sprinkler irrigation system was used and aluminum access tubes were installed for monitoring soil water content with a neutron probe. *Amaranthus tricolor* seedlings were transplanted 4 weeks after germination. The spacing used was 0.3 m between plants and 0.3 m between rows. Five rates of potassium were used (0, 30, 60, 90, 120 kg K ha^{-1}) and potassium was applied as KCL (50). Nitrogen was applied as LAN (28) at a rate of 150 kg ha^{-1}. using Swiss chard as a reference crop. Treatments were laid out in a randomized complete block design with three replications. Plant biomass, marketable leaf fresh mass, K content (%) and plant K uptake were determined.

RESULTS AND DISCUSSION

Responses of plant yield to different rates of potassium applied were significantly different ($p<.0001$) using *A. Tricolor* L. as a test crop. The fresh marketable leaves were 49.39 kg ha^{-1} at K90 and was significantly ($p<.0001$) higher than K120 which was at 46 kg ha^{-1}. Applied potassium rates had no effect on plant potassium content, however, there was a significant difference in K uptake across treatments. Increased application rate of potassium increased the above ground biomass (leaves and stems) from 209 kg compared to the control at 70 kg K ha^{-1}.

CONCLUSION

Application of potassium played a significant role in yield increment and the results have shown that the application rate of potassium had a response curve, yield of marketable leaves increased up to the rate of 90kg ha^{-1} then declined at a rate of 120 kg ha^{-1}. The recommended rate for A. tricolor according to these study was therefore 90 kg K ha^{-1}.

Keywords: potassium uptake, plant biomass, potassium availability

USING CUCURBITACIN B LEVEL IN *CUCUMIS AFRICANUS* FOR ESTABLISHING THE HARVESTING TIME

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INTRODUCTION

Wild watermelon (*Cucumis africanus*) in the Cucurbitaceae Family, is known for its cucurbitacins, used in ethnomedicines, ethnopesticides, ethnonematicides and nematode-resistant rootstocks. Generally, the concentration of secondary metabolites in organs are depended on the developmental stage of the organ in each they are compartmentalised. In terms of the level of cucurbitacins in fruits, the harvesting time is not documented. The objective of this study was to determine whether harvesting time of *C. africanus* fruit will have an influence on concentrations of cucurbitacin B.

MATERIAL AND METHODS

A field trial was initiated at the University of Limpopo, South Africa. At two-leaf stage, seedlings were hardened off for 5 days and transplanted, with irrigation being once every other day. Treatments, *viz*., 60, 67, 74, 81, 89, 96, 103 and 110 harvesting days after transplanting, were arranged in randomised complete block design, with 12 replications. Eight fruits of *C. africanus* were harvested weekly, cut into pieces, dried at 52°C for 72 h in an air-forced oven and ground in a Wiley mill to pass through a 1-mm-pore sieve. For extraction, 4 g dried crude extracts of fruit were mixed with 50 ml methanol and dichloromethane each and allowed to run for 4 h on a waterbath at 40 °C at 45 rpm (Rotary Evaporator). After extraction, sub-samples were homogenised by reducing the volume to 30 ml and then 1 ml centrifuged at 4500 rpm for 10 minutes before filtering through 0.22 µm-pore filter (Miller, Sigma). Concentrations of cucurbitacin B were quantified using the gradient HPLC Prominence 20.

RESULTS AND DISCUSSION

Harvesting time contributed 73% total treatment variation in cucurbitacin B concentration, with the depended (y-axis) and independent (x-axis) variables having had significant ($P \leq 0.05$) quadratic relationships. The quadratic relationship model explained 79% of the observed variation in cucurbitacin B. Using the optimisation relationship ($x = -b_1/2b_2$) from the quadratic equation, cucurbitacin B was optimised at 5.24 weeks after first harvest.

CONCLUSION

This study showed that *C. africanus* fruit have optimum cucurbitacin B concentration at 5.24 weeks after first harvest and should therefore not be left lying in the field after this period.

ACKNOWLEDGEMENT

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Keywords: Cucurbitacin, extraction, phytonematicides, nematodes

IMPROVING COWPEA YIELDS IN SOUTH AFRICA

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INTRODUCTION

Cowpea (*Vigna unguiculata*) is a widely grown crop in the semi-arid and sub-humid zones of Africa and Asia. The dry grain contains on average 25% protein, and several vitamins and minerals, and is used as edible seed. Young leaves, pods and green seeds are also used as vegetables. Green pods are consumed fresh and the leaves are used as a nutritious relish for eating pap or are dried and made into soups. The crop residue is a nutritious fodder for livestock and the fallen cowpea parts and roots contribute to soil fertility. Many biotic and abiotic factors are responsible for the low grain yield in the traditional South African farming systems. The average yield worldwide is estimated at 450 kilograms per hectare, the lowest of the major tropical grain legumes. Evaluation of new germplasm for adaptation, and their subsequent commercialisation are critical to achieving food security in South Africa. The objective of the project is to evaluate local and international cowpea germplasm and identify the most suitable types for South African conditions.

MATERIALS AND METHODS

During 2012/13 season, 60 cowpea accessions, mostly introductions from IITA and local landraces and breeding lines, were evaluated at three locations (Potchefstroom, Taung and Polokwane). Plots consisted of two 0.75 m rows x 5 m length and 20 cm intra-row plant spacing. Alpha Lattice design with three replications was used. Data were recorded on six phenological and agronomic traits viz, days to 50% flowering, days to maturity, plant height, pod yield/plot, grain yield/plot and dry fodder yield/plot. Twenty top performing genotypes were selected for further evaluation. During 2013/14 season, a replicated variety trial consisting of 20 varieties and two checks was conducted at Potchefstroom, Taung and Bushbuckridge.

RESULTS AND DISCUSSION

Separate analyses of variance for each location and analysis on combined data over the three locations showed highly significant ($P<0.001$) differences among the genotypes for all the six characters studied, and hence the potential for selection and improvement within characters. Four lines (ARC-940, ARC-1077, ARC-844, and ARC-922) gave superior or equal grain yield to the check variety PAN 311 in all localities. Accession ARC-234 produced significantly high dry fodder yield of 6.2 t/ha over the check variety, Bechuana white with 4.3 t/ha.

CONCLUSIONS

The cowpea germplasm evaluated showed significant variation in phenological and agronomic traits measured. Three accessions that gave both superior grain yield and a reasonable quantity of fodder will be promoted as a strategy to develop dual purpose varieties.

ACKNOWLEDGEMENTS

The study was funded by the Department of Agriculture, Forestry & Fisheries (Project Number: 21.1.1/12/PP-01/SGI) and ARC.

Keywords: Cowpea, fodder, food security, grain yield, protein.

QUANTIFICATION OF MICROBIAL POPULATION DYNAMICS AND ENZYME ACTIVITY IN SOIL AMENDED WITH COMPOSTS OF VARYING DEGREE OF MATURITY

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INTRODUCTION
The activity and functional diversity of microorganisms contribute to the stability and productivity of agro-ecosystems. Soil microorganisms and enzyme activities have been suggested as potential indicators of soil quality due to their crucial role in soil fertility management. Hence, management practices that can enhance microbial diversity and soil enzyme activities are essential for improving soil health and soil fertility status.The aim of the study was to assess the effects of compost maturity on bio-quality indicators of compost amended soil.

MATERIALS AND METHODS
Cattle manure-rich compost was prepared through thermophilic windrow composting using cattle manure and wood chips mixed at a proportion of 4:1 (w/w) to achieve a C:N ratio of 30:1. This compost was sampled at regular interval of 30 days until 150 days. Compost samples of varying degrees of maturity were air-dried, pulverised and mixed with 1.2 kg surface soil at an equivalent rate of 100 kg P ha-1. Each compost amended soil was transferred into well labelled plastic pot for incubation. Sampling of incubated amended soils was performed at 7 days interval until 42 days; and used for microbial count and enzyme activity assessments. Data generated were analysed as factorial experiment using SYSTAT package. Treatment and interaction effects were evaluated using Fisher protected least significant difference at probability level of 5%.

RESULTS AND DISCUSSION
The chemical composition of the different composts including the C/N and C/P ratios are fairly similar and comparable. Variation in compost maturity date, incubation time and their interaction exerted significant effects on the measured microbial counts and enzyme activities. The highest count of actinomycetes (6.18 CFU g-1), bacterial (6.73 CFU g-1) and fungi (3.06 CFU g-1) were obtained during the 42-day incubation period. Similarly, the highest concentration of β-glucosidase (3076 mg kg-1 hr-1), phosphatase (1480 mg kg-1 hr-1), dehydrogenase (120.07 µg INF g-1 2hr-1) and urease (26.15 mg kg-1 2hr-1) were obtained during the 42-days incubation period. The concentrations of bio-quality parameters measured in the compost-amended soils were highest in compost sampled at 90 days, except for phosphatase, indicating the peak of the thermophilic process. Bacteria and fungi counts were highest at 14 days of the 42-day after incubation but highest at 21 days for actinomycete. Significantly higher β-glucosidase, phosphatase and urease activities were obtained at 42 days after incubation while quantitatively higher dehydrogenase activity was obtained at 7 days after incubation.

CONCLUSION
The bio-quality parameters of composts are influenced by compost maturity and incubation time. The highest enzyme activity and microbial population counts were reached at 60 and 90 days, respectively during composting. The use of mature compost with a desirable level of bio-quality indicators is crucial for fertility management and improved soil health.

Keywords: Compost maturity, enzyme activities, microbial count, soil fertility, soil health

EFFECT OF BIOCHARS WITH VARYING PHYSICOCHEMICAL PROPERTIES ON C AND N MINERALIZATION OF SANDY SOIL

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INTRODUCTION

Biochar has a recalcitrant soil organic carbon pool which can decrease atmospheric CO_2 concentrations by sequestrating C in the long term when added to soil. The aim of this study was to investigate which physicochemical properties of various locally produced biochars determine the nature of short term changes in the rate of CO_2 respiration and N mineralization of a sandy topsoil when biochars were added.

MATERIALS AND METHODS

Two short-term (2-week) laboratory incubations were conducted to evaluate the effect of various biochars (corn stover, grape pip, grape skin, pine wood and rubber tyre, sugarcane pith) on CO_2 respiration and soil N mineralization in a sandy topsoil. Characterization of the biochars and soil was done by determining pH, surface acidity and alkalinity, total C and N, Brunauer-Emmett-Teller (BET) specific surface area (SSA), and proximate analysis. The biochars were <2mm sieved and mixed with a sandy topsoil at a rate of 2.5% (w/w). Incubations were done at 28°C, samples were taken at 12, 24, 48, 168 and 336 hours, constant moisture (at field capacity) was maintained throughout. The amount of CO_2 evolved was determined by the alkali adsorption method and titration using 0.05 M NaOH. Potential plant available inorganic N was extracted using 2M KCl.

RESULTS AND DISCUSSION

The cumulative respiration of treatments was as follows: sugarcane pith > rubber tyre > corn stover > grape skin > control > pine wood > grape pip. Biochar fixed-C content was strongly negatively correlated with respiration (168 h: $R^2 = 0.85$; 336 h: $R^2 = 0.77$). Grape pip and pine wood biochars had the highest fixed-C fraction (85.4 and 77.0%, resp.) and resulted in lower respiration than the control, and thus show good potential for long term C sequestration. In contrast, the low fixed-C contents of corn stover (0%) and sugarcane pith biochars (15.5%) confirm that they are not suitable for C sequestration. It was observed that tyre char (net release of 32.9 mg kg^{-1} of inorg. N after 168 h) promotes N mineralization relative to control; whereas all the other biochar treatments stimulated immobilization of mineral N. Neither C:N ratio nor %N of the biochars correlated with the N mineralization results.

CONCLUSIONS

The grape pip and pine wood biochars show potential as effective sinks for atmospheric CO_2 because they suppressed CO_2 respiration rate in the short term and have high fixed C contents. With the exception of rubber tyre char, all other biochar treatments showed a potentially lower availability of inorganic N. This means that over the short term, all the plant-derived biochars cause a decrease in N availability.

ACKNOWLEDGEMENTS

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Keywords: biochar, C sequestration, N mineralization, soil respiration

THE COSMIC-RAY NEUTRON PROBE: A NEW INTERMEDIATE SCALE SOIL WATER CONTENT SENSOR

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INTRODUCTION

A range of soil water measuring devices have been developed over the years to determine crop water use and irrigation requirements. Equipment currently available to producers and researchers are, however, only able to measure at extreme spatial scales. A clear gap in soil water measurement therefore exists between small scale (point) and field scale measurements. The development of the Cosmic-Ray Neutron Probe (CRP), which is classified as an intermediate scale (approximately 30 ha) soil water sensor, can potentially fill this gap. The CRP uses cosmic-ray neutrons to measure soil water content passively and non-invasively over an area of tens of hectares (Zreda et al. 2012). This study aims to assess the accuracy and usefulness of the recently developed CRP as an intermediate scale soil water sensor, whilst also identifying possible applications of the equipment in the field of agriculture.

MATERIALS AND METHODS

The study consisted of a single CRP (CRS-1000, Hydroinnova, Albuquerque, USA) installed in potato field under centre pivot (±34 ha) located in Lichtenburg (North-West). In order to validate the CRP, six neutron probe (NP) access tubes were installed on the experimental field. NP readings were taken six times during the potato growing season (18/02/2014 – 16/05/2014). Plant and soil samples were also taken during the growing season to determine gravimetric water content which was used to calibrate both the NP and CRP.

RESULTS AND DISCUSSION

A good correlation was observed between the calibrated CRP and volumetric soil water content measurements determined directly from the soil samples ($R^2 = 0.99$), while reasonably good correlations were found between NP and CRP soil water content measurements ($R^2 > 0.87$). A clear correlation, however, only occurred if the CRP calibration parameter (N_0) was adjusted throughout the growing season. This agrees with reports by Franz et al. (2013), who found that N_0 varies significantly between sites and in time for the same site. The variation in N_0 values over time can potentially be a limitation for practical use of the CRP.

CONCLUSIONS

Current results suggest that the CRP is as accurate as conventional NP measurements. It should, however, be noted that multiple calibrations of the CRP are needed to accurately estimate area average soil water contents over time. A proper evaluation of the various calibration approaches available is therefore needed in order to establish a standard and robust calibration procedure.

ACKNOWLEDGEMENTS

Potatoes South Africa and McCain are acknowledged for providing funding for this study.

Keywords: Cosmic-ray Probes, Irrigation management, Soil water estimation, Water

EVALUATING THE USE OF HARVESTING SYSTEMS AND LABOURER PLATFORMS IN THE SOUTH AFRICAN DECIDUOUS FRUIT INDUSTRY

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INTRODUCTION

The increasing cost of fruit production necessitate more cost-effective orchard practices on South African deciduous fruit farms and increasing the productivity of labour is one of the components focussed on. The aim of the study was to determine how the use of harvesting systems and platforms could decrease input costs, increase fruit quality and increase profitability for South African deciduous fruit producers. We wanted to determine the realistic potential of these machines in various orchard and management practices and identify the changes that we would need to make to facilitate automation in the orchard.

MATERIALS AND METHODS

Trials were performed during the 2012/13 and 2013/14 seasons on farms in the Koue Bokkeveld (32°57' S, 19°14' E), Witzenberg Valley (33°15' S, 19°15' E), Grabouw (34°9' S, 19°2' E), and Tulbagh (33°15' S, 19°8' E) to evaluate the effect of the Hermes Tecno L harvesting system (Hermes, Gargazonne, Italy), the Zucal Z11™ harvesting system (Meccanica Zucal, Romeno, Italy) and the N.Blosi™ (N.Blosi, Ravenna Italy) worker platform on worker productivity during harvesting, pruning and thinning. The effect of harvesting systems on the incidence of harvest injuries was also assessed. Harvesting systems and platforms were assessed under standard commercial working conditions. Full day replicates were used as far as possible in order to capture the realistic potential of the harvesting systems by including standard inefficiencies of the specific orchard/farm that might be excluded when using rows as replicates. In contrast, the conventional teams harvested both sides of the tree row in one pass. For this reason and as well as to prevent unnatural competition between workers, the harvesting systems and platforms were evaluated in separate sections of orchards.

RESULTS AND DISCUSSION

The misalignment between typical South African deciduous fruit orchards and harvesting system design leads to a decrease in labour productivity during harvesting. Orchard actions where a lot of time is spent moving the ladder relative to the time spent working on the ladder showed the greatest productivity gains when performed with platforms, e.g. summer pruning and to a lesser extent dormant pruning. Factors such as tree size, shape and uniformity, fruit distribution on the tree, fruit size and quality, orchard floor condition and aspect, labour team dynamics, harvesting incentives, bin condition, operational system employed and harvest logistics all affect the feasibility and ease of mechanization.

CONCLUSIONS

Few South African orchards and operational systems are suitable for the implementation of harvesting systems and much optimization and investment will be needed to mechanize the harvesting process. Productivity gains can be achieved with labourer platforms.

***Keywords**:* mechanisation, labour productivity, inefficiencies

IMPACT OF TILLAGE SYSTEMS ON SOIL ORGANIC CARBON

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INTRODUCTION
According to the United Nations Framework Convention on Climate Change (UNFCCC), increasing carbon (C) sequestration in agricultural soils is a key mitigation option to reduce carbon dioxide (CO_2) concentrations in the atmosphere, as soils are the largest terrestrial C sink. Agricultural soils are estimated to have lost over half of their stored organic C due to cultivation (Lal, 2004). Certain management practices, such as reduced tillage, are known to restore soil organic carbon (SOC) levels. In a medium-term study, SOC and associated CO_2 emissions were compared for conventional and reduced tillage systems.

MATERIAL AND METHODS
A conservation agriculture trial was conducted at Zeekoegat, north of Pretoria, from 2007 to 2013. For conventional and reduced tillage treatments, soil samples (0-5 and 5-10 cm) were collected and analysed for SOC using the Walkley-Black method. Carbon dioxide emissions were determined using a closed chamber method and a mobile infra-red analyser. A series of 10 CO_2 campaigns were held during August and September 2013. Gravimetric soil water content (SWC) was determined on the same days as CO_2 emissions. Collected data was used to calibrate and test the Soil Water Balance (SWB) model for broader applications.

RESULTS AND DISCUSSION
After five years of reduced tillage, SOC in the 0-5 cm layer increased from 1.26% to 1.65%, and in the 5-10 cm layer from 1.23% to 1.44%, while SOC under conventional tillage was 1.35% (0-5 cm) and 1.31% (5-10 cm). The gravimetric SWC was higher under reduced tillage, with an average of 10.25% compared to 9.93% for conventional tillage. Carbon dioxide emissions were linked to SWC (R^2=0.64), but as CO_2 emissions were lower for the reduced tillage system, factors other than SWC, such as soil aggregation, most likely have stronger correlations. Simulations with SWB corresponded well with measured data, but several modifications to the code are recommended to improve our ability to estimate tillage impacts on SOC.

CONCLUSION
Data indicate that practising reduced tillage as part of a conservation agriculture system has the potential to sequester C in the soil. A modified, calibrated version of the SWB model is envisaged in order to extrapolate these findings to a wider range of cropping systems.

Keywords: carbon dioxide, reduced tillage, greenhouse gas emissions, soil organic carbon

A SOIL QUALITY INDEX FOR PASTURES IN SOUTH AFRICA

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INTRODUCTION

Sound soil management practices are imperative for pasture production systems in the southern Cape of South Africa, which is one of the country's most important dairy farming areas. The pasture systems are predominantly based on kikuyu (*Pennisetum clandestinum*) over-sown with ryegrass (*Lolium* spp.). There are a number of issues regarding declining soil quality in this region, which threatens sustainability. To understand the seriousness of the soil degradation and to link soil quality indicators with actual soil services, soil quality should be assessed. The aim of this study was to develop an index to assess soil quality of the pasture systems in the southern Cape region (Swanepoel et al. 2014).

MATERIALS AND METHODS

A regional survey was conducted by taking soil samples on 142 commercial dairy farms in the southern Cape coastal region extending from Swellendam to the Gamtoos Valley. Soil samples were taken from kikuyu-ryegrass pastures and were analysed for 31 soil quality indicators providing information on the physical, chemical and biological functions in soil. A series of principal component (PC) analyses was performed, separately for each group of indicators (physical, chemical and biological) as well as on the complete dataset. The magnitudes of the resulting vectors were calculated and provided information on the fraction of the variance explained by the factor in a multi-dimensional space spanned by the PC.

RESULTS AND DISCUSSION

A minimum data set of the most sensitive indicators was identified. Physical indicators consisted of gravel content, water holding capacity (WHC) and penetration resistance (PR), chemical indicators of exchangeable acidity (EA), extractable P and extractable Mn, while soil organic matter (SOM) was included as a biological indicator. Linear scoring functions for these indicators were used to develop a soil quality index. The soil quality index (SQI) was equated as: SQI = 0.13(PR) + 0.16(Gravel) + 0.15(WHC) + 0.14(EA) + 0.17(P) + 0.12(Mn) + 0.13(SOM).

CONCLUSIONS

This study resulted in a soil quality index for evaluating kikuyu-ryegrass pasture systems in South Africa. This soil quality index appears to be useful for pasture systems in South Africa, but could also be useful to similar pasture systems in other countries. The index could be advantageous in monitoring soil management operations to rehabilitate degraded pasture soils. Farmers, extension officers, scientists and policy makers should be able to use this tool constructively for planning sustainable soil and crop management strategies.

Keywords: biological quality, chemical quality, dairy farming, pasture production, physical quality

ALUMINIUM TOLERANCE: GENOTYPING CURRENT AND HISTORICAL WHEAT CULTIVARS FOR ALMT1

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INTRODUCTION

Dryland wheat production in the Free State province of South Africa (SA) has been declining steadily for the last ten years due to the high-risk and unprofitable nature of wheat production. Significant yield losses occur annually due to Aluminium (Al) toxicity as result of high Al concentrations (25 ppm) present in soils with pH (KCl) lower than 5.0. Symptoms of Al toxicity in wheat are poor tillering and a plant which appears drought stressed. Aluminium inhibits general root development which leads to decreased water and nutrient uptake resulting in overall stunted plant growth. Previously it was concluded from soil analysis results that 94% of soils in the Eastern Free State in fact, have pH (KCl) lower than 4.8. The correct management strategy to improve crop production on acid soils should be the combined use of Al tolerant cultivars with traditional liming practises. However, to be able to breed genotypes with improved Al tolerance, fast, reliable and efficient selection methods must be available.

MATERIALS AND METHODS

In this study sixty-four wheat cultivars (*Triticum aestivum* L.) from the current South African wheat evaluation programme (representing cultivars from breeding companies ARC-Small Grain Institute (ARC-SGI), PANNAR and SENSAKO) and two-hundred and eighty different historical wheat cultivars taken from the ARC-SGI germplasm collection (Bethlehem) were genotyped for the presence of different forms of the aluminium tolerance gene *ALMT1*. All wheat cultivars recommended for cultivation in the three wheat production regions of South Africa for the 2014 season were phenotyped, based on the hematoxylin staining method and genotyped for the presence of the different alleles of the aluminium tolerance gene *ALMT1*. The molecular data of all the SA cultivars was compared with phenotypic seedling data for Al tolerance for marker trait association. Atlas66, an Aluminium resistant cultivar, was used as a control. Bulk fresh leaf material of each cultivar was harvested and DNA isolation performed with a modified CTAB method. DNA was quantified and diluted to 50ng/µl final concentration. *ALMT1* gene specific and promoter type markers were used during PCR. Amplified PCR products were run on 2% w/v standard agarose gel at 100V for 3 hours. A 100 bp DNA ladder was used to size and score *ALMT1* gene presence and type.

RESULTS AND DISCUSSION

Of the 64 SA cultivars screened, *ALMT1* gene alleles I, II, IV and V were identified. Nine (14%) of the SA cultivars had resistant *ALMT1* type V, phenotypically confirmed. Four cultivars could be classed as moderately resistant based on ALMT1 type IV presence but did not correspond with phenotypic data. Fourty-five cultivars were classed and confirmed as sensitive Al types I and II. A 93% correlation was observed between the phenotypic and *ALMT1* molecular data across all cultivars. A number of Al resistant genotypes were identified from the historical cultivars to be used as possible breeding parents.

CONCLUSIONS

Soil acidification is a very real problem in South Africa and the single most important cause of declining soil fertility. A limited number of dryland Aluminium tolerant genotypes are present in the current South African cultivar spectrum. This study has shown the *ALMT1* marker can be successfully used to distinguish between highly resistant aluminium types (V) and sensitive types (I and II) as validated by phenotypic screening. A few Al tolerant cultivars were identified both from current and historical cultivars. Marker-assisted selection for *ALMT1* genotypes, especially moderate to highly tolerant types IV, V and VI should stabilise and may even improve yields on acidic prone soils.

***Keywords**:* ALMT1 gene, Aluminium toxicity, hematoxylin staining, PCR, pH, wheat

WHAT DO WE KNOW ABOUT MACADAMIA WATER RELATIONS?

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INTRODUCTION

Understanding the environmental control of water relations and canopy transpiration (T) contributes to better modelling of crop water use for improved irrigation water scheduling and planning. Currently this is poorly understood in macadamia due largely to a lack of research, but it deserves attention due to the rapid increase in the area planted to macadamia in South Africa. It was hypothesised that macadamias would be well coupled to the atmosphere, but that, as with other evergreen subtropical crops, transpiration would be limited under conditions of high atmospheric evaporative demand due to strong stomatal control.

MATERIALS AND METHODS

Transpiration of a six year-old 'Beaumont' macadamia orchard was continuously monitored, using the sap flow technique, for two years (from 2010 to 2012) at White River, South Africa. Additional measurements of weather variables, leaf stomatal conductance, leaf water potential, photosynthesis and canopy size were also performed. The dependency of T on individual environmental factors was analysed in various portions of the distribution of T using a segmented, non-linear quantile regression approach.

RESULTS AND DISCUSSION

Daily rates of orchard T varied throughout the season following typical changes in atmospheric variables, with lower rates occurring in winter and autumn and higher rates in spring and summer The trees were well-coupled to the atmosphere, with a seasonal average coupling coefficient of 0.17, indicating that transpiration was largely controlled in response to the vapour pressure deficit (VPD) and is typical of a tall, rough crop. Results suggest that T of irrigated macadamias is primarily governed by VPD, followed by solar radiation and to a lesser extent by air temperature.

CONCLUSIONS

Models for estimating the water use of macadamias should therefore focus on the estimation of canopy conductance in response to environmental variables rather than focussing on atmospheric demand limited models.

ACKNOWLEDGEMENTS

Funding support is provided by the Water Research Commission and the National Department of Agriculture, Forestry and Fisheries.

Keywords: leaf water potential, stomatal conductance, transpiration, vapour pressure deficit

THE CONTRIBUTION OF HAIRLINE CRACKS ON THE SKIN OF 'AFRICAN DELIGHT' PLUMS TOWARDS MOISTURE LOSS

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INTRODUCTION

Micro cracks in the fruit cuticle make a substantial contribution to moisture loss, and hence shrivel incidence (Maguire et al., 1999; Lescourret et al., 2001; Knoche and Peschel, 2007). Currently the concentric rings found at the stem end of 'African Delight' plums are classified as cosmetic with no contribution towards moisture loss. The objective of this study was to determine if hairline cracks develop in the peel of 'African Delight' plums and its possible contribution to postharvest moisture loss.

MATERIALS AND METHODS

One hundred 'African Delight' plums of similar size and maturity and without external blemishes were sampled at the optimum commercial harvest maturity. Fruit were classified according to the water vapour permeance of their peels into three classes, namely low, medium and high. Subsequently five peel samples (20 samples) of four fruit per water vapour permeance class were stained with a fluorescent marker and were investigated under a fluorescent microscope for open cracks. Crack width was determined from the microscope images and classes were compared.

RESULTS AND DISCUSSION

The concentric rings were found to be indeed open cracks. Based on the mean crack length and width, they were classified as hairline cracks. It was also found that fruit with higher moisture loss rates had wider cracks compared to fruit with lower moisture loss rates, suggesting that wider or more cracks lead to more moisture loss.

CONCLUSIONS

It is suggested that careful attention should be paid to proper implementation and management of postharvest handling protocols of 'African Delight' plums with concentric rings on their pedicel ends to prevent moisture loss, and hence, postharvest shrivel manifestation.

Keywords: Fluorescent microscopy, Japanese plums, Shrivelling

SEASONAL CHANGES AND ALLOCATION OF MACRO NUTRIENTS IN 'EMERALD' AND 'SNOWCHASER' SOUTHERN HIGHBUSH BLUEBERRIES

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INTRODUCTION

The rate of fertilizer uptake depends on the nutrient demand and growth rate differences of plants during the season. The accumulation of biomass is correlated with nutrient uptake and therefore nutrients are taken up most readily when growth rate is high or fruit are developing. Much of the nutrients taken up by the plant are lost through the season by processes such as leaf abscission, fruit harvest and pruning and need to be corrected by the application of fertilizer. This study aimed to investigate the macro nutrient content of different plant parts of 'Emerald' and 'Snowchaser' southern highbush (SHB) blueberries at five distinct phenological stages during the season in order to develop fertiliser recommendations.

MATERIALS AND METHODS

The trial was conducted on SHB blueberries, 'Emerald' and 'Snowchaser' at Backsberg Wine Estate (S 33° 49, 684′ E 18° 54, 917′) in the Paarl district in the Western Cape of South Africa during the 2013/2014 growing season. Two-year old, bearing plants in 20 L bags were replanted into 35 cm pots in Jan. 2014. A mixture of peat moss, coir and perlite in a 7:2:11 ratio was used as growing medium. All plants were grown in an evergreen system under 20% white net. A continuous fertigation system with single dripper lines was installed in the tunnel. All plants received the same standard balanced nutrient solution, containing N, P, K, Ca, Mg and all the micro-elements. Plants were sampled at five distinct phenological stages; growth cessation in the first season, early fruit set (which coincides with vegetative budbreak), harvest, summer pruning, and growth cessation the second season. Plants were divided into canes (≥1 year), young shoots, leaves, roots, flowers and berries. Material was sent to Bemlab (Pty) Ltd (16 Van der Berg Crescent, Gant's Centrum, Strand 7140, South Africa), an agricultural analytical laboratory for macro and micro nutrient analysis.

RESULTS AND DISCUSSION

In 'Emerald' N and P were remobilized from the leaves to the roots and in 'Snowchaser' only N was remobilized from the leaves to the roots after growth cessation. Reserves were more important for new growth in 'Emerald' than for 'Snowchaser', as 'Snowchaser' depended more on nutrient uptake between growth cessation and early fruit set. 'Snowchaser', however, was more dependent on reserves between early fruit set and harvest. Uptake varied through the season as demand fluctuated. Most of the nutrients were taken up after summer pruning in both cultivars. For 'Emerald' 73% of the N, 70% of the P, 49% of the K and 64% of the Ca and Mg was taken up after summer pruning. For 'Snowchaser' 75% of the N, 64% of the P, 49% of the K and 61% of the Ca and 63% of the Mg was taken up after summer pruning.

CONCLUSIONS

Fertigation recommendations for 'Emerald' and 'Snowchaser' spaced at 2.5 x 1 m (4000 plants/ha) could be made according to the macro nutrient uptake pattern per plant.

Keywords: Nutrient requirement, fertigation, phenological stage, blueberry

EVALUATING THE EFFECT OF ROW SPACING AND PLANT POPULATION ON MAIZE PRODUCTIVITY UNDER CONSERVATION AGRICULTURE

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INTRODUCTION

The use of conventional tillage practices for crop production has become a profit threating form of farming principle due to the huge cost of production inputs associated with its use. Farmers mostly plant without having the knowledge of recommended plant population per hectare and tend to use high plant population with a goal to achieve high yield. Agricultural potential land is now being invaded for human settlement. There is a need to promote narrow row spacing since farmers will be forced to feed the increasing population estimated at 9 billion people by 2050 under limited land availability.

MATERIALS AND METHODS

An on-farm rain-fed trial was conducted at Viljoenskroon, during the 2013/14 cropping season, subjected to either minimal soil disturbance or conventional tillage systems. The treatments consisted of three maize densities (20 000, 40 000 and 60 000 plants ha^{-1}) and three row-spacing's (0.52, 0.76 and 0.9m). A randomised complete block design was used in a split plot arrangement and replicated three times. Tillage systems were assigned to the main plots, row spacing to the sub-plots and maize densities to the sub-sub plots. Each plot comprised of four 10m long maize rows (cv. DKC 78-35R). Maize grain yield was determined from the two inner rows in each plot at physiological maturity.

RESULTS AND DISCUSSION

There was no significant interaction among factors of tillage, row spacing and plant population for all the parameters except for tillage x plant population on cob diameter. Maize plots under conventional tillage planted at 20 000 plants ha^{-1} gave significant greater cob diameter than in the same plant density under minimal soil disturbance plots. Average grain yield was 8820 kg ha^{-1} Grain and stover yield from 60 000 plants ha^{-1} was significantly higher than that of 20 000 plants ha^{-1} under both tillage practices. Significantly higher stover yield was obtained when plants were spaced at 0.52 m. 1000 kernel mass from plots spaced at 0.52 m was significantly lower than when spaced at 0.76 m and 0.9 m. The 1000 kernel mass of plots planted to 20 000 plants ha^{-1} was significantly higher than plots planted at 40 000 and 60 000 plants ha^{-1}, respectively.

CONCLUSIONS

Plots under conventional practices perform better in all parameters measured compared to minimal soil disturbance plots. This could be generally ascribed to the fact that as rainfall was not a limiting factor during the planting season; CA practices could not offer moisture benefits that could have resulted in improved yields during dry season.

ACKNOWLEDGEMENTS

A funding by Agricultural Research Council (ARC) and Maize Trust and also technical assistance provided by Mr. William Makgoga are highly appreciated.

Key words: grain yield, row spacing, tillage practices

REGISTRATION OF SIX SOUTH AFRICAN SPRING WHEAT GERMPLASM LINES RESISTANT TO RUSSIAN WHEAT APHID; STEM-, LEAF- AND STRIPE RUST

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INTRODUCTION

Russian wheat aphid (RWA) (Diuraphis noxia, Homoptera: Aphididae) and cereal rusts i.e. stripe (Puccinia striiformis), leaf (Puccinia triticina f. sp. tritici) and stem rust (Puccinia graminis f. sp. tritici) can cause significant yield losses on wheat (Triticum aestivum L.). Should they occur in combination or succession, the impact is devastating. Host plant resistance as a single trait for either aphid or rusts has proven to be an effective control measure; however combining multiple resistant genes against different biotic stresses is even more advantageous.

MATERIALS AND METHODS

Complex breeding lines generated from a top-cross between two BC5 generation lines, one with RWA resistance (ex PI 225227) and the other with rust resistance (Lr34/Yr18, Sr35), were selfed to the F3 generation. In 2011, concurrent phenotypic screening (RWA biotype RWASA1) and MAS with gene specific markers was used to identify nine lines with resistance to multiple biotic stressors. During 2012, these nine lines were grown out in a wire enclosure in Bethlehem. Three hundred and forty-three single plants were harvested from the 2012 planting and evaluated at Tygerhoek and Vaalharts during 2013. SDS page analysis of these lines indicated that the high molecular weight glutenins present were 2*, 17+18 and 2+12 while variation occurred for the low molecular weight fractions. Forty-one lines were selected based on general appearance and performance, straw strength, relative growth period and plant height. The initial selection was narrowed down to 10 lines using yield and hectolitre mass data. Four more lines were culled based on validation of marker presence and insufficient seed. Bread making quality was determined using the applicable AACC methods and HPLC analysis.

RESULTS AND DISCUSSION

Genotyping for the Lr34/Yr18/Sr57/Pm38/Sb1/Ltn1 gene complex and Sr35, the phenotypic reaction to RWASA1 and RWASA2 as well as thousand kernel weight, hardness, diameter, break flour yield, flour yield, flour protein content, mixograph dough development time, loaf volume, moisture basis and % SDS-unextractable polymeric protein will be presented. Six lines homozygous for the targeted resistance genes with acceptable bread making quality are released for use by breeders.

CONCLUSION

In addition to the combination of RWA and cereal rust resistances, these lines include useful diversity in terms of selected agronomic traits and should be valuable to wheat breeders in areas where these pests occur.

ACKNOWLEDGEMENTS

The ARC and WCTrust are acknowledged for funding projects GK05/04 and GK05/12.

Keywords: Diuraphis noxia, Triticum aestivum, host plant resistance

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INTRODUCTION

The Agricultural Research Council (ARC) has contributed tremendously to the sustainable production of peaches and nectarines by developing cultivars and technologies that allow farmers to produce higher yields, more profitably and with fewer resources. The aim of this study is to quantify the benefits of this research in a bid to demonstrate this organisation's role in advancing the sustainability of the industry's production. This demonstration of the benefits of research is essential as will make as case for an increase in research funding as this has been decreasing over the years.

MATERIALS AND METHODS

The study utilises the supply response function to illustrate the relationship between peach and nectarine production and various variables. This function is represented as follows:

$$lnQ_{\ j} = \beta_0 + ln\beta_1 X_{\ i(t-i)} + ln\beta_2 P_{\ j(t-i)} + ln\beta_3 P_{\ r(t-i)} + ln\beta_4 W_{\ t} + \sum_{i=1}^{n} \beta_5 lnR\&D_{\ t-i} + u_t$$

Where: *Qj* is the quantity of peaches and nectarines produced, *Pj(t-i)* is the lagged price of peaches and nectarines, $Pr_{(t-i)}$ is the lagged price of other deciduous fruits, the *Xi*s are lagged prices of conventional inputs, $R\&D_{t-i}$ is research investment, *W* is a rainfall index, and u_t is the residual which accounts for variables not included in the model. The *β*s are the elasticities of dependent variable (Q_j) with respect to the lagged independent variables and *n* is the maximum lag of research investment that affects yield. The rate of return is calculated using R&D elasticities.

Data of R&D investment were acquired from the ARC's financial databases while market variables from Department of Agriculture Forestry and Fisheries' *Agricultural Statistical Abstracts*. Variables were collected for a 41-year time series that stretched from 1971 to 2012.

RESULTS AND DISCUSSION

The results of the study show that investments in research and development (R&D) have had a positive effect on peach and nectarine production that lasted for at least 21 years. The study found that the industry derives the highest benefits from R&D investment in the 13th year after investment. Thereafter, the benefits continue to be positive and of increasing significance for an undefined period of time. The rate of return calculation revealed that every R100 invested in the ARC's peach and nectarine research programme yields a R56 increase in value in the industry.

CONCLUSIONS

The high rate of return shows the investment in R&D economically worthwhile. Being so high, it would benefit the industry if investment in the ARC were to increase as this will yield higher future returns. The lesson that can be learnt from this study is that investment today has an effect in the production produced in the future. Therefore today's investment in research and development can secure the future of the industry.

Keywords: R&D investment, productivity, rate of return

PRINCIPLES FOR THOUGHT IN SHIFTING THE CONCEPTUAL BARRIERS IN SOIL CLASSIFICATION

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INTRODUCTION

South African agriculture has been excellently served since the early 1970s by the Binomial and Taxonomic Soil Classification Systems. The classification of soils has provided a proven, sound scientific framework for agricultural development and information advice packages. It has seen extensive use in agricultural, environmental and planning projects. We owe a debt of gratitude to the insights provided by the developing fathers of the system, and to the teachers and advisors who have applied its practical simplicity in its many spheres of application. However, new insights into soil morphological observation, the need for increased levels of detail and understanding in interpretative application, and altered perspectives in application now require new perspectives to the initial classification principles. This paper provides perspectives to shape revised principles in a future soil classification system.

MATERIAL AND METHODS

The Binomial and Taxonomic Soil Classification Systems, and current descriptions, analyses and information systems from the breadth of South Africa serve as a basis for this discussion.

RESULTS AND DISCUSSION

Classification structure: The current use of only two or three diagnostic horizons severely limits understanding of soil genesis, ecological function, and potential soil information transfer applications. The altered perspective proposes that all recognisable diagnostic horizons be included in the formal classification structure. This implies an "open-ended structure" to accommodate real soil profile sequences in appropriately defined categories and classes. Stating the depth of classified material now becomes important. A multi-level classification structure could easily be envisaged with new definitive categories above (Soil Groups) and below (Families) the well-established soil form, while new classes (Soil Forms) at the soil form category level would seem to be an imperative.

Nature of diagnostic horizons: All materials traditionally defined as "soil" should in future be recognised as "diagnostic soil horizons". The implication is that no materials should be classified as "unspecified". Whilst retaining the conceptual basis for most diagnostic horizons, the definitions of most horizons will require adaptation. The Eluvial, Gley, Plinthic horizons and others should be all subject to review. Additional horizon materials, such as saprolite and fractured rock, which exert significant impact in ecological functioning of soils should be introduced as diagnostic horizons. The principles governing accumulation and humification of organic matter in wetland and freely drained topsoils will require attention.

CONCLUSIONS

The principles for future soil classification should be firmly established in a fresh and innovative culture of open-minded examination of factual observation and analysis, grounded in recognised scientific principles, and built on the established foundations of the South African Soil Classification System to guide and formulate its future development.

Keywords: soil classification, diagnostic horizons

PROPERTIES AND DISTRIBUTION OF SOILS OF THE AMATHOLE DISTRICT, EASTERN CAPE PROVINCE

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INTRODUCTION

Characteristic soils can be identified in the Amathole District of the Eastern Cape Province that can be directly associated with the geological formations and the range of climate variables of the district. Green, blue and grey mudstones and sandstones of the Adelaide Subgroup (Pa) comprises the dominant geology, together with mudstone and thick sandstone of the Tarkastad Formation (TRt) and Jurassic Karoo dolerite (Jd). The characteristic dominant soil forms observed in the high and moderate rainfall classes are discussed together with their mean soil properties. The characteristic soil properties have application in information transfer.

MATERIALS AND METHODS

The dominant geology formation of each Land Type of the Amathole District was determined and a code comprising the geology formation, broad soil pattern and rainfall range assigned to each Land Type. Using this code it is possible to determine the dominant soils for each geological formation and rainfall range through a simple summation process. Dominate characteristic soil groups are easily identified and referenced in the paper. Using these dominant soil groups, soil profiles representing each geological formation were extracted for the ARC-ISCW Soil Profile Information System and mean properties evaluated for a range of physical, chemical and mineralogical properties. These often characteristic soil properties are presented in concise tables for each dominant soil group.

RESULTS AND DISCUSSION

Generalized soil distribution derived from geology formations: In the Adelaide Subgroup geology a red and yellow-brown soil group occurs in the coastal high rainfall regions, together with smaller plinthic and duplex soil groups in the intermediate rainfall regions. Lithosolic soils are distributed throughout the region. In the coast belt, steeply sloping land results in soil loss and limited soil depth, while in the sub-humid interior an arid moisture regime limits soil weathering. Similar soil groups are encountered on the Tarkastad Formation, although with different mean soil properties. The Karoo dolerite, rich in weatherable minerals, gives rise to dominantly red apedal soils in the high rainfall regions, shallow black clays and structured red soils in the intermediate regions and base-rich lithosols in the sub-humid interior.

Generalized soil property values derived from soil profile analyses: Oakleaf, Cartref, Glenrosa and Mispah profiles of the Adelaide Subgroup have a dominantly fine sandy texture, intermediate silt values (mean 30%) and a sandy clay loam to loam texture (mean clay 20-25%). Intermediate Organic carbon (1.0 -1.4%) topsoil CEC (7.7 – 10.5 cmol (-)/kg) and P (4.6 – 18.0 mg/kg) and P sorption (22 -29 %) were determined. The Tarkastad soils have characteristic high fine sand contents (> 70%) with low topsoil CEC.

CONCLUSION

The characteristic soil groups and their mean properties can be productively used to construct the technology transfer information packages for agricultural development.

Keywords: Amathole District, dominant soils, soil properties

CAN GENERIC CALIBRATION EQUATIONS BE USED WITH ECHO® SOIL MOISTURE SENSORS?

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INTRODUCTION

Echo® type sensors are commonly used to monitor soil water content and schedule irrigation. However, to obtain accurate values, these sensors need to undergo a costly and time consuming calibration process for each soil in which they will be used. The objective of this study was to evaluate the applicability of generic calibration equations for use with the Echo® type sensors (models E10, E20 and 10HS).

MATERIAL AND METHODS

Four calibration procedures (M1, M2, M3 and M4) were evaluated. For M1, each sensor type was calibrated using four volumetric soil water contents (SWC) and their corresponding mV readings, per soil type (potted soils with clay contents of 11%, 22% and 50%). These data were further analysed to address three other calibration scenarios. In the second calibration method (M2), each sensor was calibrated using the pooled data from all three soils to generate a calibration curve covering a much wider SWC range. Thereafter, the mean of all the M2 calibration curves per sensor type were used as the calibration curve for new un-calibrated sensors and sensor performance was evaluated (M3). Lastly, the calibration equation for each uncalibrated sensor was estimated from the mean relationship between calibration coefficients (y-intercept and slope) with clay contents (M4).

RESULTS AND DISCUSSION

Good results were obtained for calibration methods M1, M2 and M3 with all sensor models producing coefficient of determination (r^2) values greater than 0.9. Satisfactory results (r^2 values greater than 0.7) were produced with method M4 for only the 10HS type sensor.

CONCLUSIONS

Due to the stability and similarity of the sensors within a model group (E10, E20 or 10HS), the use of a generic calibration curve for these sensors is possible. However, all new sensors require testing before use for their similarity with the group (slope of the curve quantifying the air-water vs mV relationship). In a shipment of new sensors it was observed that occasionally one or two sensors have a different air-water vs mV relationship, indicating the requirement for calibration of such sensors by means of the conventional method.

Keywords: soil water sensor, Echo, calibration, clay content

TERRAIN SUITABILITY ASSESSMENT: A GEOMATICS APPROACH

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INTRODUCTION

Terrain suitability assessment appraises terrain suitability units from a general point of view taking into consideration terrain conditions and soil qualities. It is therefore a classification of specific areas of land in terms of their suitability to support a specific land use in a sustainable way. The objective of this study was to develop a geomatics (GIS based) approach for identifying broad scale terrain units suitable for cultivation practices in terms of sustainable land use.

MATERIAL AND METHODS

Several baseline datasets were created from an interpolated 30m Digital Elevation Model (DEM), including slope and terrain units. Terrain units were created according to the guidelines given by the Land Type Survey of South Africa. The process involved the use of different parameters in an algorithm to create concave and convex areas from the DEM. A landform is a feature on the Earth's surface that collectively comprise terrain. Examples are mountains, hills, plateaux and plains. Landforms were calculated using focal statistics to establish the repetitive occurrence of combinations of terrain units and slope. Terrain suitability classes were created using natural entities consisting of a combination of landforms and soil depth. The classes range from 1 (not suitable) to 6 (highly suitable).

RESULTS AND DISCUSSION

The results showed that terrain suitability classes 5 and 6 which have no to limited restriction in terms of landform and soil depth cover only 3% of the study area. The total area suitable for cultivation is around 34% of the study area. The most representative terrain suitability classes are 2 (very low) and 3 (low), which cover more than 66% of the study area.

CONCLUSIONS

The geomatics approach was found to be a useful tool for identifying areas suitable for cultivation, particularly in study areas as large and inaccessible as the Eastern Cape. GIS information on land suitability is critical in order to obtain better, faster and cost-effective assessments for sustainable utilization and allocation of natural resources.

Keywords: Cultivation, DEM, Geomatics, Land use, Terrain suitability

THE PRODUCTION POTENTIAL OF KIKUYU-RYEGRASS PASTURE IN A MINIMUM-TILL SYSTEM

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Introduction

Dairy production from planted pastures in the southern Cape is based on minimum-till kikuyu pastures. Anti-quality factors, relatively low forage quality and variable seasonal dry matter production of kikuyu, however, limit milk production from kikuyu pasture. The strategic incorporation of annual or perennial ryegrass into a kikuyu pasture is the most economical pasture based practice whereby to improve the seasonal pasture production and forage quality of kikuyu. The selection of ryegrass species or variety can impact on the production potential of the kikuyu pasture base, and careful consideration should be given to choice of ryegrass to over-sow. The aim of the study was to quantify the seasonal dry matter yield, botanical composition, forage quality and grazing capacity of irrigated kikuyu over-sown with Westerwolds ryegrass, Italian ryegrass or perennial ryegrass.

Material and Methods

The study was conducted over two years as a system trial on existing kikuyu and grazed by Jersey cows in a put-and-take system. Westerwolds ryegrass (*L. multiflorum* var. *westerwoldicum*) was over-sown into kikuyu during March by broadcasting seed onto the stubble at 25 kg ha^{-1} and mulching to ground level. Italian ryegrass (*L. multiflorum* var *italicum*) was planted into kikuyu with an Aitchison seeder at 25 kg ha^{-1} during March after mulching. During April, perennial ryegrass was planted into mulched kikuyu using an Aitchison seeder at 20 kg ha^{-1}. Pastures were grazed at a 28 day interval and topdressed monthly with 55 kg N ha^{-1}.

Results and Discussion

The seasonal spread of growth and production within the kikuyu-ryegrass systems was affected by the ryegrass species or variety over-sown. The highest seasonal dry matter production was during summer for Westerwolds ryegrass-kikuyu, spring for Italian ryegrass-kikuyu and spring to summer for the perennial ryegrass-kikuyu pasture. The perennial ryegrass-kikuyu treatment maintained a more even seasonal distribution for growth rate, dry matter production and grazing capacity than the other kikuyu-ryegrass systems. Kikuyu over-sown with perennial ryegrass also had a higher total annual dry matter production and mean annual grazing capacity than when over-sown with Italian or Westerwolds ryegrass. The seasonal change of kikuyu-ryegrass pastures from ryegrass dominant in the winter to kikuyu dominant in the summer, resulted in a decrease in metabolisable energy and crude protein content, while neutral detergent fibre decreased.

Conclusion

From the viewpoint of fodder flow planning, it is recommended that kikuyu be over-sown with ryegrass to lower the risk and cost of a dairy production system based on kikuyu.

Keywords: forage quality, over-sow, botanical compoistion, growth rate, seasonal production

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INTRODUCTION

Soil organic matter (SOM) plays a key role in nutrient cycling and soil quality. Understanding the factors influencing decomposition and mineralization is essential for optimal management. To our knowledge, no research has been done on the effect of commercial fertilizers on compost decomposition dynamics in soils. The aim of this study was to investigate the effect of various NPK fertilizers on the decomposition dynamics of composts in sandy soil.

MATERIAL AND METHODS

Laboratory decomposition studies under ambient temperature and FWC were conducted over a 3-month period using local Cape Flats sandy soil and two commercially available composts treated with 3 types of fertilizers. Compost A contained 39% C and 2.2% N, while Compost B contained 18.8% C and 3.8% N. The composts were applied at a rate of 0.5% C by mass to the soil whilst a control received no compost. The following fertilizer applications were used; tomato fertilizer (NPK: 100:20:150), cabbage fertilizer (NPK: 250:100:200) and NP fertilizer (NP: 150:150). Throughout the incubation, respiration, dissolved organic carbon (DOC) and ß-Glucosidase activity was determined at fixed time intervals. At the start and the end of the study, total C and N, loss on ignition (LOI), and soil pH, were determined.

RESULTS AND DISCUSSION

It was found that both cumulative respiration and enzyme activity were primarily dependent on the compost quality; Compost A (wider C:N ratio) generally showed higher rates of respiration while Compost B (richer in polysaccharides) had higher ß-Glucosidase activities. In response to the fertilizer treatments, elevated ß-Glucosidase activity was observed for NP fertilizer only. This was attributed to the significant decrease in pH for NP treatments. The cabbage fertilizer application was found to significantly increase DOC production in all treatments, while concomitantly, slightly decreasing respiration. This effect was much more pronounced the lower the inherent N content of the soil-compost mixtures (% change in DOC due to cabbage fertilizer: Control soil = +225%, Compost A = +81%, Compost B = +27%). The increased DOC response could be attributed to the higher inorganic N content of the cabbage fertilizer, which could have suppressed lignin degradation while enhancing abiotic humification reactions (Berg 2000). The final LOI results indicated 5-8% less SOM in the cabbage fertilizer compost treatments relative to the controls.

CONCLUSIONS

The findings of this study show that high applications (above 250kg/ha) of inorganic N fertilizer to sandy soil treated with compost can promote the formation of DOC while concomitantly suppressing respiration. This could ultimately enhance humus formation and potentially promote SOM stabilization if the DOC reacts with soil clay minerals, instead of leaching into groundwater.

Keywords: Compost decomposition, Dissolved organic carbon, Inorganic fertilizer

WATCHING THE GRASS GROW FROM SPACE: CAN SATELLITE IMAGERY BE USED TO ESTIMATE EVAPOTRANSPIRATION AND BIOMASS ACCUMULATION FOR IRRIGATED MAIZE?

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INTRODUCTION

Increasing water scarcity in many catchments in South Africa is placing pressure on irrigation to use water more efficiently. Evapotranspiration (ET) is challenging to measure, and the methods we commonly use to do so (e.g. Eddy covariance, surface renewal, soil water balance method) are most often point scale measurements, leaving uncertainties regarding spatial variability in a cropped field. A major advantage of using satellite imagery to estimate crop ET is its capability to present detailed information for large areas (e.g. for 30 to 1000 m pixels in a 60 × 60 km image) in a visually intuitive way. The aim of this study was to assess the accuracy of the Surface Energy Balance Algorithm for Land (SEBAL) to estimate maize ET, biomass accumulation and yield, and explore ways in which this information can be useful to different potential users.

MATERIALS AND METHODS

Maize ET and biomass accumulation was monitored using the satellite-based SEBAL model for a 60 × 60 km area in the Douglas Region, Northern Cape. In-field measurements of biomass accumulation and soil water extraction were done for seven fields on commercial farms spread across the region. Measured field data was used to calibrate and test the SWB model, following which estimates of ET and biomass accumulation were compared with those obtained using SEBAL. For one 'super-site', Eddy covariance was also applied to estimate ET for additional verification.

RESULTS AND DISCUSSION

Good correlations were observed for ET estimates obtained using in-field measurement techniques combined with crop modelling and estimates using satellite imagery. Biomass accumulation was also well estimated using SEBAL. As SEBAL does not estimate yield directly, innovative ways to do so for maize were explored, with varying levels of success.

CONCLUSIONS

Results from this study reassure us that quantitative remote sensing models such as SEBAL can be used with confidence for different applications in South Africa, for example, on-farm management, farming practice evaluation and at larger scales in Integrated Water Resources Management.

Keywords: evapotranspiration, SEBAL, water scarcity

BIOCHAR PRODUCTION AND APPLICATION - AN OVERVIEW

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Sustainable biochar is a powerfully simple tool to fight global warming. This 2,000 year-old practice converts agricultural waste into a soil enhancer that can hold carbon, boost food security, and discourage deforestation. Sustainable biochar is one of the few technologies that is relatively inexpensive, widely applicable, and quickly scalable.

A substantial amount of research have been done on the use of biochar in soils over the past 10 years. These studies show various advantages of the use of biochar in agriculture and specificly in conjuction with chemical fertilizers. Some concerns are raised regarding toxic elements in biochar when using certain feed stocks. The advantages of making biochar part of a plant feeding programme by far outweighs the perceived dissadvantages of using a “low quality” biochar or none whatsoever.

The barriers inhibiting researchers, scientis and resource managers to use biochar include 1) consistant “good quality” and sustainable supply of biochar and 2) the cost-effective production of biochar. The challenge to researchers, sientists, manufacturers, users, resource managers and government is the absence of a collaborated effort to find solutions to the barriers the industry faces.

It is imperitive that all roll-players be involved to find solutions and that theirs is a conserted effort to inform, educate and consult all stakeholders in order to build a sustainable biochar production and application industry in Southern Africa.

Keywords: Biochar, production, application, soil fertility

PHOSPHATE FERTILIZER VALUE OF SEWAGE SLUDGE

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INTRODUCTION
A growing population, urbanization and an increase in the number of industries are causing an increase in sewage sludge (SS) that needs to be either beneficially used or disposed of. Application of SS to agricultural lands is a well-known practice but the plant available phosphate and phosphate fertilizer value of SS has been of concern due to the wide variety of soils that SS is applied to and the different phosphate removal processes that sewage waste water undergoes at the water care works (WCW) and the source used to produce SS. In an incubation study the plant available phosphate and phosphate fertilizer value of different SS mixed with four different soils and were compared with that of MAP. Bray-1 was used in the study to determine if plant available phosphate from SS is influenced by, among other factors, clay content and mineralogy of the soil and the method of phosphate removal from the waste water at the WCW.

MATERIALS AND METHODS
Five sludges (that underwent different biological and/or chemical processes at the respective WCW) and KH_2PO_4 and mono ammonium phosphate (MAP) were incubated with four top soils collected from the eastern Highveld of South Africa. Four replicates of P treatments were prepared and applied at 72 mg total P kg^{-1} dry soil and an un-amended control. The experimental units were capped and incubated in the dark at 25°C under aerobic conditions at field capacity for 168 days. Sub-samples were extracted with Bray-1 at different sampling dates. Phosphate in solution was determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES).

RESULTS AND DISCUSSION
Bray-1 extractable phosphate from sludge-amended soils in the incubation study suggested that different waste water treatments had an effect on plant available phosphate but these levels were still optimal for plants, even for the Fe treated sludge. The chemical (ferric chloride reactant) removal of phosphate from waste water decreased the potential phosphate plant availability; examples are sludges from Daspoort and Vlakplaas. With biological phosphate removal (BPR), the potential plant available phosphate was higher compared to chemically removed phosphate as in the case of sludge from Agriman. A relative phosphate fertilizer value (RPFV) was determined by comparing the sludges to MAP.

CONCLUSIONS
Soils with high clay contents decreased the plant available phosphate from the phosphate source regardless of the source type (being either commercial fertilizer or sludge), so that soil properties dominate at higher clay content because of increased P sorption capacity. When conducting incubation studies on the availability of phosphate from sewage sludge in soil it is best to do it in a soil with a low phosphate fixation capacity and low clay content. The reason is to better isolate sludge effects from soil effects on phosphate fixation. This may aid in better quantification of mineralization and solubilisation of phosphate from a sludge amended soil. The RPFV isolates the soil effect, so that BPR sludges achieved results comparable to MAP while plant available phosphate from chemically P removed sludges were lower.

Keywords: Ammonium phosphate, Bray-1, incubation, municipal wastewater sludge, phosphate photo-availability, relative phosphate fertilizer value %.

IMPACT OF BIO-STIMULANTS ON HERBICIDE STRESS: A PRELIMINARY STUDY

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INTRODUCTION

Grain crops are very important worldwide; however the successful production thereof is influenced by various factors, one of the most important being efficient weed control. Annual losses in maize production for example due to weed infestation are estimated at about 10-80 % due to competition, and various factors, ultimately reducing yield (Saladin et al., 2003). Bio stimulants can supply a solution via increased growth, induced resistance against both biotic and abiotic stress conditions, and stimulation of various metabolic processes, increasing quality and production of crops to mention only a few positive effects (Parrado et al., 2008).

MATERIAL AND METHODS

A maize and wheat trial laid out in a complete randomized block design were conducted in glasshouses of the Department of Soil, Crop and Climate Science from the University of the Free State in South Africa during the 2013/2014 growing season. A standard fertilizer program was applied based on soil analysis under irrigation. All the treatments were applied according to the specifications of the distributors and replicated 7 times. Certain physiological and morphological parameters were measured as well as soil microbial activity.

RESULTS AND DISCUSSION

In the maize trial the bio stimulant increase the leaf area, root weight and cob weight compared to the herbicide treated control. The photosynthetic rate was significantly increased during the growing season with the addition of the bio stimulant compared to the control as well as the soil microbial activity and diversity. In wheat the root and top growth, as well as, ear weight were increased compared to the treated control. The bio stimulant significantly increased the photosynthetic rate as well as yield by 22% compared to the herbicide control.

CONCLUSION

Bio stimulants can lighten stress related to possible herbicide damage and competition on crops.

Keywords: Herbicide stress, maize, wheat

REVISED CLASSIFICATION OF ANTHROPOGENIC SOILS IN SOUTH AFRICA

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INTRODUCTION

Anthropogenic soils and materials refer to relatively fine, crushed particulate mineral or organic materials resulting from one or more of the almost endless number of human activities that drastically disturb land from an original natural state. They comprise introduced materials from mining as well as from industrial, construction or urban activities that result in the creation of parent materials for new Anthrosol soils.

PRINCIPLES IN CLASSIFICATION OF ANTHOSOLS

The Anthrosols may involve the drastic alteration of Natural Soils by physical, chemical or hydrological processes resulting from drastic deep tillage, mechanical working, water diversion, pollution and extraneous additions of harmful solids or liquids. Their function and qualities differ substantially from those of the natural or original condition; the original morphology is no longer recognizable, does not apply any longer or has not developed yet. Due to the vast amount of land covered by these disturbed, polluted or new materials, it has become more important to include them in the soil database especially for land use planning, urban development and even for agricultural purposes.

RESULTS AND CONCLUSIONS

This classification of Anthrosols is separate from that of Natural Soils at the highest level, but uses a similar multi-level structure. The focus is on the morphological, physical, chemical and hydrological properties in a holistic sense and not on soil use. The proposed soil use could serve as supportive information to the classification on qualifier level. Careful observation and analysis together with an awareness of the type and extent of pedogenic indicators is necessary for detection. Chemical, physical and morphological characteristics are sometimes unique in Anthrosols.

The research and investigation into the revision of the South African Anthropogenic soils has resulted in the classification of five soil forms namely Witbank (transported); Grabouw (physically disturbed); Industria (chemically polluted); Stilfontein (hydric disturbed) and Cullinan (extended open excavations).

ACKNOWLEDGEMENTS

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Keywords: disturbance, pedogenic indicators, multi-level structure, five new soil forms

SOIL EROSION AND DAM DIVIDENDS: SCIENCE FACTS AND RURAL 'FICTION' AROUND THE NTABELANGA DAM, EASTERN CAPE, SOUTH AFRICA

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INTRODUCTION

The Mzimvubu River is the largest undeveloped river in South Africa. This in conjunction with the geographic importance (former homeland) of the river encouraged the Department of Water Affairs to investigate the potential of building a large multipurpose storage dam in the river. The Ntabelanga site in the Tsitsa tributary was recently proclaimed the appropriate site for the dam. Despite the widely acknowledged benefits of large dams, dam development continues to come up against important questions of social and environmental sustainability. Dam building is associated with intensification of land use and often leads to land degradation. The success of large infrastructural projects is not only a matter of whether it is economically or environmentally feasible but is increasingly being measured by sociological coherence. The presented study focuses on soil erosion problems in the Ntabelanga area before the Mzimvubu dam is constructed. For this purpose, the extent of erosion is firstly highlighted, followed an attempt to indentify erosion sensitive areas. The perceptions of local communities on the extent, causes and direct impact of soil erosion on their livelihoods were identified.

METHODOLOGY

The extent of erosion was determined through visually identifying erosion gullies in the study area from aerial photographs and satellite images. Erosion sensitive areas were identified in land type Db344 (adjacent to the anticipated inundation footprint) with digital soil mapping (DSM) using a combination of remote sensing and terrain analysis techniques. Validation observations (43) were used to determine the map accuracy. Rural perceptions were captured by a number of informal interviews with two communities in the study area.

RESULTS

Approximately 10% of the total study area is severely affected by gully erosion. The DSM revealed that 71% of Db344 has soils highly susceptible to erosion with map accuracy of 72%. The local communities are aware of the erosion problem and perceive that the causes are mainly related to rainfall. They expect that the building of the dam will reduce erosion as a greater area would be cultivated under irrigation.

CONCLUSION

Erosion is a severe problem in the Ntabelanga area. Discrepancies between the causes and peoples perspectives on erosion might result in tension when the planned dam doesn't meet their expectations

Keywords: Digital soil mapping, erosion sensitive soils, Mzimvubu dam, perceptions on erosion.

SOYBEAN NODULE DEVELOPMENT AND SENECENCE: THE ROLE OF CYSTEINE PROTEASES AND THEIR INHIBITORS

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INTRODUCTION

Symbiotic nitrogen fixation (SNF) drives plant development and yield. In soybean this interaction is short-lived leading to senescence and reduction of SNF. Understanding the contribution of specific enzymes and proteins during this process, could enable manipulation of this process to prolong active SNF, improving yields and turnover for the farmer.

MATERIALS AND METHODS

Soybean seeds (Prima 2000) were inoculated with a commercially available *Bradyrhizobium japonicum* (WB 74-1) inoculum. Plants were grown under controlled conditions in a greenhouse and RNA was isolated from the nodules at 4, 8 and 14 weeks. Three RNA samples from each time point were pooled and sequenced. The data processing, normalisation and data mining were done using the Galaxy platform. Transcript quantification and validation was done using qPCR. The activity of these target enzymes and proteins were further investigated with enzymatic assays.

RESULTS AND DISCUSSION

Comparing the gene expression profiles allowed for the identification of different gene sets within the cysteine protease and cysteine protease inhibitor (cystatin) families active during different periods of nodule developmental and senescence. A subset of the cystatins, identified in soybean, showed higher expression during nodule development, possibly playing a maintenance role during development, to prevent unintended activity of the proteases. The remaining cystatins had preferential expression during senescence, possibly regulating proteolysis when nodules senesce and undergo programmed cell death to maintain nitrogen fixation in determinate soybean nodules for as long as possible. This is possibly a controlled release on proteolytic activity by the cystatins with the onset of senescence. The direct interaction between these proteins and their enzyme targets are currently being further investigated.

CONCLUSIONS

Characterising components of the cysteine proteases-cystatin system gave insight into the activity and potential functioning of these genes during nodule development and senescence. Knowing when, where and what these proteins are doing, might enable strategies to be devised to circumvent premature senescence, prolonging active nitrogen fixation by delaying nodule senescence.

ACKNOWLEDGEMENTS

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Keywords: Cystatin, Cysteine protease, Development, Nodule, Soybean, Senescence

PRACTICAL CONSIDERATIONS FOR A NATIONAL SOIL DATABASE

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INTRODUCTION

Recently the call for the creation of a national soil database gained momentum due to the Soil Information Brainstorm held in Stellenbosch, 2014. Such a database would be a valuable asset to the South Africa, filling the current void of a lack of spatial soil information needed to make necessary policy decisions. To create such a database one should start with merging existing legacy data into one database. From this foundation, new data could be gathered and added to the database. It is a challenging task to merge data collected by different people, using different lab methods over a period of more than 40 years into one database. During a recent South African Soil Surveyors Organisation (SASSO) meeting in Cathedral Peak, the members divided into groups and collected data which were to go into a single database. This provided an ideal case study to identify some of the pitfalls which might be encountered when creating a national database.

MATERIAL AND METHODS

The fifty soil surveyors were divided into ten groups and sent into four different catchments of the Cathedral Peak research area. Each group were given a gps, soil auger, sampling boxes and vague instructions to make at least 5 observations along a transect of the catchment. Four different data dictionaries were used amongst the 10 groups. Samples were collected and labelled as the groups saw fit and analysed at the Cedara labs for basic soil properties. All the data was sent to a central location and merged into a database by one person. The data generated was used to update an existing soil map for the area which was created using digital soil mapping methods and only 18 soil observations. Soil pH, Carbon, CEC and basic cations were analysed at the University of the Free State laboratories for the first map. The process was assessed by the challenges encountered with the merging of the data from different groups into one database, and the accuracy improvement of the current soil map.

RESULTS AND DISCUSSION

The data proved invaluable in the upgrading of the existing map. In addition to a higher accuracy, more soil map units were also identified and mapped. Challenges encountered with the merging of the databases were inconsistent numbering of the observations and samples and having differing depth values in the different data dictionaries. Quality control was missing and there are question marks on the level of accuracy of the described profile data. Lastly the lab analysis results obtained from the two different laboratories vary immensely, and some form of standardisation is needed.

CONCLUSIONS

The value of such a combined database was proven by the big improvement in the soil map. To ensure ease of incorporating future field work into a database, a single data dictionary and sampling and labelling protocol should be followed. For both existing and newly acquired data the following parameters must be included for each entry into the database: date, gps co-ordinates, surveyor and the laboratory where analysis was done.

Acknowledgements
I would like to thank the members and management of SASSO for having this workshop and allowing the data to be used.

Keywords: Soil classification, data management, SASSO, digital soil mapping

APPLE WHITE ROOT GROWTH DYNAMICS

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INTRODUCTION

The availability of data concerning apple root growth patterns in Southern hemisphere regions is extremely limited. Quantitative information on white primary root growth dynamics is, however, critical when attempting to further improve nutrient uptake via better fertilizer scheduling, as well as for understanding tree carbon balance (Atkinson and Wilson, 1980; Eissenstat et al., 2006). Earlier research from the Northern hemisphere reported a bimodal root growth model with white root activity early to mid-season, and a second phase commencing after harvest until winter (Atkinson and Wilson, 1980), whereas more recent reports indicate more complex and less consistent white root growth patterns (Eissenstat et al., 2006). In this paper, white root growth dynamics were quantified in the Elgin-Vyeboom area for a mature, bearing 'Golden Delicious'/M793 (GD) and 'Cripps' Pink'/M793 orchard, a young, bearing 'Fuji'/M7 as well as a young, non-bearing 'Royal Gala'/M7 orchard.

MATERIALS AND METHODS

Mini-rhizotron technology was used to quantify primary white root production patterns for various apple cultivars under commercial orchard conditions. White roots were quantified from images collected on a regular basis during two consecutive seasons. Soil water and temperature as well as physiological measurements were performed on the same trees to determine possible correlations between these parameters.

RESULTS AND DISCUSSION

Although a bimodal root growth pattern was observed for the bearing GD during the 2013/14 season, the timing, intensity and duration of white root activity differed between orchards. Substantial primary root growth occurred during winter months and was most pronounced in the 'Fuji' orchard.

CONCLUSION

Although the number of root growth cycles per season are important, the greatest differences between the cultivars considered and other related findings is in the duration, timing and intensity of rooting cycles which have location specific practical importance.

ACKNOWLEDGEMENTS

Funding for this project was provided jointly by Yara International and HORTGRO Science.

Keywords: apple roots, mini-rhizotron, physiological measurements

IRRIGATION OF APRICOT TREES WITH POOR QUALITY WATER

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INTRODUCTION

Below average production of apricot tree plantings in Montagu, Koo and Barrydale in the Little Karoo could be ascribed to the deteriorating water quality of the Breede River (Moolman et al., 1999) and highly saline groundwater from boreholes which provide this area with irrigation water. Profit margins for farmers are such that decreased yields cannot be tolerated. Correct management of low quality water could improve production and net farm income and could decrease irrigation return flow into the river system.

MATERIAL AND METHODS

A drainage lysimeter was used to evaluate the effect of saline irrigation on apricot (Prunus armeniaca cultivar Palsteyn) trees over four years at Stellenbosch (S33˚ 55'; E18˚ 53') in the Western Cape. Salinity levels included a control (municipal water) and target levels of 0.7, 1.0, 2.0, 3.0 and 4.0 dS m^{-1}. The effect of saline irrigation water on soil water salinity, as well as, tree response was monitored.

RESULTS AND DISCUSSION

The salinity and SAR in the soil receiving irrigation water of 1 to 4 dS m^{-1} remained above 0.8 dS m^{-1} and below 10 respectively. Leaf water potential, leaf osmotic potential and relative water content of leaves decreased significantly with increased irrigation water salinity. Sodium increased significantly in above-ground woody tree parts in the 2 and 3 dS m^{-1} saline irrigation treatments. Chloride was correlated with foliar damage at irrigation water salinities exceeding 1 dS m^{-1} and leaf area duration decreased with increased salinity. The reduced canopy area in the higher salinity irrigation water treatments intercepted less light and, in combination with lower stomatal conductance and decreased net photosynthesis rate of leaves, led to reduced water consumption and final fruit size.

CONCLUSIONS

Growers were advised not to use irrigation water with salinity exceeding an electrical conductivity of 0.74 dS m^{-1} for irrigation of Palsteyn apricot on Marianna rootstock where a leaching fraction of 0.1 was applied.

ACKNOWLEDGEMENTS

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Keywords: chloride, fruit, growth, salinity, sodium

THE EFFECT OF GAMMA IRRADIATION ON GROWTH AND EFFICIENCY OF ENERGY CONVERSION IN *TRITICUM MONOCOCCUM* CULTIVAR EINKORN SEEDLINGS GROWN IN THE DARK

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INTRODUCTION

The gamma irradiation dosage that gives a 50% reduction in plant height after a week's growth in light, is assumed to be the ideal dosage to obtain a specific characteristic. By planting in the dark, the efficiency of energy conversion into growth can be determined. It isn't affected by physiological processes and therefore a better indication of retardation in growth due to cell death.

MATERIAL AND METHODS

Triticum monococcum cultivar Einkorn seed were given gamma irradiation dosages of 50 Gray (Gy), 150 Gy, 250 Gy and 350 Gy. The seeds were placed in germination paper in an incubator at 25°C in the dark in a randomized complete block design with eight repetitions. Every 12 hours embryos / seedlings were removed for a total period of 168 hours and dried at 110°C. Embryo / seedling growth, reserve energy usage, respiration and the efficiency of energy conversion into growth were determined. A two factor analysis was used for statistical testing.

RESULTS AND DISCUSSION

The reduction effect of gamma irradiation on leaf and root growth, reserve energy usage and the efficiency of the conversion of energy into growth was highly significant between all the irradiation dosages. Root growth displayed a stoppage in growth at 250 Gy and 350 Gy at 108 h of imbibition. The effect on respiration ranged from highly significant to not significant between all the irradiation dosages. The efficiency of energy conversion into growth of the 50 Gy dosage (92.34% of control from 60 h to 132 h) recovered to the same level as the control after 132 h of imbibition, while the 150 Gy (89.95% of control) displayed at a lower level an efficiency parallel to the control from 120 h onwards. The efficiency of energy conversion into growth of the 250 Gy (73.08% of control) and 350 Gy (70.52% of control) dosages displayed large reductions after 108 h and 84 h respectively and no recovery afterwards. In comparison to this reserve energy usage at 50 Gy, 150 Gy 250 Gy and 350 Gy at the same time length displayed a 92.32%, 63.04%, 59.40% and 47.62% of the control with physiological processes playing a larger role at 150 Gy and higher.

CONCLUSIONS

The recovery of the efficiency of energy conversion into growth can be used as an indicator of what dosage level can be used to obtain a specific characteristic. The fact that no full recovery takes place higher than a specific dosage, gives it an upper limit.

ACKNOWLEDGEMENTS

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***Keywords**:* cell death, dosages, Gray, wheat.

INFLUENCE OF TILLAGE AND CROP ROTATION ON SELECTED SOIL PHYSICAL PROPERTIES OF THE SHALE DERIVED SOILS IN THE R?ENS SUB-REGION OF THE WESTERN CAPE

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INTRODUCTION

Conservation agriculture became a very important management strategy around the globe with research showing that decreases in soil disturbance tends to improve soil physical properties and therefore positively influencing, amongst others, soil water storage capacity and water use of crops. The aim of this study was to investigate to what extent different tillage practices and crop rotation systems influence selected soil physical properties and water dynamics in the soil 7-8 years after introduction of the treatment combinations.

MATERIAL AND METHODS

The study was a component trial (2013 and 2014) within a long-term research programme investigating the effect of soil tillage and crop rotation on soil quality at the Tygerhoek Research Farm near Riviersonderend. Three crop rotations, continuous wheat (WWWW), wheat/medic-clover/wheat/medic-clover (WMcWMc) and wheat/canola/wheat/lupin (WCWL) including all sequences of wheat/canola/wheat/lupin (WCWL) were allocated to main plots. (Last letter of sequence indicates current crop). Two tillage methods, conventional (CT) and no-till (NT) were allocated to sub-plots and replicated three times. Soil cores were taken at 0-100, 100-200, 200-300 and 300-450 mm depth increments. Coarse fragments (>2.0 mm), particle size distribution, water stable aggregate percentage and water retention capacity were recorded. Infiltration rate and unsaturated hydraulic conductivity were determined *in situ* during the 2013/4 fallow period, using a minidisk infiltrometer. Bulk density was measured *in situ*, during the fallow, with a calibrated Troxler surface gamma-neutron gauge.

RESULTS AND DISCUSSION

Tillage and crop rotation did not influence (P=0.05) bulk density, coarse fragments, infiltration rate, unsaturated hydraulic conductivity and water stable aggregates. Mean bulk density was slightly higher under NT (1464.9 kg m^{-3}) compared to 1440.4 kg m^{-3} for CT. CT resulted in a marginally higher (P>0.05) increase in coarse fragments with depth, probably due to the use of the disk plough. Infiltration rate tended (P>0.05) to be lower for CT (29.6 mm h^{-1}) compared to NT (39.9 mm h^{-1}). The unsaturated hydraulic conductivity tended to be higher (P>0.05) under NT, possibly the cause of better micropore continuity. Aggregate stability was slightly higher (P>0.05) under CT (78.3%) than NT (76.9%) and significantly decreased (P=0.05) with depth despite clay content increasing, proving the positive effect of organic matter on aggregate stability in the high C topsoil.

CONCLUSIONS

The current study shows that in the short to medium term (7-8 years after starting the treatments) tillage and crop rotation did not influence the soil physical properties studied. It is suggested that the physical properties be monitored over time to detect any significant changes in the parameters tested as a result of the treatment combinations.

Keywords: aggregate stability, bulk density, infiltration rate, soil texture, unsaturated hydraulic conductivity, water retention

POTENTIAL POSITIVE EFFECT OF CLIMATE CHANGE ON SUGARCANE PRODUCTION IN SOUTH AFRICA

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INTRODUCTION

Sugarcane is grown all year round and is harvested every 12-24 months (March/April to November/December), depending on temperature and annual rainfall. The aim of the study was to analyse simulations of present day and future climate over South Africa, with emphasis on identifying the impact of future climate change on sugarcane production areas.

MATERIAL AND METHODS

Climatic suitability for dryland cane production is determined by the ratio of annual rainfall to annual evaporative demand (ET, mm/year); production begins to become marginal when rainfall is less than around 50% of ET. Annualized dryland cane yield can be estimated as a function of annual heat units (HU, base 12 °C) and annual rainfall. Annualized irrigated cane yield can be estimated from annual ET. Environmental suitability criteria (min rainfall, min temp, soil properties and break-even yields) for sugarcane in South Africa were used to prepare a time series of maps to show potential shifts in sugarcane production areas.

RESULTS AND DISCUSSION

Maps were prepared covering the period 1970 to 2090 at 15-year intervals. An ensemble of six high resolution (0.5° horizontal resolution) climate projections was employed. The projections were successfully bias-corrected by adjusting the simulated monthly climatology's of temperature and rainfall to that of CRU TS3.1 data.

The area of suitability for irrigated sugarcane expands, limited to the eastern low-lying parts of the country (Limpopo River Valley, Lowveld and coastal parts and adjacent interior of the eastern seaboard). Due presumably to moisture constraints, the area suitable for dryland production increases slightly, confined to low-lying KZN and southern Mpumalanga (Lowveld).

CONCLUSIONS

The production area of sugarcane could increase as a result of climate change. A shift into new production areas will lead to increased production volumes, thereby opening up opportunities for new rural development projects such as ethanol processing facilities, creating more jobs and benefitting small commercial growers through market assurance.

ACKNOWLEDGEMENTS

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Climate Studies, Modelling and Environmental Health, CSIR Natural Resources and Environment for providing the climate change projections used in the study.

Keywords: climate projections; crop suitability

SOIL CARBON ACCOUNTING IN KZN MIDLANDS USING VERTICAL DISTRIBUTION FUNCTIONS

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INTRODUCTION

The mapping of soil carbon (C) stocks may be improved based on understanding the vertical soil organic carbon (SOC) distribution in Ultisols. It was hypothesized that sampling for a soil C inventory to 1m depth in areas with known SOC vertical distribution patterns may be reduced to a single sample per observation point (taken in triplicate close to the soil surface).

MATERIAL AND METHODS

A study catchment area of about 300km^2 was selected in the KwaZulu-Natal Midlands. A combination of forestry/grassland areas were selected for SOC mapping in the upper section of the catchment, where detailed soil maps and data were available. Vertical C distribution functions were developed using soil samples from 48 profiles throughout the catchment, sampled at depths of 2.5, 7.5, 12.5, 17.5, 30, 40, 50, 75 and 100cm for bulk density (BD) and C determination. The distribution functions were developed per soil type and the resulting equations linked to point soil type data at 100m resolution. Additional soil surface samples (0-5cm) were collected for BD (gravimetric) and organic C (NIR spectroscopy) determination to provide (volumetric C content at the soil surface) values for further interpolation.

RESULTS AND DISCUSSION

For the 48 profiles combined, the stratified depth-averaged SOC distribution to 1m depth has an exponential distribution and soil C stocks were calculated as a definite integral of the exponential distribution function:

where: Cv is the volumetric C content at depth z, is the volumetric C content at the soil surface (0-5cm), k is the empirical coefficient of the exponential function, and z is soil depth.

Large variation was observed in the SOC distribution of individual profiles, as well as on average for profiles grouped per land use or soil type. As a result, different k-values characterized by the standard mean error of estimate are suggested for various groupings. Raster layers were developed for each of the variables since the variation of each parameter shows a different spatial pattern. The values were co-kriged with curvature, elevation and slope parameters derived from a 20m digital elevation model (DEM). The values of k were grouped per soil type, associated with point observations of soil types and interpolated using co-kriging with the derived DEM parameters. The raster calculation produced a map of SOC stocks to 1m depth.

CONCLUSIONS

It is concluded that vertical SOC distribution can be successfully described by an exponential function. Such functions can be developed based on different soil and land use characteristics in order to produce the best predictive capacity. This enables the prediction of cumulative SOC content to 1m depth using only a volumetric C content value at the soil surface.

Keywords: Soil carbon mapping, soil carbon stock, soil organic carbon, vertical SOC distribution

THE GLOBAL SOIL PARTNERSHIP - A UNIFIED VOICE FOR SOILS

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INTRODUCTION

Soils are under increasing pressure from various land uses and extraction processes to feed a growing population and meet its needs for biomass, fibre, fodder, building materials, building surfaces and more. This necessitates improved and coordinated management approaches to ensure the long-term preservation of soils for future use.

MATERIAL AND METHODS

The Global Soil Partnership (GSP) was established by members of the Food and Agriculture Organization (FAO) of the United Nations as a voluntary initiative to improve governance of soil resources, promote awareness among stakeholders on sustainable soil management, address critical soil issues of global and regional relevance, support the acquisition of relevant soil knowledge and promote links between existing multilateral initiatives and bodies. The GSP will address these aims through five main pillars of action to be implemented through Regional Soil Partnerships. Global action plans for four of these pillars have been endorsed during the Second Plenary Assembly of the GSP and an implementation plan for Africa will be developed by June 2015.

RESULTS AND DISCUSSION

To date the GSP has been financially supported especially by the European Commission and FAO (hosting the Secretariat). To mobilize additional funding for GSP activities, a Healthy Soils Facility had been established. The global action plans and regional implementation plans are part of this facility as motivation to secure longer term funding for implementation of sustainable soil management implementation, soil research for development, education, awareness, the development of soil databases and monitoring and evaluation activities. The Eastern and Southern African (sub)regional Soil Partnership was launched in Nairobi, Kenya, in March 2013 where it was agreed that similar environmental and developmental challenges, priorities and needs exist within the region to improve soil health and management and to increase food security. It acknowledged the benefits to be gained from establishing national and regional soil information systems, widespread application of sustainable soil management practices and capacity development. The five priorities for the region were identified as: 1) developing, updating and disseminating national and regional soil information; 2) developing and implementing training and capacity development programmes; 3) guiding and enabling sustainable soil management implementation; 4) addressing soil degradation; and 5) establishing links and networks with other national, regional and global initiatives that impact soil health. These priorities, together with those of the Central and Western African Soil Partnership, will form the basis for the development of an African implementation plan.

CONCLUSIONS

As a voluntary coalition the GSP relies strongly on the participation and inputs of all levels of stakeholders into its activities at global, regional and national levels. The scene for sustainable soil management is being set at global and regional levels, but it is up to national partners to utilize the GSP umbrella and support to guide and motivate implementation of GSP priorities at national level.

Keywords: Global Soil Partnership, sustainable soil management, soil monitoring