Abstracts:

Oral Presentations

POTENTIAL INFLUENCE OF ORGANIC ACIDS FROM ECTOMYCORRHIZAL FUNGI ON WEATHERING OF HARD MINERAL MATERIALS (IRON ORE MINERALS)

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Many studies have proposed that factors such as pH, nutrient limitation, particle size, organic acid production, and mechanical penetration of the mineral have different influences on mineral weathering (Jain and Sharma, 2004; Adeleke et al., 2012). Organic acids usually produced by soil microorganisms are well recognised in biological weathering of soil minerals. Ectomycorrhizal (ECM) fungi are part of the soil microbial community with special capability to produce organic acids. These fungi are able to absorb nutrients from rocky and hard mineral materials through high production of low-molecular-weight HOC=O compounds - organic acids (Burford *et al*., 2003; Jain and Sharma, 2004).

The present study examined the potential roles of organic acids produced by four ectomycorrhizal fungi on the weathering of iron ore minerals. Low grade quality iron ore minerals from Sishen iron ore mine were utilised in this study in an experiment that involved both mycorrhizal and non-mycorrhizal *Pinus patula*. Basic nutrients were provided using Hoagland solution but the solution was modified by limiting the source of K to encourage the plants. In addition, sources of Mg were also halved to limit the alternative K source (Mg) available to the fungi during the weathering process (Van Schöll et al. 2006). Four types of ECM fungi were used, namely *Pisolithus tinctorius* (PT), *Paxillus involutus* (PI), *Laccaria bicolor* (LB) and *Suillus tomentosus* (ST).

After harvest, the organic acids contents of the soil were analysed using high pressure liquid chomatography (HPLC). Soil was analysed to determine the concentration of four different organic acids - oxalic acid, citric acid, malonic acid and maleic acid. Potassium and phosphorus contents of the plant shoots and roots were also analysed.

Among the organic acids analysed from the soil samples in this study, citric acid was produced in highest amounts, followed by oxalic acid. Particle size of iron ore and fungal type significantly affected production of organic acids. Neither nutrient (K) limitation nor the addition of iron ore minerals increased organic acid production by either mycorrhizal or non-mycorrhizal plants. With no statistically significant difference between the amount of citric acid detected in treatments with highest and lowest potassium mobilisation, the quantity of organic acid produced in the present study can therefore not be directly correlated to mobilisation of either P or K from the iron ore minerals.

The study has also shown that that mineral weathering occurred as a result of a combination of factors; not only in response to organic acid production by the ectomycorrhizal fungi.

REFERENCES

Adeleke RA, Cloete E, Bertrand A, Khasa DP (2012). Iron ore weathering potentials of ectomycorrhizal plants. Mycorrhiza 22:535–544

Burford EP, Kierans M, Gadd GM (2003) Geomycology: fungi in mineral substrata. Mycologist 17:98–107.

Jain N, Sharma D (2004) Biohydrometallurgy for nonsulfidic minerals—a review. Geomicrobiol J 21:135–144

Keywords: Ectomycorrhiza, iron ore metals, organic acids, phosphorus, potassium

MANAGING POOR QUALITY MINE WATER: IS IRRIGATION PART OF THE SOLUTION?

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INTRODUCTION

Salt loads associated with decanting mine water from Witwatersrand gold mines will have to be reduced significantly to prevent contamination of existing freshwater supplies in the Vaal Basin. Several standard technologies exist to remove the salts from this water, but these techniques are expensive, energy intensive, and create high volumes of brine waste product requiring disposal or value addition. Previous research done in the Mpumalanga coalfields has shown that when $CaSO_4$-rich mine water is used for irrigation a significant quantity of gypsum precipitates (becomes insoluble) in the soil, reducing salt loads in the irrigation return flows. Multiple crop species irrigated with sprinkler did not show foliar injury symptoms and yields were higher than for dryland production. Furthermore, gypsum precipitation did not result in any observable physical or chemical changes that would adversely affect soil productivity.

MATERIALS AND METHODS

Current research focus has shifted from Mpumalanga to the Vaal Basin to investigate the feasibility of using irrigation as part of a long-term goldfield mine water treatment strategy. Alternative neutralization steps to remove acidity and harmful metals, including using aluminium sulphate or manganese wad, or irrigating directly to limed soils or mine dumps are being investigated. Long-term simulations with SWB-Sci are being conducted to quantify the amounts of salts that are being precipitated and the fractions of soluble salts that are being exported via irrigation return flows.

RESULTS AND DISCUSSION

Preliminary results show that a significant fraction of the salts are precipitated out in the soil, with the size of this fraction largely dependent on the method of pre-treatment and the quality of the irrigation water. For the eastern, central and western underground mining basins, the most important considerations will therefore be (1) suitability of water quality (following different treatment options) to ensure significant gypsum precipitation in the soil, and (2) the hydrological setting of the irrigation scheme(s) so that, where necessary, the irrigation return flows return to the polluted groundwater source or can be intercepted and treated to remove remaining salt loads.

CONCLUSIONS

In addition to potentially representing a more cost-effective treatment option than reverse osmosis and having a smaller environmental footprint, further positive spin-offs of using this mine water for irrigation are job creation and increased food security. Careful irrigation scheduling, and storage of mine water during phases of lower demand (e.g. high rainfall periods) are also important considerations that need to be taken into account.

ACKNOWLEDGEMENTS

We gratefully acknowledge the support of the Water Research Commission (Project K5/2233, Feasibility study on the use of irrigation as part of a long-term neutralised acid mine drainage management strategy in the Vaal Basin) for funding this research.

Keywords: Acid mine drainage, gypsum precipitation, SWB-Sci

EVALUATION OF SYMBIOTIC N FIXATION, CARBON ASSIMILATION AND WATER-USE EFFICIENCY OF FIELD GROWN SOYBEAN (GLYCINE MAX L. MERR.) GENOTYPES IN NORTHERN GHANA

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INTRODUCTION

Grain legumes contribute huge amounts of symbiotic nitrogen to cropping systems in Africa. Soybean (*Glycine max* L. Merr.) is a vital food legume with the ability to form symbiosis with specific root-nodule bacteria and contribute rich amount of N to soil N fertility. Soybean fixes up to 337 kg N ha^{-1} with *Bradyrhizobium japonicum* inoculation (Herridge, 1982). Symbiotic N fixation (SNF) can be influenced by high temperatures and low soil moisture (Siczek & Lipiec, 2011). This study assessed SNF (as ureides in xylem sap) and water-use efficiency (WUE) in six field-grown soybean genotypes.

MATERIALS AND METHODS

Six soybean genotypes (Anidaso, Quarshie, Salintuya 1, Jenguma, TGx-1834-5E and TGx-1448-2E) were planted in experimental plots at three sites (namely, Duko, Kanshegu and Nyankpala). At flowering, photosynthetic rates (A) and leaf transpiration (E) were measured on young trifoliate leaves using IRGA-6400. WUE was calculated as the ratio of A to E from the measurements taken. Accumulated xylem sap on root stocks of decapitated plants were collected with micro-pipettes into vials and stored at – 4 °C for analysis of ureides (allantoin and allantoic acid).Plants were harvested, oven-dried (70^{o}C), weighed, ground (0.85 mm) and analyzed for ^{13}C using mass spectrometry.

RESULTS AND DISCUSSION

The six soybean genotypes showed significant (p=0.05) differences in shoot dry matter, yield and symbiotic N_2 fixation. A 2-Way ANOVA revealed significant (p=0.05) differences in plant growth and ureide concentration of xylem across the locations. There was however no effect of rhizobium inoculation on ureide levels in xylem sap, whether across locations or among genotypes. At Duko, there was a positive correlation between photosynthetic rates and grain yield of soybean genotypes. Enhanced N_2 fixation and high photosynthetic rates translated into high WUE and increased grain yield in genotypes Anidaso, Jenguma and TGx-1448-2E at Duko.

CONCLUSIONS

The high WUE in Anidaso, Jenguma and TGx-1448-2E suggests that it can withstand intermittent drought notwithstanding its enhanced N fixation ability. These genotypes will be particularly encouraged for cultivation in the study area which is characterized with erratic rainfall amidst soils low in organic matter.

Keywords: Bradyrhizobium japonicum, nitrogen fixation, xylem sap

PYRAMIDING STEM RUST RESISTANCE GENES SR2, SR25 AND SR26 INTO SOUTH AFRICAN WHEAT CULTIVARS

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INTRODUCTION

Stem rust, caused by *Puccinia graminis* Pers. f. sp. *tritici*. Eriks. & E. Henn. (*Pgt*) still remains an important disease of bread wheat (*Triticum aestivum L*.) worldwide (Leonard & Szabo, 2005). The appearance of Ug99 strains in East Africa, Iran and South Africa has increased interest among researchers to reduce the impact of Ug99. Resistance genes *Sr2* and *Sr26* are effective against all races of *Pgt*, including *Ug99* and its derivatives (Singh *et al*., 2006). *Sr25* is effective against most races. In this study, a durable rust resistance strategy, as proposed by the Borlaug Global Rust Initiative, was deployed to introgress three resistance genes into widely used South African bread wheat cultivars as a means to increase broad-spectrum resistance to several races.

MATERIALS AND METHODS

Five South African wheat cultivars were crossed with several donor lines carrying pyramided genes. The resulting F_1 plants were backcrossed to recurrent parents for 2 to 3 times to generate BC_2F_1 and BC_3F_1 plants. Before making backcrosses, diagnostic molecular markers for *Sr2*, *Sr25* and *Sr26* were used to select lines with combination of the *Sr* genes. The PCR products were resolved on 1% agarose gel electrophoresis for *Sr2* and *Sr26*, and on polyacrylamide gel electrophoresis for *Sr25*.

RESULTS AND DISCUSSION

A total of 91 BC_1F_1 and 20 BC_2F_1 lines containing the three pyramided genes were developed. However, some lines only contained two pyramided genes with either a combination of *Sr2* and *Sr26*, or *Sr2* and *Sr25*, or *Sr26* and *Sr25* of the BC_2F_1 generation. About 635 BC_3F_1 lines were screened with diagnostic markers for *Sr2* and *Sr26*. After BC_2 an BC_3 generations, recovery of the genome of the recurrent parent is estimated at 87.5 and 93.75%, respectively. Although there is evidence that the *Sr25* and *Sr26* genes, used in this study, have no adverse effect on grain yield and end-user quality, the germplasm still needs to be evaluated for quality, yield and resistance traits.

REFERENCES

LEONARD, K.J. & SZABO, L.J.S., 2005. Stem rust of small grains and grasses caused by *Puccinia graminis*. *Mol Plant Pathol*. 6, 99–111.

SINGH, R.P., HODSON, D.P., JIN, Y., ESPINO, J.H., KINYUA, M.G., WANYERA, R., NJAU, P. & WARD, R.W. 2006. Current status, likely migration and strategies to mitigate the threat to wheat production from race *Ug99* (TTKS) of stem rust pathogen. *CAB. Rev. Perspect Agric. Vet. Sci. Nutr. Nat. Resour*. 1(054):13.

ACKNOWLEDGEMENTS

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Keywords: Stem rust resistance, pyramiding

THE EFFECT OF SEED TREATMENT AND STORAGE CONDITIONS ON THE YIELD AND YIELD COMPONENTS OF VARIOUS LEVELS OF SPROUTED SEED

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INTRODUCTION

Wheat farmers face severe economic losses when their wheat is downgraded as a result of preharvest sprouting. Consequently planting fields with retained sprouted grain is viewed by many farmers as an economic alternative. Limited information on the field performance of sprouted seed and crops grown from sprouted seed is available. Although seed with low levels of sprouting damage can retain its germination capacity for a time, it is thought to deteriorate more rapidly than sound seed when stored for a certain time. The effect of seed treatment on these seeds is also not clear. Therefore, the effect of seed treatment and storage conditions on the yield and yield components of various levels of sprouted wheat kernels, when used as seed, was determined.

MATERIALS AND METHODS

Five levels of sprouted kernels (0%, 25%, 50%, 75% and 100%) were treated with two different seed treatments, namely Gaucho (active ingredient imidacloprid) with Flite (active ingredient triticonazole) and Gaucho with Anchor (active ingredient carboxim + thiram). Untreated seed of each sprouting severity group was used as a control. The seed were divided into three groups for planting in year 1, and the remainder was stored under three different storage conditions for 12 months and 24 months respectively. These conditions included temperatures of 10°C, 15°C-18°C, and 22°C-25°C. Germination was determined in the laboratory, while emergence and yield components were determined in the field before harvest. The trials were harvested when the moisture content was <13%.

RESULTS AND DISCUSSION

A significant and constant decrease in germination (%) with an increase in sprouting level was observed in the seed stored at the three storage conditions. Sound seed had a significant ($P<0.05$) higher average germination (64.8%) over all storage conditions than those with evidence of sprouting. Storing conditions, as well as sprouting levels, significantly affected emergence (%) with fresh and sound seed having a significant higher emergence (%) than seed that have been stored or that have been sprouted. Only 10% of the seed that were fully sprouted (100%) could develop into viable seedlings. A significant decrease ($P<0.05$) in the number of plants m^{-2} was evident with an increase in sprouting level, especially in the plants grown from seed treated with the various seed treatments. Yields realised during any given year were not affected by sprouting level. Even with the significant decrease in emergence (%) resulting in a significant lower number of plants m^{-2}, the yields were similar for all sprouting levels. However, after 24 months of storage, yields were significantly decreased at the higher sprouting levels.

CONCLUSIONS

It still remains the best option to plant high quality seed with a high vigour. However, if a crop is slightly sprouted, a producer can use these seed for planting, as wheat plants are able to compensate significantly, resulting in acceptable yields. It is important to take note that these seed should not be treated, as direct exposure of embryos to the chemicals of the seed treatment, may harm the embryos resulting in poor emergence and seedling stand.

Keywords: emergence, germination, seed treatment, seed quality, storage, wheat

SWAMP: A SOIL LAYER WATER SUPPLY MODEL FOR MACROSCOPIC WATER UPTAKE OF FIELD CROPS UNDER OSMOTIC STRESS

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INTRODUCTION

Models like SWAP, HYDRUS and SALTMED compute crop water uptake under osmotic stress with an empirical piecewise linear, or S-shaped dimensionless-reduction function. These functions require parameters which correspond normally to the Maas and Hoffman threshold and slope values. As highlighted by Skaggs et al. (2006), "more research is needed if the above-mentioned models are to be employed as predictive tools that do not require extensive crop- and site-specific calibration of these parameters, involving inverse modelling". The objective of this paper is to present and evaluate an alternative model that does not rely on these parameters, i.e. SWAMP (Bennie et al., 1998; Barnard et al., 2013).

MATERIALS AND METHODS

Osmotic potential parameters were incorporated into the soil layer water supply algorithm of SWAMP and lysimeter data used to evaluate the model. SWAMP was calibrated to represent the soil conditions of the trial, i.e. salt accumulation due to deteriorating water quality of peas and maize grown on sand and sandy loam water table soils. Simulations of weekly water uptake during the growing season were statistically analysed.

RESULTS AND DISCUSSION

SWAMP was able to successfully (I_{SWAMP}> 70%) simulate a reduction in water uptake of both crops during the growing season under osmotic stress conditions. No macro-pattern was observed, which means that the water uptake residuals contain no structure that is not accounted for in the algorithm and parameters.

CONCLUSION

Given above-mentioned conditions, it can be concluded that SWAMP is successful in simulating crop water uptake under osmotic stress. SWAMP can therefore be introduced as an alternative macroscopic water uptake model that does not rely on the empirical piecewise linear and S-shaped functions.

REFERENCES

Barnard, J.H., Van Rensburg, L.D., Bennie, A.T.P., Du Preez, C.C., 2013. Simulating water uptake of irrigated field crops from non-saline water table soils: validation and application of the model SWAMP. Agricultural Water Management 126, 19-32.

Bennie, A.T.P., Strydom, M.G., Vrey, H.S., 1998. Use of computer models for agricultural water management on ecotope level. Water Research Commission Report No. TT 102/98, Pretoria, South Africa.

Skaggs, T.H., Van Genuchten, M.T., Shouse, P.J., Poss, J.A., 2006. Macroscopic approaches to root water uptake as a function of water and salinity stress. Agricultural Water Management 86, 140-149.

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Keywords: Field crops, irrigation, soil salinity, water quality

INVOLVEMENT OF SOLUBLE SUGARS, PROLINE AND ASCORBIC ACID AS POSSIBLE MECHANISMS IN RESISTING CHILLING STRESS IN 'EUREKA' LEMONS [*Citrus limon* (L.) BURM.F.]

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INTRODUCTION

Cold storage of lemons often leads to chilling injury (CI), a physiological disorder causing pitting, red blotch, surface lesion and staining of the lemon rind, limiting fruit marketability and causing economic losses. It was hypothesised that treatment with methyl jasmonate (MJ) and salicylic acid (SA) may enhance chilling tolerance of lemon fruit by enhancing certain defence compounds (proline, ascorbic acid and soluble sugars) in the rind thereby mediating a CI reduction of lemon fruit.

MATERIALS AND METHODS

Lemon [*Citrus limon* (L.) Burm.] fruit cv 'Eureka' were collected from three locations of varying climatic conditions (moderate sub-tropical, warm temperate and cool subtropical climate). Fruit were treated with 10 µM MJ, 2 mM SA, or 10 µM MJ plus 2 mM SA before cold storage at -0.5°C for 28 days. Lemons were removed from storage after 0, 7, 14, 21, or 28 days storage and transferred to room temperature for 7 days to simulate shelf life. After this period CI occurrence was rated. Alterations in biochemical parameters involved in chilling tolerance (proline metabolism, soluble sugars and ascorbic acid) were examined with the intention to elucidate the mode of action of such MJ and SA treatments.

RESULTS AND DISCUSSION

Postharvest treatment of 'Eureka' lemons with MJ and SA significantly (P = 0.05) reduced CI and enhanced proline, ascorbic acid and soluble sugars concentrations, systems probably involved in chilling resistance. The concentration of soluble sugars, proline, and ascorbic acid increased following treatment with MJ and SA; this may have played a role in enhancing chilling tolerance in lemon fruit. The treatment combination of 10 µM MJ plus 2 mM SA was more effective in alleviating CI and enhancing such known stress defence compounds than individual applications of either 10 µM MJ or 2 mM SA. The efficacy of MJ and SA in reducing CI and enhancing such compounds depended on the MJ/ SA concentration, the origin of the fruit (farm location) and the interaction of the two factors. Agronomical factors prevailing on a certain farm might have also played a role in lemon susceptibility to CI.

CONCLUSIONS

This study suggest that enhancement of biochemical mechanisms such as proline, ascorbic acid and soluble sugars in lemon flavedo during cold storage may be involved in chilling tolerance mediated by MJ and SA treatment.

ACKNOWLEDGEMENTS

This study was supported by the South African National Research Foundation and the South African Citrus Academy.

Keywords: Ascorbic acid, methyl jasmonate, proline, salicylic acid, soluble sugars

THE EFFECTS OF CONVENTIONAL AND CONSERVATION AGRICULTURAL PRACTICES ON SOIL AGGREGATE STABILITY AND RELATED PROPERTIES

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INTRODUCTION

Studies have shown that crop rotation and reduced tillage induce higher soil carbon (C) and nitrogen (N) levels compared to conventional tillage practices (Havlin et al. 1990). It is also documented that soil organic matter (SOM) may increase soil aggregate stability (Greenland et al. 1962). The formation of stable soil aggregates is a function of organic compounds that are produced during the decomposition of SOM. In a 4-year study the medium-term effects of conventional (CT) and reduced (RT) tillage, as well as fertilizer level and crop system, were evaluated on soil aggregate stability and related properties. Results from the fourth experimental season, as well as temporal trends of soil properties are discussed.

MATERIALS AND METHODS

Composite undisturbed surface soil samples were taken annually over four experimental seasons on a dryland conservation agriculture (CA) field trial. The sampled plots statistically represented two tillage practices and four fertilizer/crop systems. Soil aggregate stability and water retention were determined according to Beukes (1987). Soil organic carbon (SOC), total N and inorganic N (NH_4-N, NO_3-N) were determined on prepared subsamples according to standard analytical procedures. Standard analysis of variance was performed to test for significant differences between treatments for the various soil properties.

RESULTS AND DISCUSSION

Reduced tillage induced significantly higher aggregate stability (AS), as well as soil C and N compared to CT. There are trends that inorganic N contents and C/N ratios are higher under RT than under CT. Significantly lower water retention was recorded for RT, compared to CT. Temporal AS increased moderately under RT but decreased over time under CT. Soil organic C and N under RT showed an initial increase, followed by a leveling off, while under CT these properties showed a decline. No statistically significant effects of fertilizer level (low and high) or crop system (mono-culture maize vs. maize/legume intercrop) on AS, or any soil other property, were measured.

CONCLUSIONS

Reduced tillage in a CA system led to increased AS, SOC, N, C/N ratios, as well as inorganic N, compared to CT. Stable soil aggregates led to improved water retention relationships with envisaged positive effects on infiltration, drainage and soil aeration. Temporal trends show increases of AS, SOC and N under RT compared to CT.

REFERENCES

Beukes DJ. 1987 Evaluation of the volumeter method to quantify aggregate stability of a vertisol [Afr]. *South African Journal of Plant and Soil* 4 (2): 94-97.

Greenland DJ, Lindstrom GR, Quirk JP. 1962. Organic materials which stabilize natural soil aggregates. *Soil Sci Soc Am Proc* 26: 366-371.

Havlin JL, Kissel DE, Maddux LD, Claassen MM, Long JH. 1990. Crop Rotation and Tillage Effects on Soil Organic Carbon and Nitrogen. *Soil Sci Soc Am Proc* 26: 448-452.

Keywords: Aggregate stability, conservation agriculture, soil carbon, tillage, water retention

PHYSIOLOGICAL AND MOLECULAR CHARACTERIZATION OF BRADYRHIZOBIAL ISOLATES, NODULATING SOYBEAN IN ETHIOPIA

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INTRODUCTION

Nitrogen (N) is one of the key nutrients required for plant growth and grain yield. The high cost and unavailability of chemical N fertilizer are major factors limiting its use by smallholder farmers in developing countries, especially Ethiopia. There is therefore a need to tap inexpensive sources of N such as biological N_2 fixation for increasing crop yields in Ethiopia. The aim of this study was to use different soybean genotypes to trap indigenous bradyrhizobia in Ethiopia, isolate the bacteria from root nodules, and characterize them using physiological and molecular techniques.

MATERIALS AND METHODS

Soil samples were collected randomly from two regions in Ethiopia, sieved, and potted. A glasshouse experiment was conducted using different soybean genotypes to trap rhizobia from the collected soils. At mid-flowering stage, nodules were harvested from the plants, isolated, and the bacterial isolates authenticated, as described by Somasegaran and Hoben (1985). The growth of isolates at different pH levels and in different NaCl concentrations was evaluated. Genomic DNA from purified bacterial cells was isolated using a cetyltrimethylammonium bromide-based (CTAB) protocol. The bacterial isolates were analyzed using PCR-RFLP with various restriction enzymes.

RESULT AND DISCUSSION

The results of the study showed the presence of genetic diversity among the rhizobial isolates. Shoot dry matter was positively correlated with nodule dry weight, thus indicating the symbiotic performance of the isolates. The bacterial isolates showed growth (measured as the optical d) in extreme pH ranges (pH 4.5 to 9.0). Multi-locus – RFLP fingerprinting indicated marked variation among the isolates, and the diversity was mainly linked to the host variety than soil type. The bacterial isolates were dominated by strains of *Bradyrhizobium elkanii.*

CONCLUSION

It is concluded that Ethiopian soils have indigenous bradyrhizobia that can boost the production of soybean in regions where effective rhizobia are absent.

REFERENCES

Somasegaran, P. & Hoben, H. J. 1985. Methods in legume-rhizobium technology. USAID.

Zelleke, G., Agegnehu, G., Abera, D., Rashid, S. 2010. *Fertilizer & Soil Fertility Potential in Ethiopia: Constraints and opportunities for enhancing the system* (Online). Washington: International Food Policy Research Institute (IFPRI).

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Keywords: Root nodules, bacterial isolation, genomic DNA, PCR-RFLP

RESILIENCE OF NEW CITRUS SCIONS AND ROOTSTOCKS IN THE FACE OF CLIMATE CHANGE

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INTRODUCTION

The effects of climate change are experienced as amplified climate variability extremes. The impact on citrus includes, amongst others, higher costs of irrigation under hotter conditions and long-season varieties of citrus being at risk of yield and quality decline. Citrus producers need resilience regarding climate change as tree crop production is a long-term commitment. The mitigation focus can be either on the physical environment such as management practises or on deploying genotypes with enhanced tolerance/resistance to biotic and abiotic stresses. The latter will include breeding new scions and rootstocks to survive the highly competitive export domain but instead of selecting the best performer, selection will focus on selecting the less environment sensitive genotype in the top performing group of selections. Rootstock-scion interactions for the trait under investigation are thus of critical importance as testing performance (evaluation) of new scions cannot be done without grafting it onto a rootstock and more importantly the performance of a rootstock can only be derived by measuring the attributes of the scion such as yield and quality of the fruits produced. For future breeding application, these interactions for yield and quality within citrus are quantified and discussed.

MATERIALS AND METHODS

Data of superior ARC-ITSC and imported genotypes within the grapefruit, midseason oranges, Valencia, early and late mandarin groups, grafted onto four different rootstocks evaluated for five seasons were submitted to an additive main effects and multiplicative interaction (AMMI) statistical model to determine the interactions amongst scion, rootstocks and environments. Groups were deemed mega-environments.

RESULTS AND DISCUSSION

Different scion groups showed significant effects for genotype (G), environment (E) and GxE interactions (GEI) with regard to yield, except for mid-season oranges which coincided with late mandarins, confirming groups as mega-environments. Within the early mandarin group, scions contributed more to the stion than rootstocks and were more susceptible to the environment. For late mandarins and Valencias, scions and rootstocks contributed equally to the stions performance but mandarin scions were more susceptible to the environment while Valencia rootstocks were more susceptible. In the grapefruit group, rootstocks contributed three times as much to the stion than the scion but scions and rootstocks were equally susceptible to the environments.

CONCLUSIONS

It was determined that stion GEI can successfully be separated into a scion GEI and a rootstock GEI for yield per mega-environment (scion group). With regard to variation within a group it was found that there was indeed and interaction amongst rootstocks and scions and the interaction of the rootstocks and scions with environment (year) and the impact thereof on the stion were differential and substantial.

Keywords: AMMI, GxE, mega-environment, stion, tree breeding

CONSUMER PREFERENCE FOR PEAR EATING QUALITY AND APPEARANCE

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INTRODUCTION

Pear consumption in South Africa is very low at 0.94 kg compared to 11.55 kg per capita in Italy (World Pear Review, 2011). In order to grow the local market so that the industry is less reliant on overseas markets, it is important to produce top quality fruit that appeals to local buyers. The aim of this study was to determine the preference for eating quality and appearance among pear consumers in the Western Cape, South Africa.

MATERIALS AND METHODS

To identify the drivers of preference and possible consumer groupings, 10 pear cultivars with a range of taste characteristics were evaluated. Instrumental measurements were taken for each cultivar after a trained panel assessed the sensory attributes of each. Consumers from different age, gender and ethnic groups then did a taste test and filled in questionnaires recording their preferences for taste and appearance. To identify potential consumer groups, a Ward hierarchical cluster analysis was performed on the residual data.

RESULTS AND DISCUSSION

Consumer preferences cannot fully be explained by age, gender or ethnic group, although there are small, but significant differences among these groups for specific pear attributes. It is likely that other demographic features are responsible for differences in preference. On the whole consumer preference shows a strong positive correlation with melt character, juiciness, overall pear flavour and sweet taste. There were, however, some consumers who indicated a preference for harder, crunchy pears with a sour taste. Contrary to previous belief, the data indicate that the appearance of bi-coloured pears is not preferred by most consumers; in fact it scored relatively low for appearance, although it was rated higher by the white ethnic group than by the other two groups.

CONCLUSIONS

The data indicate that the majority of consumers of all three ethnic groups, genders and ages in the Western Cape, show a preference for pears with a distinct pear flavour, a sweet taste that also contains a fair amount of malic acid, soft, juicy flesh with a melting character, and a yellow or pale green peel colour with a typical pear shape (elongate-concave).

REFERENCES

World Pear Review 2011, Published by Belrose, Inc., 1045 NE Creston Lane, Pullman, WA 99163, USA

Keywords: Appearance, eating quality, pear, preference, sensory

HYDROPEDOLOGICAL INTERPRETATION OF ANCIENT AND RECENT SOIL PROPERTIES

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INTRODUCTION

Hydrological modelling utilises flow paths and storage mechanisms to develop conceptual hydrological models. Soil, a first order hydrological control, has signatures of these mechanisms developed by the soil water regime during soil formation. Changes in soil chemistry typically precede changes in morphology, consequently soil chemistry is an indicator of the recent hydrology.

MATERIALS AND METHODS

Morphological and chemical properties at 100mm intervals of profiles 209 and 221 in the Weatherley catchment were examined and the hydrological response was inferred from these properties. Long term soil water content and tension data was used to verify the inferred response.

RESULTS AND DISCUSSIONS

Soil morphology, an indicator of ancient soil water regime correlated well with current duration of soil water contents approaching saturation. The high chroma of profile 221 (Hutton) seldom exceeds drained upper limit and serves as a recharge soil. This condition is indicative of a fast vertical flowpath and excess water recharging the underlying fractured rock. Slight increase in chemical properties with depth in the red apedal and the decrease in the unspecified with signs of wetness indicates that leaching is present and that cations are removed from the profile. Morphological indicators are therefore supported by a high degree of leaching.

Profile 209 (Katspruit) is a storage mechanism and a slow flowpath indicated by the gley morphology on the footslope. The high pH and base saturation in the G horizon support the morphological deductions, but there are deviations at the A/G interface in the chemical properties suggesting the development of an E horizon and a flowpath not identified in the morphology.

CONCLUSION

Soil chemistry improved identification of hydrological processes currently active in the diagnostic horizons in soils and can therefore be used to verify hydrological trends in soil.

Keywords: Morphology, chemical properties, flowpath, storage mechanism, hydrological response

PROPAGATION OF MELINIS MINUTIFLORA TO IMPROVE PUSH-PULL TECHNOLOGY ADOPTION BY SUGARCANE GROWERS

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INTRODUCTION

A technology, termed 'push-pull', establishes the grass *Melinis minutiflora* P. Beauv. (melinis) as a hedge to either repel the sugarcane stalk borer *Eldana saccharina* Walker (eldana) or to act as a barrier to prevent *Cynodon dactylon* (L.) Pers. (cynodon) creeping into sugarcane fields from adjacent verges and roadsides. However, farmers are reluctant to adopt this technology, due in part to the perception that obtaining sufficient amounts of plant material for planting is difficult. The objective of this study was to develop a simple way for growers to propagate their own melinis, either from seeds or cuttings, in order to facilitate adoption.

MATERIALS AND METHODS

Seed germination: Melinis seeds were collected and rubbed against paper to remove hairs. Seeds were subjected to 50% hydrochloric acid for 20 minutes, thoroughly rinsed, treated for five minutes in 8% sodium hypochlorite then rinsed again, and finally sterilized in ethanol for 2 minutes prior to incubation in Petri dishes in the glasshouse (28 ^{0}C).

Vegetative propagation: In the first of three trials, two-node cuttings from top, middle and bottom sections of mature melinis stem material were grown with or without a commercially available hormone rooting powder, and with the lower node buried in sand or vermiculite. In the second trial, based on results from the first trial, two, three and four-node cuttings from the tops of mature melinis stem material were dipped in rooting hormone powder and grown in a sand medium. Here, secateurs were sterilised for each cutting. A third trial is in progress, based on results from the second trial and aimed to simplify the procedure as much as possible. All trials were incubated under glasshouse conditions.

RESULTS AND DISCUSSION

Seed germination and seedling establishment: A mean germination of 57±28% was achieved after treatment of seeds with acid and sodium hypochlorite. This demonstrated the viability of melinis seeds, with a seed coat-imposed dormancy that was broken with acid scarification. One disadvantage was the wide range in % germination (23%-87%), due to fungal contamination killing seeds before radicle emergence. An additional treatment of seeds with a fungicide would therefore be necessary. Although approximately 50% of these germinated seedlings were successfully established in potting soil, it was deemed impractical for farmers to adopt propagation via germinated seeds, due to the exacting procedures required (chemicals) and vulnerability to fungal contamination.

Vegetative propagation: An initial trial showed best establishment (24%) was achieved with cuttings taken from tops of stems and planted in vermiculite, compared with only 8% in sand. The second trial showed establishment in sand, more practical for farmers, could be increased to approximately 40%, with two, three and four-node cuttings, probably due to repeated sterilisation of the secateurs. It is therefore recommended that, for on-farm propagation, the most practical method is to remove two-four node cuttings from tops of established melinis plants, using secateurs dipped repeatedly in a commonly used on-farm sterilant, with establishment in sand under nursery conditions.

CONCLUSIONS

These findings indicated that although melinis seeds were viable, vegetative propagation of two-four node stems in sand was considered more practical. It is hoped that recommendations will help promote adoption of melinis as a tool for integrated pest management of eldana and/or integrated weed management of cynodon.

Keywords: Melinis minutiflora, propagation, adoption, *Eldana saccharina, Cynodon dactylon*

INFLUENCE OF POULTRY MANURE AND SEWAGE SLUDGE-BASED PHOSPHO-COMPOST APPLICATION ON PHOSPHORUS AVAILABILITY AND UPTAKE BY MAIZE

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INTRODUCTION

Inorganic phosphorus (P) fertiliser is routinely applied to address P deficiency on crop land. This is however constrained by high costs and limited availability in some areas, leading to low or sometimes non-use. The consequence is low crop yields and widespread food insecurity problems in many homes. The direct application of P-rich ground phosphate rock (GPR), typical of Phalaborwa rock, has also achieved limited success due to its dusty nature and non-reactivity under certain conditions. Thermophilic co-composting of such non-reactive GPR with organic wastes following mixing in different proportions or ratios to form a P-rich single product described as phospho-compost, is reported to increase the P solubility from GPR. This study aimed at evaluating the bio-availability of co-composted Phalaborwa GPR and the potential of such phospho-composts to increase soil available P.

MATERIALS AND METHODS

A greenhouse pot experiment was conducted to assess different phospho-composts produced from separately mix ratios (5:5; 7:3; 8:2; 9:1 & 10:0) of GPR with either poultry manure (PM) or sewage sludge-based (SS) using two surface soil samples with maize as test crop. The phospho-composts were produced through windrow thermophilic co-composting. The soils used differed markedly in chemical composition and clay content. The phospho-composts were applied at 60 kg P ha^{-1} while an un-amended control was included as reference. Urea was applied at a rate of 80 kg N ha^{-1} to eliminate N constraints following phospho-compost application. Thoroughly mixed soil-filled pots containing treatments were replicated four times and arranged in a completely randomized design. Four maize seeds (PAN6479) were sown per pot but thinned to two at two weeks after plant emergence. Plant growth, tissue P content and uptake as well as residual soil P were determined on termination of the trial at 42 days after plant emergence.

RESULTS AND DISCUSSION

Results showed that the different phospho-compost mix ratios significantly ($P<0.05$) increased the tissue P uptake and available soil P contents. The highest amount of 0.12 and 0.11 mg P pot^{-1} uptake from poultry manure and sewage sludge-based phospho-compost, respectively were obtained from the 8:2 mix ratio representing approximately 200% increase over the un-amended soil. The lowest amount of 0.04 mg P pot^{-1} was obtained from both GPR amended and control pots. Similarly, tissue P uptake was 83.3% higher in soil containing relatively higher clay content than that with lower clay content. The highest residual soil Bray P1 of 11.81 mg kg^{-1} was obtained from PM-based phospho-compost mix ratio of 8:2.

CONCLUSION

Thermophilic co-composting promoted increased bio-availability of P from the non-reactive Phalaborwa GPR. Application of the various phospho-compost mix ratios resulted in increased available soil P contents while the PM-based mix ratio of 8:2 gave the highest tissue P uptake.

Keywords: Co-composting, non-reactive ground phosphate rock, phospho-composts, P uptake, soil extractable P, organic wastes

SURVEY ON INCIDENCES AND CONTRIBUTING FACTORS TO EAR ROTS AMONG SOUTHERN AFRICAN MAIZE HYBRIDS

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INTRODUCTION

Maize is the principal crop in Southern Africa contributing in between 70-98% of energy requirements. Ear rots caused by a number of fungi have the potential to contaminate grain with mycotoxins that can adversely affect human and livestock health. This study aims to evaluate the incidences and contributing factors of ear rots among maize hybrids from across Southern Africa as well as to identify the associated mycoflora.

MATERIALS AND METHODS

A total of 640 maize hybrids from across Southern Africa were assessed under natural conditions at Cedara Research Station for ear rots incidence by counting the number of diseased ears per plot. The experiment was arranged in an augmented incomplete block design with two local check hybrids (PAN 67 and PAN6Q740BR) repeated in each block. Field grain weight, days to silking and grain moisture content at harvest were measured to ascertain if there is any correlation with the occurrence of ear rots. Fungi on diseased kennels showing different symptoms of ear rots were isolated, cultured and morphologically identified in the laboratory at the University of KwaZulu-Natal. The isolates were sent to ARC-PPRI in Pretoria for confirmation.

RESULTS

There were significant differences among hybrids with 19% of the hybrids showing nil or negligible infections (<5% disease symptoms). They performed better than the two control checks PAN67 (12.74%) and PAN6Q740BR (19.95%). While 81% showed severe symptoms of ear rot infection. Most ear rots were caused by *Diplodia maydis* (49.6%), followed by *Fusarium verticillioides* (27.9%), *F. graminearum* (12.4%) and *Aspergillus flavus* (10.0%). A simple regression analysis showed a significant association between yield loss and percentage ear rots (ß= -0.80, R^2=0.64, P<0.001). However there was not any significant association at P=0.05, between percentage ear rots and grain moisture content (ß= -0.33, R^2=0.11, P=0.131), and between ear rots incidence and silk emergence date (ß= -0.19, R^2=0.04, P=0.37).

CONCLUSIONS

Results showed that there is a high prevalence of ear rots among maize hybrids. Grain moisture content and days to silking are not factors that contribute to ear rotting meaning that some other factors are involved or it is a complexity of factors. *Diplodia maydis* is the most commonly occurring ear rot causing fungal species.

Keywords: Maize hybrids, mycotoxins, ear rots

ORGANIC RESOURCE QUALITY AND SOIL TEXTURE INTERACTIONS INFLUENCE N_2O EMISSIONS

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INTRODUCTION

The combined addition of organic resources (ORs) with N fertilizers is increasingly gaining recognition as a feasible option for increasing soil fertility and crop yields in sub Saharan Africa (SSA). While crop yields have generally increased with the combined addition of ORs and N fertilizers, there is a paucity of information on how this management option influences N_2O emissions. The objective of the study was to determine the influence of the combined addition of organic resources (OR) of differing quality with N fertilizer and their interactions with soil texture on N_2O emissions.

MATERIALS AND METHODS

A mesocosm study was conducted in the field central Kenya on two sites with contrasting soil texture; a sandy (22% clay) and a clayey soil (65% clay) in a completely randomized block design with three replicates. Gas samples were collected to measure N_2O emissions using a gas chromatograph over eight months following the combined application of 120 kg N fertilizer ha^{-1} [urea; $(NH_2)_2CO$] with *Tithonia diversifolia* (high quality), *Calliandra calothyrsus* (medium quality) and *Zea mays* (maize; low quality) residues incorporated in the soil at an equivalent rate of 4 t C ha^{-1} compared with no input control.

RESULTS AND DISCUSSION

Generally, N_2O emissions were greater in the clayey soil than the sandy soil but there were interactions between soil texture and OR quality. On the sandy soil the greatest N_2O emissions over eight months were observed with *Tithonia* applied with N fertilizer (0.49 kg N_2O-N ha^{-1}). In contrast, the greatest N_2O emissions of 1.42 kg N_2O-N ha^{-1} were observed on the clayey soil with sole-applied *Calliandra*. The addition of N fertilizer with *Tithonia* on the sandy soil almost doubled N_2O emissions compared with sole-added *Tithonia*. On the clayey soil, the addition of N fertilizer with *Calliandra* tended to lower N_2O emissions compared with where *Calliandra* was applied alone. Polyphenols did not seem to influence N_2O emissions, as there were no differences between sole-applied high polyphenol content OR *Calliandra* and low polyphenol content *Tithonia* on the sandy soil. Additionally, on the clayey soil, *Calliandra* had greater N_2O emissions than *Tithonia*. N_2O fluxes were generally greater after receiving at least 40 mm of rain following the addition of ORs and N fertilizer.

CONCLUSIONS

Our results indicate that OR-N is a useful indicator for predicting N_2O emissions; greater emissions were observed with residues with high OR-N. Thus OR-N will be useful for proposing management strategies that mitigate emissions for systems relying on the incorporation of ORs, especially on finer textured soils.

Keywords: Integrated soil fertility management, N_2O emissions, N fertilizers, organic resource quality, tropical agro-ecosystems

OBSERVED FUNGAL FREQUENCIES AND THEIR IMPACT ON PLANT PARAMETERS UNDER CONSERVATION AGRICULTURE CROPPING SYSTEMS ON A SANDY LOAM SOIL IN THE NORTH WEST PROVINCE DURING 2012/13

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INTRODUCTION

An estimated 368 000 hectares of South African soil is under no-till production (Derpsch *et al.*, 2010). Conservation Agriculture (CA) is currently practiced on a small scale in the Highveld climatic region of South Africa, but it is foreseen that more producers in this area will convert to CA in the near future in order to limit expenses. The current study report on the observed effect of established CA cropping systems on selected fungal frequencies and their associated impact on root and crown rot severity, plant mass and yield during the 2012/13 season on a sandy loam soil.

MATERIALS AND METHODS

The trial was initiated and monitored since 2008/09 and the current paper report on the results of the drought stricken 2012/13 season. The impact of monoculture maize under conventional tillage (CT) practices together with five CA cropping systems, which included two- and three- year rotation systems of maize with cowpea and sunflower were evaluated. Yield, plant mass, root and crown rot severity and fungal frequencies of selected root and crown rot pathogens as observed on maize roots and crowns were quantified and analysed through analysis of variance and biplots over three sampling dates i.e. 21, 70 and 100 days after planting (i.e. 1st, 2nd and 3rd Sampling Date - SD).

RESULTS AND DISCUSSION

Root and crown rot severity at 1st and 2nd SD were low. Crown rot experienced with the 3rd SD affected plant mass and yield and correlated with *Stenocarpella maydis* and *Macrophomina phaseolina* frequencies measured. Fungal frequencies were affected differently by the various cropping systems, with CA systems reducing the frequencies of some fungi.

CONCLUSIONS

Since 2008/9, each season was unique with regard to the environment x treatment interaction. The 2012/13 season experienced severe drought conditions, which allowed insight into which fungal populations can become prominent under specific established cropping systems associated with CA.

REFERENCES

Derpsch, R., Friederich, T., Kassam, A. and Hongwen, L., 2010. Current status of adoption of no-till farming in the world and some of its main benefits. *International Journal of Agricultural and Biological Engineering* 3(1): - (no page numbers). Open access at http://www.ijabe.org.

ACKNOWLEDGEMENTS

The Maize trust is thanked for funding provided.

Keywords: Conservation agriculture, crown rot severity, fungi, crop rotation

ENFORCING DORMANCY IN LITCHI, CV. 'MAURITIUS', WITH ETHAPON TO IMPROVE FLOWERING

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INTRODUCTION

Flower induction in litchi takes place in dormant buds and is induced by low temperatures. If shoots are not hardened/dormant by the time flower induction takes place flowering will be reduced. In order to remove a young flush occurring during flower induction time (March-May) Ethapon (a.i. ethephon) is applied by growers. However, reoccurring flushes during that time use a lot of starch reserves which are necessary for flowering and fruiting. Water stress is also recommended to enforce dormancy in litchi. However, water stress cannot always be applied successfully depending on rainfall during this period. In order to avoid any flush in areas where water stress cannot be used, an alternative method to enforce dormancy in litchi trees is necessary. The aim of the study therefore was to use Ethapon on dormant trees, after the last desired post-harvest flush has hardened, to suppress flushing and enforce dormancy up until the cold period starts when flower induction take place.

MATERIALS AND METHODS

The trial was conducted in Nelspruit on 10-year old 'Mauritius' litchi trees during the 2013 litchi season. The treatments were applied to dormant trees on 2 April 2013 and were as follows: T1: 750 ppm Ethapon (a.i. ethephon), T2: 1000 ppm Ethapon and CK control (untreated). As flush control during April is a standard orchard practice, control trees were subjected to one Ethapon spray by the farm. T1 and T2 were not sprayed by the farm for further flush control. Data collection included tree phenology (4 branches per tree), temperature and relative humidity, percentage flowering, fruit set and yield. In an additional trial branches with either dormant buds or buds in the initial stages of growth were treated with the same concentrations as above to determine the effect of Ethapon on different bud growth stages.

RESULTS AND DISCUSSION

Ethapon applications to dormant trees could reduce and prevent further flushing for the 750 and 1000 ppm treatment, respectively, even though climate was favourable for flush growth. Flushing occurred in the control trees and had to be controlled with Ethapon by the farm. Application with 1000 ppm Ethapon delayed flower panicle emergence by about 2.5 weeks, but percentage flowering was highest in this treatment (100%) compared to the 750 ppm application (97.5%) and the control (92.5%).Branches treated with Ethapon showed different reactions depending on the growth stage of the bud at time of application.

CONCLUSIONS

After one year of results it can be seen that application of Ethapon to dormant trees/branches can enforce dormancy, reduce vegetative flushing and increase flowering. Further trials are necessary to determine the earliest and latest application time of Ethapon as well as the withholding effect of Ethapon on new growth.

Keywords: dormancy, Ethapon, flower induction, *Litchi chinensis* Sonn.

THE MYCORRHIZOSPHERE - MAKING CONNECTIONS

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INTRODUCTION

Arbuscular mycorrhizal fungi form a symbiotic relationship with the roots of approximately 80% of all plants, including many economically important crop and pasture plants. The fungi form a special relationship inside the roots of the plant, forming highly branched tree-like structures called arbuscules. The fungi access soil nutrients and transfer these to their host plant in exchange for photosynthetically derived carbon, ultimately enhancing plant growth and survival. These fungi provide an intimate link between the plant and the soil environment. Their extensive hyphal network in the soil provides a niche area for the growth of a diverse range of soil microorganisms which can directly or indirectly benefit the mycorrhizal association as well as the host plant. This network and the area that it influences is referred to as the mycorrhizosphere. The primarily objective of this presentation is to emphasis the important role mycorrhizal fungi play in the soil with particular reference to their interaction with other soil microorganisms.

MATERIALS AND METHODS

Bacteria associated with arbuscular mycorrhizal fungi were isolated using standard microbiological techniques. Isolates were tested for their ability in culture to solubilise complex inorganic phosphate, produce indole acetic acid and chelating compounds such as siderophores. Their potential biological control ability was assessed against common soil fungal pathogens using an *in vitro* dual culture system. Selected bacterial isolates were identified molecularly and several were tested in pot trials for plant growth promotion and mycorrhizal helper properties.

RESULTS AND DISCUSSION

A diverse range of bacteria were associated with arbuscular mycorrhizal fungal spores. These have been identified as belonging to the genera *Acinetobacter*, *Alcaligenes*, *Bacillus*, *Microbacterium*, *Micrococcus*, *Serratia* and *Staphylococcus* and several isolates have some characteristics required for plant growth promotion as verified by increased shoot and root biomass of selected plant species. Mycorrhizal root colonisation was significantly increased when in the presence of bacterial isolates such as *Micrococcus luteus*, indicating their role as mycorrhizal helper bacteria.

CONCLUSION

This presentation will summarise studies conducted by the Mycorrhizal Research Group at Rhodes University. Understanding and unravelling the interactions and connections made between mycorrhizal fungi, other soil microorganisms and the soil environment itself, is essential to maintaining sustainability of soil and crop production.

REFERENCES

Dames, J.F. and Ridsdale, C.J. (2012). What we know about arbuscular mycorrhizal fungi and associated soil bacteria. *African Journal of Biotechnology* 11: 13753-13760

Keywords: Arbuscular mycorrhizal fungi, rhizobacteria, plant growth promotion, phosphate solubilisation, plant protection, glomalin

EVALUATION OF ROOT-KNOT NEMATODE (*Meloidogyne incognita*) RESISTANT SOYBEAN GENOTYPES FOR THEIR HOST STATUS AND YIELD POTENTIAL

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INTRODUCTION

Soybean (*Glycine max* (L.) Merr) is a major source of protein and oil in South Africa, with production of the crop being progressively increased. Due to increased hectares being planted as well as expansion of the crop into areas where maize was traditionally grown, parasitism of both crops by root-knot nematodes (RKN) is imminent. *Meloidogyne incognita* and *M. javanica* are present in areas where soybean-maize cropping systems are practised and have been reported to reduce yields of both crops substantially. Sustainable production of soybean as well as other crops is thus jeopardized due to the build-up of RKN species in local cropping systems. However, the use of RKN host plant resistances a useful and cost effective tool to optimize soybean production. Since cultivar Egret is the only RKN-resistant cultivar available locally, assessments of the host status and yield potential of soybean genotypes to *M. incognita* will contribute to better cultivar selection in areas with high RKN incidence.

MATERIALS AND METHODS

The host status of seven soybean lines and their yield were determined for *M. incognita* in greenhouse and field trials and compared to that of Egret. For resistance screenings, 5000 *M. incognita* eggs and J2/seedling were inoculated on roots of two-leaf-stage seedlings in a greenhouse. Fifty-six days later, gall ratings, egg and J2 counts as well as reproduction factor values/root system were determined as indicators of resistance. Randomised complete-block design trials with three replicates were used at seven localities during the 2010/11 and 2011/12 growing seasons to determine the yield of these soybean lines and cultivar.

RESULTS AND DISCUSSION

All lines had higher resistant levels to *M. incognita* than cultivar Egret. However, although Egret had the highest yield (2 680.9 kg ha^{-1}) in field trials, it was not significantly higher than those of lines 7 (2278.3 kg ha^{-1}), 5 (2179.1), 6 (2086.6 kg ha^{-1}) and 3 (2064.8 kg ha^{-1}).

CONCLUSIONS

All seven soybean lines showed higher levels of resistance to *M. incognita* than cultivar Egret, but four of them had comparable yields to the latter cultivar. As host plant resistance is a useful and cost-effective tool for optimization of soybean yield in RKN-infested areas there is a need for more of these cultivars being developed and made available in the market.

Keywords: Meloidogyne incognita, root-knot nematode, resistance, soybean

PHOSPHORUS AVAILABILITY FROM SEWAGE SLUDGE

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INTRODUCTION

The agricultural use of sewage sludge is important for the long term sustainable management of sewage sludge in Gauteng. The phyto-availability of phosphorus (P) is determined by sewage sludge treatment processes. The P content of sludge that underwent biological P removal (BPR sludge) is generally lower (= 1%) than ferric chloride treated sludge (1% < P < 4%). Although the P content of BPR sludge is lower, the P availability is considered to be higher than ferric chloride treated sludge (Fe-sludge). In developed countries wastewater care works (WCW) are moving away from tertiary ferric chloride treatment. In South Africa it will probably still be used in the foreseeable future to keep P levels of water discharged from WCW as low as possible. P in Fe-sludge is not necessarily insoluble and an understanding of the chemistry of P in the sludge can be used to manipulate its solubility. The aim of this study was to determine the nature of P in sewage sludge and P release (or solubility) and plant availability when introduced to the soil.

MATERIAL AND METHODS

Various approaches were used, this included an incubation study, pot trial and P fractionation of the sludge. A Scanning Electron Microscopy / Energy-dispersive X-ray spectroscopy on the nature of P in sludge is currently ongoing.

RESULTS AND DISCUSSION

The percentage water soluble P (PWEP, water soluble P as percentage of total P) of Fe-sludge (0.1 – 0.26%) suggested that P solubility was quite low. P plant availability was lower for Fe-sludge compare to BPR sludge. However, the expected worst case Fe-sludge (11% Fe and P: Fe stoichiometric ratio of 0.4, indicating excess Fe) still raised P to sufficient levels for plants. The effectivity of this Fe-sludge was on average 70.2 % (± 9.08) that of mono-ammonium phosphate (MAP) for various top soils with various P sorption capacities. This was calculated using a basic P fertilizer index which expresses the Bray 1 extractablility of P for a soil amended with Fe-sludge relative to the same soil amended with MAP (at equivalent P loading rates). The higher than expected solubility in the soil was attributed to; 1) The poor crystallinity of ferric phosphate in this organic matrix; 2) Reductive dissolution of the ferric phosphate (sludge is an electron donor); 3) The chelation of either ferric or ferrous iron by organic ligands released during the oxidative breakdown of sludge in the soil.

CONCLUSION

The transport costs of low grade fertilizer are always an important consideration. However, if financially viable Fe-sludge still holds value as a P nutrient source. There are opportunities to manipulate the P equilibrium of sludge using calcium (to shift the equilibrium to calcium phosphate) or magnesium (to favour struvite formation).

ACKNOWLEDGEMENTS

Water Research Commission and East Rand Water Care Company for funding this research.

Keywords: Ferric chloride treated sludge, BPR sludge

SPATIAL AND TEMPORAL VARIATION OF BLACK MAIZE BEETLE *Heteronychus arator* (COLEOPTERA: SCARABAEIDAE) IN A MAJOR MAIZE PRODUCING REGION OF SOUTH AFRICA

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INTRODUCTION

Black maize beetle (*Heteronychus arator* Fabricius) is economically the most important coleopteran pest of maize in South Africa, occurring mainly in the eastern part of the maize production area. It is a sporadic pest and prediction of outbreaks is difficult. Two peaks in the annual flight pattern occur during a particular maize production season. The first is during October to December when only 5% of a population flies and the second during February to April, when 95% of the population flies. The flight pattern of *H. arator* was monitored for 11 consecutive years.

MATERIAL AND METHODS

Eighty six modified Robinson light traps were placed in 15' grids (approximately 30km x 30km) throughout the eastern part of the maize triangle. Weekly captures for three consecutive months from February every year were fixed in 70% alcohol and counted.

RESULTS AND DISCUSSION

Black maize beetle populations showed a highly clustered distribution across the study area and hotspots as well as cold spots tended to recur in the same area with minimal variation. Spatial variation that occurs amongst beetle populations is confined to one area approximately 60km x 90km on the border of three provinces (Mpumalanga, Free State and Gauteng) which differed in intensity over the years. Black maize beetles' temporal variation during the 11-year capture period indicated that during 2005 and 2009 two distinct peaks occurred. These peaks, however, differed in intensity with a maximum average of black maize beetles during 2005 (5229) and 2009 (11857).

CONCLUSIONS

Black maize beetle data indicated highly significant spatial clustering across the study area not only between locations but also over years. This indicates that control measures for black maize beetle can be drastically reduced to a small area (60km x 90km) situated on the border of the border of the Free State, Gauteng and Mpumalanga provinces. Additionally, within this area, temporal variation of black maize beetles indicated that epidemic outbreaks occur every five years.

Keywords: Heteronychus arator, spatial variation, temporal variation

THE EFFECT OF MECHANICAL BLOOM THINNING WITH THE DARWIN 300, ON THE TIME REQUIRED FOR HAND THINNING, YIELD, FRUIT SIZE AND FRUIT QUALITY

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INTRODUCTION

The thinning of stone fruit is very important in order to produce fruit of high quality, with the appropriate fruit. Hand thinning contributes largely to the total production cost, as hand thinning is labour intensive, and labour costs are increasing. The efficacy of the Darwin 300™ at full bloom in reducing hand thinning requirement in a 'Zypher' nectarine orchard was evaluated in consecutive seasons, while also determining the effect on yield, fruit quality and return bloom.

MATERIALS AND METHODS

The trial was performed on the farm Tandfontein, in the Koue Bokkeveld, South Africa, over the 2011/2012 and 2012/2013 seasons. The trial was performed on the cultivar 'Zypher' on 'SAPPO 778' rootstock planted in 2005 at a spacing of 4 x 1.5 m and the trees are trained to a slender spindle. The Darwin 300™ was used with a constant tractor speed of 4.8 km/h, while mechanical thinning was performed at full bloom, with rotor speed varying from 200, 220 and 240 r.p.m. A randomised complete block design was used with 7 trees per plot (using central 5 trees) and 5 blocks.

RESULTS AND DISCUSSION

The time required to hand thin the five trees was consistently reduced by an average of 43% in 2011/2012 season and 33% in the 2012/2013 season. In the 2011/2012 season, an inverse linear trend was observed with increasing rotor speed in the time required to hand thin. This ilinear trend was also observed in the yield per tree in the 2011/2012 season. The yield per tree was consistently reduced and resulted in an average reduction of 21% in the 2011/2012 season and 27% in the 2012/2013 season. The bloom thinning and a reduction in the yield resulted in an increase in the fruit size during both seasons. The total soluble solids were increased in both seasons. In the 2011/2012 season no negative effects were found in the fruit quality, but in the 2012/2013 season the percentage of fruit cracking and pit split was significantly increased by all three machine treatments. The increase in the percentage of fruit cracking was 9%, and the percentage of pit split was 16%.

CONCLUSION

The consistent reduction in the time required for hand thinning will result in a reduction in the cost associated with hand thinning. The reduction in the yield could be avoided by not thinning as aggressively by hand and therefore increase in the number of fruit on the tree, if the increase in fruit size is not wanted. The increase in fruit size could also realize an increase in the marketable yield, therefore compensating for the reduction in yield.

REFERENCES

Schupp JR, Baugher TA, Miller SS, Harsh RM, Lesser KM. 2008. Mechanical thinning of peach and apple trees reduces labour input and increases fruit size. *HortTechnology.* 18(4): 660-670

Keywords: Mechanical thinner, nectarine, hand thinning

THE ROLE OF NUTRIENT SOLUTION COMPOSITION ON THE UPTAKE OF NUTRIENTS, GROWTH AND VASE LIFE OF CUT TULIPS GROWN HYDROPONICALLY UNDER SOUTH AFICAN CONDITIONS

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INTRODUCTION

Tulip cut flowers, though popular world-wide as speciality flowers, are cultivated only on a limited scale in South Africa. As the development of successful and profitable forcing programs for cut tulip production requires optimization of cultivation aspects this study aimed to investigate the production potential and postharvest quality of forced cut tulips from both early and late-forcing bulbs, as grown hydroponically using four different nutrient solutions.

MATERIALS AND METHODS

Early- and late- forced bulbs of four cut tulip cultivars, 'Leen van der Mark', 'Jan Van Nes', 'Ile de France' and 'Royal Virgin', were grown in four nutrient solutions, namely a nutrient solution formulation used routinely by tulip producers in South Africa ("Current SA"), a standard Steiner solution ("Standard Steiner"), a nutrient solution used by tulip producers in Belgium ("Europe"'; Deckers 2010) and a solution where "Europe" was amended with 20% nitrogen provided as ammonium ("Europe+NH_4^+"). A split plot experimental design was used. Various production factors together with the postharvest quality were monitored.

RESULTS AND DISCUSSION

Nutrient solutions did not significantly affect growth, although "Standard Steiner" and "Europe" produced plants with the largest leaf area. The longest vase life was produced when using nutrient solution "Europe" (5.4 days) for early-forcing bulbs and nutrient solution "Standard Steiner" (8.5 days) for late-forcing bulbs. Significant cultivar differences were observed for all parameters evaluated, with 'Leen van der Mark' generally displaying the best quality and longest vase life.

CONCLUSIONS

This study provides evidence that the use of an optimized nutrient solution can be a significant aid towards an extended vase life of cut tulips and that calcium and potassium are of particular importance; however, the extent to which a balanced nutrient solution can assist in the production of quality cut tulip stems is greatly dependent on the chosen cultivar as well as the physiological age of the bulbs.

REFERENCES

Deckers S. 2010. Soil Service of Belgium. Email: sdeckers@bdb.be

ACKNOWLEDGEMENTS

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Keywords: Bulb age, calcium forcing, fertilization regime, nitrogen, vase life

THE EFFECTS OF ELECTRICAL CONDUCTIVITY ON *Cucurbita pepo* ZULULAND LANDRACES AND THEIR HORTICULTURAL PHYSIOLOGICAL CHARACTERISTICS

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INTRODUCTION

Cucurbita pepo is a highly polymorphic species with cultivars being grouped into eight morphotypes in two subspecies, ssp. *pepo* and ssp. *ovifera* (Ferriol et al, 2003). Quantifying the characteristics and horticultural properties for pumpkin, *Cucurbita pepo,* will aid in the knowledge and potential contribution of landraces to the greater economy. Landraces are highly adapted species that have not been used in plant breeding, and are, therefore, of interest as they possess characteristics that have not been exploited. The objective of the study was to identify morphological differences (growth habit, shape, ribbing, fruit colour, texture, flowering and microbial spoilage) of three Zululand landraces, along with biochemical differences (carotenoids, phenolic, soluble sugar, and total antioxidant concentration), and the relationship with shelf-life, and respiration rate after cold storage.

MATERIALS AND METHODS

Cucurbita pepo landrace seeds were collected from the Botany Department at the University of Zululand, South Africa. The landrace seeds were planted in a closed hydroponic system, at three nutrient strengths, 0 dSm^{-1}, 2.5 dSm^{-1} and 3.0 dSm^{-1}. After harvest fruit were stored at 4 °C, and removed at weekly intervals to room temperature for shelf-life evaluation where microbial spoilage was scored.

RESULTS AND DISCUSSION

Fruit yield increased significantly (P = 0.05) at 3.0 dSm^{-1} in comparison with the 2.5 dSm^{-1} and 0 dSm^{-1} strengths. Morphological differences were observed among landraces. Growth habit, fruit shape, colour and flowering time were distinctively different between landraces. The occurrence of spoilage was less at 3.0 dSm^{-1}, with a higher occurrence at 0 dSm^{-1}. High electrical conductivity provided a better defense mechanism (total antioxidants, soluble sugar and carotenoids) for fruit at shelf-life.

CONCLUSIONS

Increases in electrical conductivity collate to increases in internal fruit quality, and biochemical properties, prolonging shelf-life. It is possible that electrical conductivity equips fruit with a higher amount of assimilates that provide protection in order to prolong shelf-life.

REFERNCES

Ferriol M, Pico B, Nuez F. 2003. Genetic diversity of a germplasm collection of *Cucurbita pepo* using SRAP and AFLP markers. *Theor Appl Genet* (2003) 107:271–282

Keywords: Cucurbita pepo, electrical conductivity, fruit quality, hydroponic systems, landraces

FUNCTIONAL CHARACTERIZATION OF CYSTEINE PROTEASES IN SOYBEAN ROOT NODULES EXPERIENCING PREMATURE SENESCENCE DUE TO WATER DEFICIT

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INTRODUCTION

Soybean (*Glycine max*) forms a symbiotic relationship with *Bradyrhizobium japonicam* which leads to the formation of nitrogen fixating root nodules. Root nodules convert nitrogen into ammonium which the plant needs for protein synthesis. Water deficit conditions afects the root nodules and causes premature nodule senescence, shortening their already short life span of 11-13 weeks. Nodule senescence leads to a decline in biological nitrogen fixation which leads to lower yields. A better understanding of genes, such as cysteine proteases genes, that are involved in the protein remobilization process during senescence is needed to understand premature senescence caused by water deficit n nodules.

MATERIALS AND METHODS

A greenhouse trail was done with soybean plants that were placed under water stress conditions by withholding water for 10 days. Enzyme activity assays were done using 2 ug of protein extracted from crown nodule using the substrates Z-Phe-Arg-MCA which selects for papain-like cysteiene proteases and Z-Ala–Ala-Asn–MCA selecting for legumain-like proteases. RNA was extracted using a Qiagen RNeasy ® plant mini kit so that gene expression studies could be done. Primers for different protease genes were designed and a Semi-quantitative RT-PCR was done using 400ng of cDNA. Furthermore, a transcriptome study of the crown nodules placed under water deficit conditions is planned to identify all cysteineproteases involved in premature nodule senescence.

RESULTS AND DISCUSSION

Activity and transcription profiles of two classes of cysteine proteases, papain- and legumain-like cysteine proteases were investigated in soybean nodules during water deficit conditions which induced premature senescence. An increase in protease activity was associated with a significant decrease in nitrogenase activity of nodules measured as acetylene reduction. Semi-quantitative RT-PCR for cysteine protease showed a decrease in transcription of several papain-like proteases and an increase in expression of several legumain-like proteases after water deficit treatments.

CONCLUSIONS

Our findings show the importance of cysteine proteases during premature nodule senescence but in order to fully characterize the nodule protease system during premature senescence we are currently sequencing the entire transcriptome of nodules at various stages of induced senescence.

Keywords: Nodules, cysteine proteases, water-deficit

CONTRIBUTION OF BREEDING EFFORTS TO DRYLAND WHEAT YIELD IMPROVEMENT IN SOUTH AFRICA SINCE 2003

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INTRODUCTION

Wheat production in South Africa fell substantially in the past 15 years and the country, once a net exporter in the 1980s has become 4th largest importer of wheat in Africa. Farmers argue that they cannot continue to produce wheat profitably anymore. The average yield of dryland wheat in South Africa is 2.25 t ha^{-1} against a global benchmark of 3.0 t ha^{-1}. As one way of improving the genetic pool available to farmers, the Agricultural Research Council-Small Grain Institute (ARC-SGI) conducts a national cultivar evaluation program to evaluate all newly released wheat cultivars of all seed companies (PANNAR, ARC-SGI and SENSAKO) on a scientific basis. In this study, 10-year (2003 to 2012) cultivar evaluation data from the summer rainfall areas of South Africa was analysed to estimate the contribution of breeding efforts to yield improvement.

MATERIALS AND METHODS

The dryland wheat production area is divided into 4 different production localities, namely: South Western Free State (SWFS), North Western FS (NWFS), Central FS (CFS) and Eastern FS (EFS). Yield improvement due to breeding efforts (%) in each of these localities was interpreted as predominantly attributable to the difference in mean genotype effect of 2003 (g_1) and 2012 (g_2) gene pool as given by the formulae $[(g_2 – g_1)/g_2] \times 100$. The mean yields of control cultivars for 2003 and 2012 were used to provide an environment index (e), to account for environment (E) and $G \times E$ effects. Similarly, the mean yields of 2003 and 2012 were used to provide a pooled phenotype effect (p), which was the combined effect of G, E and ($G \times E$) effects. Assuming that $p = g + E + (G \times E)$, and $g = p – e$, the following equation was used to estimate yield improvement due to breeding efforts:

$[(g_2 – g_1)/g_2]$ (%) $= [(p_2 – p_1)/p_2] - [(e_2 – e_1)/e_2] \times 100$

Where: e_1 = Yield of control cultivars in 2003; e_2 = Yield of control cultivars in 2012; p_1 = Yield of the cultivar pool of 2003 and p_2 = Yield of the cultivar pool of 2012

RESULTS AND DISCUSSION

A negative effect of -0.09, -8.0 and –15.8% on yield was obtained for CFS, NWFS and SWFS respectively, due to change in cultivars. Only EFS had an improvement (9.33%) of yield. It is normally expected that newly released cultivars should outperform the old ones in terms of yield. However, based on these negative genotype effects on yield, important questions can be raised. Firstly, have we reached a plateau in terms of genetic yield improvement? Should breeding be location specific? Should new breeding strategies be identified? And lastly, should research rather focus more on refining our crop and resource management strategies?

CONCLUSIONS

Investment in genetic technology alone has not adequately addressed the yield challenge and there is a need for other strategies to complement breeding efforts.

ACKNOWLEGEMENTS

The Winter Cereal Trust is highly acknowledged for funding this work.

Keywords: plant breeding, wheat yield

ROSE-SCENTED GERANIUM ESSENTIAL OIL YIELD AND QUALITY AS AFFECTED BY LEAF AGE

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INTRODUCTION

Essential oil yield and composition vary with developmental stages of the whole plant. In *Erigeron canadensis,* the content of limonene in leaves declined with advance in leaf age, while the opposite was true in flower oil (Góra *et al.*, 2002). With progress in leaf maturity, the content of cis-sabinene hydrate in the oil decreased from 40 to 1%, but the content of terpinene-4-ol increased from 10 to 30% in *Melaleuca alternifolia* leaves (Southwell and Stiff, 1989). Knowledge of the relationship between leaf age, and essential oil yield and composition could help essential oil crop producers to maximize their production through adjusting crop harvesting practice with the herbage growth stage.

MATERIAL AND METHODS

Change in essential oil composition and oil yield with leaf age in rose-scented geranium (*Pelargonium capitatum x P. radens* cv. Rose*)* was investigated in a glasshouse of the University of Fort Hare, during January to April and April to August 2012. The plants were allowed to grow to about the 12-leaf stage. From the top to bottom, the leaves were put into five groups (each group comprising two successive leaves, Pairs 1, 2, 3, 4 and 5). Leaf growth (leaf fresh and dry mass), and essential oil yield and composition data were collected and compared.

RESULTS AND DISCUSSION

Leaf fresh and dry mass data were significantly lower in the top-most (youngest leaves) and the oldest leaves compared with the rest pair of leaves harvested. Essential oil in the youngest leaves was colourless, but with advance in leaf age, it tended to have a blue-green colour. Oil content (on dry mass basis) from the top to bottom, for Leaf Pairs 1, 2, 3, 4, and 5 were about 7.0, 4.9, 3.2, 2.4, 1.9%, respectively. Oil yield showed a significant increase in the second youngest pair of leaves and progressively declined, resulting in a significant lower yield in the oldest leaves. Leaf Pairs 1, 2, 3, 4 and 5, contributed about 19.3, 22.0, 17.71, 12.03 and 8.5% of the total yield per branch, respectively. Citronellol:geraniol ratio was significantly lower in the young leaves than in the old leaves. Linalool and geranyl formate concentrations were the highest in the youngest leaves, and the opposite was true in isomenthone. Other essential oil components did not respond to leaf age. In agreement with works of Góra *et al.* (2002), Motsa et al. (2006), and Southwell and Stiff (1989), the current results indicate that early leaf age affect essential oil yield and composition. Thus, shorter regrowth cycles would increase essential oil yield and quality of rose-scented geranium.

REFERENCES

Góra, J, Lis, A, Kula, J, Staniszewska, M, Woloszyn, A 2002. Chemical composition variability of essential oils in the ontogenesis of some plants. *Flavour and Fragrance Journal,* 17: 445-451.

Southwell, IA, Stiff, IA 1989. Ontogenetical changes in *Alternifolia* leaf.*Phytochemistry,* 28: 104-1051.

Motsa, NM, Soundy, P, Steyn, JM, Learmonth, RA, Mojela, N, Teubes, C 2006. Plant shoot age and temperature effect on essential oil yield and oil composition of rose-scented geranium (*Pelargonium* sp.) grown in South Africa. *Journal of Essential Oil Research,* 18: 106-110.

Keywords: Essential oil, leaf age, oil composition, rose-scented geranium

ROSE-SCENTED GERANIUM (*Pelargonium graveolens*) GROWTH, YIELD AND ESSENTIAL OIL QUALITY AS AFFECTED BY PACLOBUTRAZOL APPLICATION

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INTRODUCTION

Rose-scented geranium (*Pelargonium* spp.) is an aromatic and medicinal plant. The plant is commonly cultivated for its high value essential oil. Factors such as bulky herbage yield accompanied by low oil content, reduces rose-scented geranium oil yield (Eiasu et al., 2008). Paclobutrazol (PBZ, a growth regulator) is reported to reduce stem length without affecting leaf growth (Esmaielpour et al., 2011). Therefore, application of PBZ on rose-scented geranium would reduce canopy size without a significant reduction in the number of leaves per plant. This will increase the number of plants per area and, in addition, will maximize the oil yield per hectare.

MATERIALS AND METHODS

The experiment was conducted in a glasshouse at the University of Fort Hare, Alice. A randomized complete block design with four replications was applied. One month after cutting back of the plants, PBZ was applied at the rates of 0, 100, 200 and 300 mg/l on the regrowth and harvested at four months of age. Data, such as chlorophyll content, plant circumference, plant height, fresh and dry mass and oil composition, were determined.

RESULTS AND DISCUSSION

With an increase in PBZ concentration, total herbage mass and plant height tended to decline (Esmaielpour et al., 2011). Thus, in most cases, herbage fresh and dry mass, of treated plants had lower weight than the control. Paclobutrazol significantly reduced canopy circumference. There was no significant difference ($P< 0.05$) in oil yield and composition. Visually, plants that received PBZ had deep green colour although the chlorophyll data did not show a significant difference.

CONCLUSIONS

These results clearly shows that PBZ assisted geranium plants with compact canopy, which would enable farmers to increase income by increasing planting density, reducing distillation cost as the herbage volume and mass without reducing oil yield per plant.

REFERENCES

Esmaielpour, B, Hokmalipour, S, Jalilvand, P, Salimi, G, 2011. The investigation of paclobutrazol effects on growth and yield of two potato (*Solanum tuberosum*) cultivars under different plant densities. *Journal of Food, Agriculture and Environment* 9, 289-294.

Eiasu, BK, Steyn, JM, Soundy P (2008). Growth and essential yield of rose-scented geranium (*Pelargonium capitatum* x *P. radens* 'Rose') as affected by withholding irrigation at different times during regrowth. *New Zealand Journal of Crop and Horticultural Science* 36, 285-294.

ACKNOWLEDGEMENTS

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Keywords: Essential oil quality; inhibited growth; oil yield; paclobutrazol (PBZ); rose-scented geranium

AN INVESTIGATION INTO FACTORS INFLUENCING FLOWERING AND PITHING IN THE SOUTHERN AFRICAN SUGARCANE INDUSTRY

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INTRODUCTION

Flowering in sugarcane is a physiological process that can affect stalk yield and quality. The phenomenon in sugarcane stalks that causes formation of dry cavities within the internodes is known as pithing, which can affect sucrose extraction during processing. The propensity of flowering and pithing are affected by climatic and management factors. Flowering is induced when day (T_{max}) and night temperatures (T_{min}) are greater than 28°C and 20°C, respectively at the time of year when the photoperiod is approximately 12.5 hours (Donaldson& Singels, 2004). The aim of this study was to investigate the relationship between climatic factors that influence the propensity of flowering, pithing and cane yield based on data from South Africa, Zambia and Malawi.

MATERIALS AND METHODS

Data were collected from Dwangwa Estate, Malawi (12°29' S 34° 8' E), Nakambala Estate, Zambia (15° 52' S 27° 46' E) and the Nkomazi production area in Mpumalanga, South Africa (25° 40' S 31° 43' E). Weather, flowering, pithing and cane yield data of selected sugarcane cultivars (N) were analysed for five seasons (2008 – 2012) to assess the relationships between flowering and pithing, and weather trends associated with flowering.

RESULTS AND DISCUSSION

Flowering of South African N sugarcane cultivars was higher in 2009 in Malawi and Zambia due to more days with a T_{max} > 28°C, fewer nights with T_{min}< 20°C and 50% higher rainfall during the floral initiation period for the first three weeks of February compared with 2008, 2010, 2011 and 2012. Cultivars N14, N23 and N36 flowered profusely in Malawi (mean annual total flowering per field = 72%, 60% and 63%, respectively over five seasons), and N23 flowered profusely in Zambia (93% over 3 seasons, 2008 - 2010) but a correlation between flowering and cane yield was not evident. However, flowering in N14 and N23 during the 2010 season in Mpumalanga was associated with a 10% reduction in final cane yield. Pithing was observed to be between 0.8 – 9% in Malawi and 5.5 – 13.6 % (percentage of stalks that contained pith per field) in Zambia.

CONCLUSIONS

No relationship between flowering and sugarcane yield was found in the Malawi and Zambia data. The extent of flowering in all three regions was highly correlated to the temperature experienced during the floral initiation period and the occurrence of rainfall between initiation and flower emergence.

REFERENCES

Donaldson, R., A., Singels, A. 2004. Yields and estimated economic returns from using ethephon to supress flowering in annually harvested sugarcane. Proc. S. Afr. Sug. Technol. Ass. 78, 123 – 136.

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Keywords: Sugarcane, flowering, pithing, yield effects

RESIDUE EFFECTS ON MAIZE YIELD AND ROOT ROT SEVERITY

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INTRODUCTION

While there is consensus about the need for a 30-40% mulch cover to combat physical soil degradation by wind and water, the optimum level of cover remains questionable. There is uncertainty regarding the yield and possible biological benefits likely to result from cover loads greater than those customarily considered adequate and more information is needed. Can higher cover-load effects on yield prove more profitable than the use of cover for fuel and livestock? This study was conducted to help answer this question.

MATERIALS AND METHODS

The experiment from which these data were obtained was initiated in 2006 on a Hutton clay loam near Winterton. The primary objective was to develop strategies to ameliorate the negative effects of root rots in maize-wheat cropping systems. The annual rainfall at the site is approximately 720 mm, with 85% falling between October and March. In the first season, conventional fallow treatments provided no benefits. This led to the trial being modified to provide analogues, with and without extra cover, of four of the 15 treatments (tilled with methyl bromide fumigation, tilled without fumigation, maize fallow, and N as anhydrous ammonia). Subsequently, a bare fallow treatment was included to more clearly define cover effects. Soil and plant samples were collected for chemical analysis and root and crown rot assessments were made. Topsoil moisture content was measured, earthworm counts conducted, and infiltration rates determined. In the fifth season 0- to 50-mm topsoil samples were drawn to determine the effects on carbon accumulation.

RESULTS AND DISCUSSION

The effects of extra cover on maize yield were strongly influenced by season. While negligible in two exceptionally wet seasons, in seasons during which rainfall was less than 670 mm the yield benefit was in excess of 10%, even where maize residues exceeded 10 Mg ha^{-1}. Benefits were attributable to elevated soil moisture content, markedly increased earthworm populations and infiltration rates, and carbon accumulation. Cover induced decreases in root and crown rot were also implicated, but it appears that in average rainfall seasons the negative effects of soilborne diseases can be overwhelmed by moisture benefits.

CONCLUSIONS

Cover loads greater than those traditionally used have economic benefits, which need to be compared to the use of residues by livestock.

ACKNOWLEDGEMENTS

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Keywords: Cover, earthworms, maize, residue, root rot

WHEAT STEM RUST IN SOUTH AFRICA - CURRENT STATUS AND FUTURE DIRECTIONS

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INTRODUCTION

Plant diseases are among the major causes of food insecurity, as they can drastically decrease crop yields as the degree of disease outbreak gets severe. In South Africa, stem rust caused by *Puccinia graminis* Pers. f. sp. *tritici*. Eriks. & E. Henn. (*Pgt*) is one of the most important diseases of wheat. Records of the occurrence of stem rust in South Africa date back to the late 1720's, when it was first discovered in the south-western parts of the Western Cape. Stem rust can be controlled by growing resistant cultivars. However, one of the challenges in genetic control is that *Pgt* frequently acquires new virulence to overcome resistance in existing cultivars. To date, there is tremendous evidence that the pathogen continues to evolve. The appearance of stem rust race Ug99 (TTKSK) in East Africa in 1999 and subsequent epidemics in Kenya and Ethiopia, accompanied by the occurrence of four Ug99 variants in South Africa have resulted in a renewed interest in understanding the status of *Pgt* races and stem rust resistance in the world as well as the need for new genetic control strategy. The presentation will provide an overview of stem rust races and their prevalence in South Africa, and also draw attention on the resistance genes currently deployed to combat this disease. The aim of the presentation is to provide perspectives on the journey that has been travelled towards fighting the stem rust disease in South Africa, and also provide recommendations on the way forward.

UNDERSTANDING THE PROBLEM

In South Africa, stem rust is one of important diseases that continue to draw particular attention from plant breeders as a result of pathogenic variability, manifested by the appearance of new virulent races or pathotypes within *P. graminis* f. sp*. tritici* (Le Roux, 1987; Visser *et al*., 2009).

CONCLUSION AND RECOMMENDATIONS

South African breeders and pathologists need to continuously replace old cultivars with new ones that have durable resistance against stem rust. This could be achieved by introgressing multiple genes that confer resistance to stem rust, and by searching for new genes with effective resistance against new and evolving pathotypes. The use of diagnostic DNA markers makes it feasible to identify and pyramid several stem rust resistant genes.

REFERENCES

LE ROUX, J., 1987. Pathotypes of *Puccinia graminis* f. sp*. tritici*. with increased virulence for *Sr24*. *Plant Dis.* 71, 1115-1119.

VISSER, B., HERSELMAN, L., PRETORIUS, Z.A., 2009. Genetic comparison of Ug99 with selected South African races *of Puccinia graminis* f. sp. *tritici*. *Mol. Plant Pathol.* 10: 213-222.

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Keywords: Pathogen variability, *Puccinia graminis* f. sp. *tritici*, stem rust, wheat

RESEARCH AND THE INDUSTRY: THE WAY FORWARD

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INTRODUCTION

Without research agriculture in South Africa cannot survive. Worldwide there is a need for relevant research as the pressure on resources and food security is increasing yearly, especially in Africa. To battle this growing concern research needs to be diverse and follow an integrated approach combining research, practical application and producer needs. The aim of this paper is to assess the current situation and propose possible ways forward.

MATERIALS AND METHODS

Several interviews with private supply companies and small cooperatives in the Western Cape area have formed the base of this study to determine the need from the industry for research, the relevance of research conducted and the practical, but scientific sound application of the research conducted by various institutions.

RESULTS AND DISCUSSION

From the study conducted it is evident that the need from the industry for relevant research is higher than ever. The cost of producing optimal yields and maintain good quality is increasing yearly. Input costs are ever increasing and inputs and resources needs to be optimally utilized. Thus better farming techniques needs to be established through relevant research. Currently 85% of technical applications used in practice is applied research conducted through field trials by the industry. This poses a great concern. Research institutions (Universities, government and private institutions) focus on a small amount of research topics and inter department research is minimal. The practical implementation of the research poses a further concern. Agricultural support in the industry needs to be aware of the current research that is being conducted, understand the implementation of the research and commit to be scientifically sound in the implementation of the research on industry level.

CONCLUSIONS

Research institutions and agricultural support needs to be aware of the need for specific research by the industry. It is recommended that these research topics be prioritized by all concerned parties. It is important that inter departmental (Soil science/ Horticulture/ Agronomy and GIS) combine research projects as this compliments the implementation of the research into the industry. To ensure the correct practical implementation of the research forums may be beneficial where researchers and agricultural support staff can interlink and share ideas. Institutions like SACNASP must continue to ensure that scientific sound agricultural support is available for the implementation process.

Keywords: Research, Industry, Soil science, Horticulture, Agronomy, GIS

THE EFFECT OF HUMATE AND FULVATE AMENDMENTS ON THE VIABLE MICROBIAL POPULATION AND NUTRIENT LEACHING

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INTRODUCTION

Humic acids are products from the decomposition of plant and animal residues by soil organisms and play an important role in increasing soil fertility globally (Sara *et al.,* 2010). Humates and fulvates are carbon-rich products that can be used to increase crop production and to reduce nitrogen (N), phosphorus (P) and potassium (K) fertilisation(Selim*et al*., 2009). The aim of this study was to determine the effect of humates and a fulvate on the viable microbial population and nutrient leaching in a sandy clay and sandy clay loam soil.

MATERIALS AND METHODS

A laboratory study was done using a sandy clay (36%) and sandy clay loam (20%) soil with different mixtures of fertilises and humates and fulvate. nine treatments and three replicates. The soils were supplemented with two different fertiliser application rates (220-50-80 NPK and 165-37.5-60 NPK kgha^{-1}) with and without humates (high or low ash content) or a fulvate (200 kg·ha^{-1}). Samples were collected (initial, after two and four weeks), serially diluted and plated onto Tryptone Soy Agar (TSA) and Potato Dextrose Agar (PDA) for enumeration of bacteria and fungi, respectively. A pot trial was laid out in a complete randomized block design with five treatments and four replicates. Soils were fertilized and amended with humates and a fulvate as mentioned above. The pots were subjected to wetting and drying. After wetting the leachate and soil were collected and analysed for N, P and K.

RESULTS AND DISCUSSION

After four weeks, bacterial and fungal counts were higher in soil treated with humates and a fulvate as compared to soils containing no humic acids. Results showed that humates and the fulvate used reduced N, P and K leaching in both soils possibly due to the humic acids playing a vital role in decreasing soil N leaching. N, P and K were retained best when soils were amended with both humates and a fulvate.

CONCLUSIONS

Humic acids increased the soil microbial community and reduced N, P and K leaching.

REFERENCES

SARA, T., ORNELLA, F., SILVIA, Q. & NARDI, S. 2010. Humic substances biological activity at the plant—soil interface*. Plant Signaling & Behaviour.* 5:635-643*.*

SELIM, E.M., EL-NEKLAWY, A.S. & EL-ASHRY, S.M. 2009. Beneficial effects of humic Substances fertigation on soil fertility to potato grown on sandy soil. *Australian Journal of Basis & Applied Science* 3:4351-4358*.*

Keywords: Humic acids, leaching, microbial population, nitrogen, phosphorus, potassium

A TRANSGENIC APPROACH TO IMPROVE THE DROUGHT TOLERANCE OF POTATO

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INTRODUCTION

South Africa is classified as a water-stressed country and improving crops using biotechnological tools could assist in the protection of crops against adverse environmental conditions. A transcription factor gene (*StMYB1R-1*) was identified in potato and found to increase this plant's drought tolerance (Shin *et al*., 2011). A project was initiated in 2012 to incorporate this gene into a local potato variety, to assist in the development of the emerging potato farming sector that is constrained by a lack of water for agriculture.

MATERIALS AND METHODS

The *StMYB1R-1* gene was isolated from potato variety BP1 and subcloned into a plant transformation vector under constitutive (CaMV) or inducible (*rd29A*) promoter control (Yamaguchi-Shinozaki and Shinozaki, 1994). *Agrobacterium*-mediated transformation of potato cultivar BP1 with the different constructs was performed and selected with kanamycin. PCR screening, GUS expression analysis and transcript expression analysis were performed. A greenhouse trial was conducted with twelve selected transgenic potato lines and untransformed control BP1. Relative water content (RWC), stomatal conductance and chlorophyll content of control and water-stressed plants were measured.

RESULTS AND DISCUSSION

PCR screening with specific primers indicated the presence of the expected genes in 85 of 92 selected transgenic potato lines. GUS expression analysis successfully characterised the inducible promoter behaviour under stress. RWC and drought survival results indicated two transgenic potato lines to be more drought tolerant than untransformed BP1 control.

CONCLUSIONS

It is proposed that the transcription factor transgene will activate delayed response drought-protective genes. This will render the potato crop more drought tolerant by reducing water loss under water-stressed conditions.

REFERENCES

Shin D, Moon S-J, Han S, Kim B-G, Park SR, Lee S-K, Yoon H-J, Lee HE, Kwon H-B, Baek D, Yi BY, Byun M-O. 2011. Expression of *StMYB1R-1*, a novel potato single MYB-like domain transcription factor, increases drought tolerance. Plant Physiology 155(1): 421-432.

Yamaguchi-Shinozaki K, Shinozaki K. 1994. A novel *cis*-acting element in an *Arabidopsis* gene is involved in responsiveness to drought, low-temperature, or high-salt stress. Plant Cell 6(2): 251-264.

ACKNOWLEDGEMENTS

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Keywords: Drought tolerance, genetic engineering, potato, transcription factor

UNDERSTANDING THE FACTORS INFLUENCING *Fusarium graminearum* ON MAIZE

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INTRODUCTION

The *Fusarium graminearum* species complex (FGSC) consists of 16 species causing a variety of diseases in cereals. Fusarium head blight of small grains as well as Gibberella ear, stalk, crown and root rot of maize are the most prevalent diseases of this pathogen complex. The FGSC produces a variety of mycotoxins including Deoxynivalenol (DON), Nivalenol (NIV) and Zearalenone (ZEA) that cause mycotoxicoses in both humans and animals. In addition, yield losses occur due to reduced grain quality caused by ear rot and decreased harvesting efficiency caused by lodged plants. Understanding the factors that affect this complex on maize will assist in developing management strategies for the various FGSC maize diseases.

MATERIALS AND METHODS

In a severely infected region of the Northern Cape, where maize is grown in a summer maize winter wheat rotation systems under irrigation, abiotic factors that could possibly influence FGSC severity were studied. Seven infected fields were selected. Entire plant samples were collected from three areas within each field, from adjacent patches of both diseased and healthy plants. Quantitative PCR was performed on extracted DNA from roots, crown, stems (internode 1 and 2) and kernels to determine FGSC fungal biomass. SGS South Africa (PTY) Ltd. Agricultural Laboratory determined the nutrient levels within the maize leaves. Anova was performed on these results.

RESULTS AND DISCUSSION

It would seem that there is little difference in fungal biomass when diseased plants are compared to healthy plants, with both having various degrees of fungal infection. However in most cases the roots had less fungal biomass than the stems indicating that the complex prefers stem tissue. Potassium (K) and boron (B) levels in leaves of maize were significantly higher in healthy plants than in diseased plants. The application of K has been found to reduce the incidence of stem rot in plants indicating that either the diseased plants were not able to utilise K efficiently thus predisposing them to stem rot or that stem rot inhibited the distribution of the potassium throughout the plant. Boron has been shown to increase disease resistance to a variety of pathogens including *F. solani,* however the exact mechanism of resistance is unknown. Thousand kernel mass were significantly higher for healthy than diseased plants. This indicates that the stem rot sets in before or early on in the grain filling stage. However, no significant effect on total grain yield was recorded.

CONCLUSION

Data collected to date indicates that *Fusarium graminearum* is an important disease complex on maize. This may be a result of reduced nutrient uptake, in particular potassium and boron. This research is in progress and will contribute to an improved understanding of FGSC and factors contributing to its severity and its effect on maize yield and quality.

Keywords: Fusarium graminearum species complex, maize

DIVERSITY OF INDIGENOUS RHIZOBIA NODULATING TROPICAL GLYCINE CROSS AND NON-TROPICAL GLYCINE CROSS SOYBEAN GENOTYPES

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INTRODUCTION

The breeding of promiscuous soybean was aimed at ensuring widespread cultivation of soybean among smallholder African farmers, as they do not require inoculation. However, inconsistencies in the nodulation and nitrogen fixation have been realized with promiscuous soybean in some locations, raising questions regarding the presence, diversity and effectiveness of these rhizobia. This study aimed at assessing the diversity of indigenous rhizobia associated with promiscuous soybean grown in Mozambican and South African soils.

MATERIALS AND METHODS

Six Tropical Glycine crosses (TGx) and two non-TGx Soybean nodules were sampled from 13 smallholder farmers' fields without history of inoculation, across soybean producing areas in Mozambique. In South Africa, two TGx soybean genotypes were planted at the Agricultural Research Station, Nelspruit, to trap indigenous rhizobia in the soil. Total DNA was extracted directly from the nodules using the NucloeSpin soil kit, and PCR products obtained were subjected to the process of denaturing gradient gel electrophoresis as described by Muyzer *et al*. Community fingerprints were recorded and the digital image obtained was analyzed using software based on the Shannon-Weaver index. A dendogram depicting similarities and differences between communities was generated using Jaccard statistics and a group average across the different samples. The DGGE bands obtained were re-amplified for sequencing. Sequences obtained were subjected to a blast analysis on the GenBank. A parsimony based phylogram was drawn from the sequence alignments obtained after the BLAST.

RESULTS AND DISCUSSION

The DGGE bands obtained were grouped into three clades in the cluster analysis, separating the bacterial populations on the basis of species differences. All the DGGE bands that were sequenced belonged to the genus *Bradyrhizobium* with the exception of isolates M1987-37 and DAIAP-33 which belonged to *Rhizobium lupini* and *Chryseobacterium* sp respectively. The results also showed that bacterial species diversity was highest in nodules from Serra and Tetete, and lower in those from Mutequelesse and Nelspruit. *Bradyrhizobium denitrificans* was present in all the soybean nodules studied.

CONCLUSION

This study showed a high diversity of indigenous rhizobia belonging to the *Bradyrhizobium* genus nodulating promiscuous and non-promiscuous soybean in Mozambican and South African soils.

REFERENCES

Muyzer G, De Waal E.C, Uitterlinden A.G. 1993. Profiling of complex microbial communities by denaturing gradient gel electrophoresis analysis of polymerase chain reaction-amplified genes coding for 16S rRNA. *Applied and Environmental Microbiology* 59: 695-700

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Keywords: Indigenous rhizobia, N2 fixation, TGx soybean

EFFECT OF PLANT AGE ON SYMBIOTIC PERFORMANCE, CARBON ACCUMULATION AND $\delta^{13}C$ OF TWO FIELD-GROWN COMMON BEAN (*Phaseolus vulgaris* L.) VARIETIES IN LIMPOPO

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INTRODUCTION

Common bean *(Phaseolus vulgaris* L.) is an important food grain legume that can fix about 55 to 150 kg N ha^{-1}. Symbiotic N_2 fixation by legumes is reported to increase with plant ontogeny. This is partly attributed to better root establishment leading to enhanced water and nutrient uptake. The relative abundance of ^{13}C in tissues of C3 plant species can provide information on their water-use efficiency over an extended period of time. The aim of this study was to assess changes in symbiotic performance, C accumulation and $\delta^{13}C$ with age of two common bean varieties (RS6 and KMB) grown in Limpopo in the 2012/2013 cropping season.

MATERIALS AND METHODS

Two common bean varieties (RS6 and KMB) were planted at the University of Limpopo Syferkuil Research Farm in a Randomised Complete Block Design with four replications. Planting was done in December 2012, as well as in January and February 2013. The shoots of five plants per plot were sampled in February, March and April and processed for analysis of $^{15}N/^{14}N$ and $^{13}C/^{12}C$ isotopic ratios using mass spectrometry. Data were subjected to a one-way analysis of variance using a Statistica software program. Where there were significant differences, the Fisher's Least Significant Difference was used to separate the means at p=0.05.

RESULTS AND DISCUSSION

Plant growth, N content and N concentration were significantly greater in both RS6 and KMB genotypes established in December followed by February and least in January. Mean $\delta^{15}N$ was markedly lower in shoots of both genotypes planted in December and February; as a result, %Ndfa was much higher in plants grown in these two months but lower in January. The amount of symbiotic N contributed by common bean planted in December was markedly higher than in January for both genotypes. C accumulation was higher in both test genotypes when planted in December compared to January or February. The mean shoot $\delta^{13}C$ values were markedly higher in older plants, indicating more water-use efficiency in both genotypes for older plants than their young counterparts.

CONCLUSIONS

The growth and symbiotic performance of common bean varieties RS6 and KMB in Limpopo were greater in older plants than young plants, indicating they were affected by ontogeny. Similarly, C accumulation and water-use efficiency were greater in plants grown in December compared to February and January.

REFERENCES

Farquhar, G.D., Ehleringer, J.R.& Hubick, K.T. 1989. Carbon isotope discrimination and photosynthesis*. Annual Review of Plant Physiology and Plant Molecular Biology*, 40:503-537

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Keywords: Plant growth, varieties RS6 and KMB, $\delta^{15}N$, %Ndfa, N contributed

THE EFFECT OF ETHYLMETHANESULFONATE MUTAGENESIS ON SEED OIL CONTENT AND FATTY ACID COMPOSITION IN VERNONIA (*Centrapalus pauciflorus* var. *Ethiopica*)

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INTRODUCTION

In oil seed crops chemical mutagenesis using ethylmethanesulfonate (EMS) has been reported to induce genetic variation and alter seed oil content and fatty acid profiles. *Centrapalus pauciflorus* (vernonia) produces natural epoxidised oil which has multiple industrial uses. The objective of this study was to determine the seed oil content and fatty acid compositions of vernonia selections derived from EMS mutagenesis.

MATERIALS AND METHODS

Seeds from two vernonia lines Vge-1 and Vge-4 from 3 treatment categories i.e. MS mutants with chloroplast mutation, EMS mutants without chloroplast mutation and untreated controls, were subjected to oil and fatty acid analyses. Oil was isolated according to an established method by Folch et al. (1957) using chloroformmethanol containing butylated hydroxyl toluene as an antioxidant. Oil content was calculated as a ratio of weight of the oil to its respective sample mass. Fatty acid composition was determined after transesterification by the addition of tri-methyl sulphonium hydroxide (Butte 1983).

RESULTS AND DISCUSSION

In Vge-1, significant differences were observed in composition of linoleic and oleic acid due to EMS mutagenesis. Significant increases in linoleic and oleic acid composition were found in chloroplast mutants due to EMS mutagenesis. Differential responses were observed when lines were compared at various EMS mutation levels showing significant effect on vernolic, linoleic and oleic acids compositions. In both lines, no significant differences were observed on seed oil content, palmitic acid, stearic acid and arachidic acid compositions after EMS treatment. Oil content significantly and positively correlated with vernolic acid for Vge-1 ($P<0.001$; $r = 0.898$) and Vge-4 ($P<0.05$; $r = 0.65$). Vernolic acid significantly and negatively correlated with all other fatty acids.

CONCLUSION

The study found that EMS mutagenesis significantly changed the oleic acid and linoleic acid compositions in vernonia. However, the oil content and vernolic acid composition were not significantly affected by EMS treatment in seeds with or without mutation.

ACKNOWLEDGEMENTS

The National Research Foundation (NRF) is acknowledged for financial support.

REFERENCES

Butte W. 1983. Rapid method for the determination of fatty acid profiles from fats and oils using trimethyl sulphonium hydroxide for transesterification. *Journal of Chromatography* 261: 142-145.

Folch J, Lees M, Sloane-Stanley GH. 1957. A simple method for the isolation and purification of total lipids from animal tissue. *Journal of Biological Chemistry* 226: 497-509.

Keywords: Vernonia, fatty acid composition, oil content, mutagenesis

ORIGIN AND GROWTH STAGE AFFECT THE TOLERANCE OF *Conyza bonariensis* TOWARDS GLYPHOSATE HERBICIDE

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INTRODUCTION

Glyphosate came on the market as a broad-spectrum, non-selective, systemic herbicide in 1974. After 20 years of glyphosate use, in 1994, there were no reported cases of glyphosate resistance and it was believed that resistance was highly unlikely to develop. In 1996, glyphosate-resistant *Lolium rigidum* was reported in Australia. Since then 23 other weeds the world over have evolved resistance to this herbicide. The same happened in South Africa when the first case of resistance to glyphosate in rigid ryegrass was reported by Eksteen and Cairns (2001) in vineyards. Resistance to glyphosate in *Conyza bonariensis* was reported in 2003 by Cairns and confirmed by De Wet in the Breede Valley, Western Cape in 2005.

MATERIALS AND METHODS

Screening experiment: *Conyza bonariensis* seed was collected next to the road from Pretoria to George at 12 locations. Seed was planted in 12-cm diameter pots in a sand-coir mixture. Seedlings were thinned out to only one per pot. The recommended rate to control *C. bonariensis* is 2 L/ha Roundup Turbo. At the 4-6 leaf stage, six rates of glyphosate was applied: 0, 0.25, 0.5, 1, 2 and 4 times the recommended rate. Plants were visually assessed on a scale from 1 to 9. At 21 days after treatment (DAT) the plants were clipped at the soil surface and weighed to obtain the fresh mass. Data were subjected to ANOVA.

Growth stage experiment: From the previous experiment two resistant, two tolerant and two susceptible populations were identified. The experiment was conducted in the exact same manner as the screening experiment, with growth stage as an added factor. Plants were treated with glyphosate at two different growth stages. For the second growth stage, glyphosate was applied three weeks later than the first application.

RESULTS

In two populations, plants survived the 1x rate, and therefore, were classified as ‘resistant’. These populations plus two ‘tolerant’ and two ‘sensitive’ populations were used in the growth stage experiment. GR_{50} values calculated from dose-response curves showed that plants sprayed at the later growth stage (10-12 leaf stage) were significantly more tolerant to glyphosate.

CONCLUSION

Significant differences in tolerance to glyphosate existed between the 12 populations from diverse locations. *C. bonariensis* treated later than the label recommendation are more tolerant to glyphosate than if sprayed earlier. Label recommendations must be followed strictly to ensure that weeds can be effectively controlled, and to avoid false claims of glyphosate resistance.

Keywords: Conyza bonariensis, glyphosate, weed resistance

MICROPROPAGATION AND IN VITRO INDUCTION OF POLYPLOIDY AND THE EFFECT ON SELECTED HORTICULTURAL CHARACTERISTICS OF THE SOUTH AFRICAN AROMATIC PLANT, *Tetradenia riparia*

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INTRODUCTION

Tetradenia riparia, an aromatic shrub that occurs throughout tropical Africa and in South Africa, has traditionally been used in the treatment of cough, dropsy, diarrhoea, fever, headaches, malaria, and toothache. The essential oils are also used in the perfume industry. Although polyploidy is a naturally-occurring phenomenon, artificial induction of polyploidy has been used successfully in the breeding programmes of a number of crop species most prized by Man. Polyploid selections were developed *in vitro* in order to evaluate potential differences in selected horticultural characteristics between diploid and tetraploid lines.

MATERIALS AND METHODS

In vitro polyploidisation and verification of polyploidy

Seed was sterilized and germinated on Murashige and Skoog (1962) [MS] nutrient medium after being incubated in sterile colchicine solutions of various concentrations. Polyploid induction was verified using a Partec PA flow cytometer. Verified polyploids were proliferated *in vitro* before hardening-off and establishment in pot trials. Shoot cultures were proliferated using single-node cultures on MS medium supplemented with cytokinins. Shoots rooted spontaneously *in vitro* and were readily hardened-off in the mistbed.

Evaluation of selected horticultural characteristics

Biomass, stomatal density and essential oil content were analysed, the oil composition was characterized as well as the effect of essential oils extracted from diploid and tetraploid lines on the *in vitro* growth of *Geotrichium candidum*, a fungus causing rot in fruit and vegetables.

RESULTS AND DISCUSSION

Tetradenia riparia could easily be micropropagated and pure tetraploid lines were verified. Tetraploid *T. riparia* plants had larger, thicker leaves than diploid plants, with reduced stomatal distribution compared with the diploids, as well as higher biomass. Further, tetraploid leaves were highly dentate compared with the diploids. Tetraploids contained at least double the amount of essential oil compared with the diploids and preliminary results indicate that the tetraploid essential oils inhibited the growth of *Geotrichium candidum* at specific spore concentrations and exposure times.

CONCLUSION

Preliminary results indicate that tetraploid plants produce an essential oil with potential for mitigating postharvest diseases and further research will be carried out to determine the potential of developing 'green' products using essential oils as bioactive ingedient.

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Keywords: Tetradenia riparia, tissue culture, polyploidy, flow cytometry, essential oil

GERMINATION CHARACTERISTICS OF THE GRASS WEED *Digitaria nuda* (SCHUMACH.)

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INTRODUCTION

Specific requirements for normalgermination of related weed species often differ and a slight variation in environmental conditions can increase or decrease the rate of their emergence (Hartzler, 1999). Knowledge on the biology and germination characteristics of weeds can be an important tool when implementing integrated weed control strategies, and can be used to prevent significant numbers of new weed seeds being added to the soil seed bank (Chauhan and Johnson, 2009; Hartzler, 1999). The objectives of this study were to determine germination characteristics of *D. nuda* utilising various pre-treatments to increasing seed germination using constant and fluctuating temperature regimes in order to identify optimal germination conditions for each of the pre-treatments.

MATERIALS AND METHODS

The effect of various pre-treatments of seed and their interaction with temperature on cumulative percentage and rate of germination were evaluated for *Digitaria nuda*. Stored (12 months) and fresh (2 months) seed were pre-treated with either 0.02 M KNO_3, soaked in water for 24 h (priming), sterilized with 0.5% NaOCl or heat treated at 60 °C. Seeds were germinated at constant temperatures of 25 and 30 °C and fluctuating day/night temperature regimes of 25/10 and 30/15 °C. The effect of pre-chilling on germination of stored and fresh seed was evaluated at 30/15 °C, and seed emergence in two soil types at different burial depths (0, 0.5, 1, 2, 3, 4, 5 and 6 cm) was also determined.

RESULTS AND DISCUSSION

The pre-treatment of older seed with KNO_3 resulted in the highest germination percentage (100%), whereas the pre-treatment of fresh seed with water for 24 h gave the best germination (99%), at constant temperatures of 25 and 30 °C. Pre-chilling of seed increased germination by more than 30%. Emergence from clay loam soil was greater compared with emergence from sandy loam soil. Total seedling emergence decreased exponentially with increasing burial depths with only 5% of seed emerging from a burial depth of 6 cm.

CONCLUSION

Most grass species show some sort of dormancy and germination of *D. nuda* was increased significantly by utilizing pre-treatments of water and KNO_3 at constant temperatures of greater than 25 °C. *D. nuda* seed favoured clay soil to sandy soil. Knowledge of factors influencing germination and emergence of grass weed seed can assist in predicting flushes in emergence allowing effective control of *D. nuda*.

REFERENCES

Chauhan, B.S., Johnson, D.E., 2009. Germination ecology of spiny (*Amaranthus spinosus*) and slender amaranth (*A. viridis*): Troublesome weeds of direct-seeded rice. *Weed Science*, 57:379-385.

Hartzler, R.G., Buhler, D.D., Stoltenberg, D.E., 1999. Emergence characteristics of four annual weed species. *Weed Science*, 47:578-584.

Keywords: Burial depth; germination; potassium nitrate; priming; soil type; temperature

HOST ASSOCIATIONS OF RUSSIAN WHEAT APHID, *Diuraphis noxia* (HOMOPTERA: APHIDIDAE) BIOTYPES IN SOUTH AFRICA

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INTRODUCTION

The economic importance of Russian wheat aphid on the wheat industry in South Africa will to a great extend depend on their ability to survive and increase on host plants alternative to cultivated wheat. In order to determine the success of different Russian wheat aphid biotypes on different host plants the incidence and host associations as well as the intrinsic rate of population increase (r_m) was determined for three South African biotypes

MATERIALS AND METHODS

The incidence and host associations of Russian wheat aphid were investigated in the wheat growing areas of the Free State and Cape Provinces from 2009 to 2011. Aphid samples were collected from alternative host plants as well as cultivated wheat. Infested leaves were transported to the laboratory in Petri dishes with moist filter paper, placed in an icebox. Site collection and host plant information were noted for each sampling point. An individual aphid from each sample was transferred to a wheat plant and caged to produce a clone colony, after which the biotype of each clone was determined. The intrinsic rate of population increase (r_m) is an index of herbivore performance and alternative host suitability. The intrinsic rate of population increase (r_m) was determined for the three South African biotypes, RWASA1, RWASA2, RWASA3 on 7 different host plants. Daily reproduction of the aphids was recorded for the life span of the aphid on each plant. Intrinsic rate of increase (r_m) was calculated by the following formula: $Se^{-rx}(l_x \text{ X } m_x) = 1$, where x is the time increment (24 hours), l_x is the probability of being alive on day x, m_x is the average birth-rate on day x, and r is the intrinsic rate of increase

RESULTS AND DISCUSSION

Volunteer wheat and Rescue grass were the preferred alternative host plants to cultivated wheat for all three biotypes. No RWASA1 samples were collected from oats, but RWASA2 seemed to be able to survive successfully on oats with 12.26% of the total RWASA2 samples collected on oats and 2.83% RWASA2 samples on wild oats. Russian wheat aphid biotypes showed a positive intrinsic rate of increase on all host plants tested, indicating that these host plants were all suitable hosts to support populations of all three biotypes. The intrinsic rate of increase (r_m) on Tugela*Dn,* which is resistant to RWASA1 but susceptible to RWASA2 and RWASA3, was significantly higher for RWASA3 and lowest for RWASA1. The intrinsic rate of increase (r_m) for RWASA2 and RWASA3 was significantly lower on Tugela*Dn*5, which is resistant to these two biotypes. The intrinsic rate of increase (r_m) for RWASA2 and RWASA3 was significantly higher than for RWASA1 on both oats and wild oats.

CONCLUSIONS

Aphid infestation of winter wheat in the spring may be directly influenced by their success and abundance in non-cultivated host plants between harvest and emergence of the cultivated wheat. It is therefore important to consider the success of different Russian wheat aphid biotypes on host plant alternatives to cultivated cereals when planning a management strategy for RWA in an area.

Keywords: Russian wheat aphid, *Diuraphis noxia*, biotype, alternative host plants, intrinsic rate of increase

INFLUENCE OF DELAYED ROOTING HORMONE APPLICATION ON VEGETATIVE PROPAGATION OF *Lobostemon fruticosus* STEM CUTTINGS

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INTRODUCTION

Lobostemon fruticosus L. is a plant known to most rural communities in the Western Cape Province of South Africa and used medicinally, especially for treating wounds, blood poisoning, ringworms, skin diseases and syphilis (van Wyk, 2008). The material used is mostly wild harvested, leading to declining natural populations. Propagation and cultivation methods to establish commercial production can assist in the conservation of the species. In this study, the objective was to determine the effect of delaying rooting hormone application on vegetative propagation of *L. fruticosus* using stem cuttings.

MATERIAL AND METHODS

The study was done on a mist bed at the Agricultural Research Council-Vegetable and Ornamental Plant Institute (ARC-VOPI), Pretoria, South Africa. The layout of the study was a factorial randomised complete block design with two growth media (cocopeat and compost + cocopeat, 50:50 w/w), rooting hormone (Seradex No. 1 and control) and six application times, with five repetitions. The parameters assessed were rooting percentage, mortality rate, callus development, shoot growth, and number of leaves.

RESULTS AND DISCUSSION

Rooting percentage significantly increased with delaying the application of rooting hormone for one to two weeks after planting, as compared to the control (without hormone) and hormone application at the time of planting (week zero). Cocopeat medium gave the highest rooting percentage (67.4%) and lowest mortality rate (18%), whereas compost + cocopeat medium gave the lowest root development (31.5%) and highest number of shoots. Callus development in the compost medium, the significant difference was only for the first two weeks after treatment application but further delay had no effect.

CONCLUSION

This study concludes that delaying hormone application could increase rooting of *L. fruticosus*. However, callus production did not ensure rooting of the species.

REFERENCES

Van Wyk, B-E. 2008. Muthi and Muths from the African Bush, Pp. 62-63.

Keywords: Lobostemon fruticosus

VULNERABILITY OF RURAL CROPS/LIVESTOCK SYSTEMS TO CLIMATE IN LIMPOPO AND EASTERN CAPE PROVINCES OF SOUTH AFRICA

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INTRODUCTION

Most developing countries are increasingly vulnerable to disasters. In South Africa, millions of people live in the rural areas and are among the poorest and the most vulnerable with low capacity to cope with disaster risks. Current interventions fail to recognize the differential impacts of climate change on people's livelihoods, especially rural households. The identification and characterization of the manner in which household livelihoods are sensitive to disaster risks has become a key input for targeting, formulating, and monitoring and evaluating adaptation policies. Therefore, there is a need to raise awareness of households that are vulnerable to climate disasters to target adaptation strategies towards key vulnerabilities and to monitor exposure to climatic stresses (van Wijk et al., 2012).

MATERIAL AND METHODS

We present here a recently developed study for the assessment of vulnerabilities of mixed crop/livestock systems to climate change in South Africa: Lambani in Limpopo province and Alice in Eastern Cape. Community level data has been collected through household interviews, addressing socio-economic aspects of livelihoods, including agricultural practices. Though the larger project will assess the vulnerability of the mixed crop-livestock systems under changing climate, we focus here on the demonstration of the approach under current conditions and common practices. The crop systems are simulated by crop model simulation and the livestock systems are evaluated by experience based models.

RESULTS AND DISCUSSIONS

The mixed crop/livestock assessment methodology results will be presented at the conference. We will emphasis on the challenges faced in coupling two different types of modeling with variable time and scale resolution capacity. We will highlight the benefits of the coupling and reveal the value of a mixed approach in opposition to parallel assessments.

CONCLUSIONS

This study provides a holistic approach to assessing vulnerabilities of the smallholder rural communities to climate variability and change in South Africa. This is presented as a solid foundation for policy consideration and further research into adaptation pathways.

REFERENCE

Van Wijk M.T, Rufino M.C, Enahoro D, Parsons D, Silvestri S, Valdivia R.O, Herrero M., 2012. A review on farm household modelling with a focus on climate change adaptation and mitigation. Working Paper No. 20. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Keywords: Climate risk, small holder farmers, Household vulnerability, modeling, South Africa

ROOIBOS TEA BY-PRODUCTS AS BIOSORBENT FOR Pb(II) METAL REMOVAL IN AQUEOUS SOLUTIONS

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INTRODUCTION

Rooibos (*Aspalathus linearis)* plants are cultivated in the Cedarberg region in South Africa, for the processing and production of the Rooibos tea (internationally ascribed for its important health promoting properties). The processing of the tea produces unusable wastes such as coarse shoot materials, fine dust and rejected grades. Agricultural wastes are currently been used to remove heavy metals from aqueous solutions, however, no study has examined the absorption capacity of Rooibos plant waste material for any metal ions. This study investigated the utilization of Rooibos shoot powder (RSP) as biosorbent for the removal of Pb(II) ions from aqueous solutions.

MATERIALS AND METHODS

Aspalathus linearis shoots from producers' fields were harvested, hand-washed, oven-dried (60 ^{o}C) for 72 hours and ground into fine powder (0.85 mm). Lead solution was prepared from pure analytical grade (>97%) lead nitrate ($Pb(NO_3)_2$). Batch studies were carried out and all experiments were conducted at room temperature (25 ^{o}C), with solution pH adjusted with 1M HNO_3 or 1M NaOH solutions. The adsorption capacity of RSP for Pb(II), with respect to factors such as metal ion concentration, pH, sorbent dose, temperature and contact time was evaluated and analysis carried out as described by Zvinowanda et al. (2009).

RESULTS AND DISCUSSION

Under batch conditions equilibrium was attained within 60min and the optimum uptake percent of Pb(II) ions by RSP ranged from 37 to 77% with biosorption capacity of 15.53 $mg.g^{-1}$. However, the biosorption performance of RSP is affected by initial Pb(II) concentration, pH, sorbent dosage, temperature and contact time. The RSP biosorption capacity increased with increasing pH, contact time, temperature and Pb(II) ions concentration and decreased with increasing sorbent dosage. The biosorption process by RSP followed the Langmuir model for Pb(II) ions (R^2 0.9388; q_{max} = 18.28 mg/g) and obeys the pseudo-second order equation with good correlation (R^2=0.9614) indicating that the rate limiting step may be chemical sorption rather than diffusion.

CONCLUSIONS

This study has demonstrated the potential of Rooibos tea-by products for removal of Pb(II) ions from aqueous solution. The utilization of RPS in adsorbent technology will add economic value and also impact water treatment and waste management in the Cedarburg region of South Africa.

REFERENCES

Zvinowanda, CM, Okonkwo, JO, Agyei, NM, Shabalala, PN. 2009. A novel adsorbent for heavy metal remediation in aqueous environments. *International Journal of Environmental Science and Technology* 6:425-434.

ACKNOWLEDGEMENTS

Authors acknowledge Tshwane University of Technology and NRF for funds.

Keywords: Batch studies, biosorbent, Rooibos shoot powder

THE EFFECT OF POTASSIUM AND POTTING-BAG SIZE ON YIELD AND OIL COMPOSITION OF ROSE GERANIUM (*Pelargonium graveolens* L.)

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INTRODUCTION

Potassium has vital roles in plant metabolic processes that activate enzymes, osmoregulation, protein synthesis and synthesis of secondary metabolites (Wen-Xu et al. 2011).

MATERIALS AND METHODS

A study was conducted at the University of the Free State to evaluate the effect of K concentrations (1.3, 3.3, 5.3 and 7.3 mmol L^{-1}) and potting-bag size (5 and 10 L) on the yield and oil composition of rose geranium. Plants were grown under a climate controlled plant-house and treatments were arranged in a randomized complete block design assigned in a split plot layout. Potassium concentrations and potting-bag were allocated to the main and sub-plots, respectively and were replicated three times.

RESULTS AND DISCUSSION

Plant height, K tissue content, and oil composition (linalool, geraniol, geranyl formate, and citronellol to geraniol ratio) were the only parameters affected by the K application. However, this effect on plant height and oil composition was inconsistent and erratic. Plant height, number of branches, branch to height ratio, foliage mass, and oil yield were affected by the potting-bag size. Increased yield on a smaller pot can be ascribed to the length of the growing period, cultivation method, the type of root-media and the type of irrigation method used. Plant foliar mass was increased by the interaction between K and potting-bag at 5.3 mmol L^{-1} and 5 L potting-bag.

CONCLUSIONS

Rose geranium growers are advised to use 5.3 mmol L^{-1} K and to use 5 L potting bags to enhance yield.

REFERENCES

Wen-Xu Y, Yu-Ting Zou-Amjad M, Husaini Wei-Zeng J, Liang-Guan L, QIan Liu, Wei-Wu. 2011. Optimization of potassium for proper growth and physiological response of hoiuttuynia (*Cordata thunb*). *Environmental and Experimental Botany* 7: 292-297.

ACKNOWLEDGEMENTS

Funding from NRF and Central University of Technology, Free State is gratefully acknowledged.

Keywords: Potting-bag size, potassium, rose geranium

RANGELAND MANAGEMENT INFLUENCING AGGREGATION DYNAMICS AND ASSOCIATED ORGANIC MATTER OF CLAYEY SOILS IN A SEMI-ARID GRASSLAND BIOME

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INTRODUCTION

In the arid to semi-arid environments of South Africa more than 75% of the land is used for livestock production, and these rangelands are often subjected to degradation mainly driven by poor land management. The grassland biome of South Africa is a major resource for livestock farming, and the soils are increasingly threatened by overgrazing. Soil organic matter (SOM) is specifically a main factor in rangeland ecosystem functioning, as it improves soil structure, enhances water infiltration and thus prevents erosion through aggregate stabilization. Literature shows that only a few studies have compared the effects of continuous and rotational livestock ranching on SOM properties in semi-arid areas, and the results of these studies were mostly inconsistent. Therefore the need was identified to research this topic further. The aim of this study was to investigate how soil properties respond to intensified rangeland management under different property rights and management systems.

MATERIALS AND METHODS

Soil samples were taken of the various types of rangeland management systems under communal (continuous grazing), commercial (rotational grazing) and land reform (mixture of grazing systems) farming, and within each of these systems we differentiated good, moderate and poor rangeland conditions along a gradient of increasing grazing pressure with decreasing distance to the water points. Soil analyses included the assessment of total C and N as indices of organic matter, various plant nutrients, bulk density as well as aggregate fractionation.

RESULTS AND DISCUSSION

Results showed that soils from the commercial farms exhibited higher values for especially C and N when compared to the other farm types. Further, the communal farms with continuous grazing were generally depleted in all the measured nutrients. As was suspected, the depletion increased with intensified grazing pressure, i.e., from good to poor rangeland conditions. Along that line there was an increased breakdown of macroaggregates with losses of the C and N stored therein. However, the commercial farms also exhibited a decline of macroaggregates and their associated C content near the water points.

CONCLUSIONS

We conclude that aggregate fractionation is a sensitive indicator for detecting the beginning of soil degradation in these ecosystems. Degradation was less pronounced under the rotational grazing of the commercial farms than under communal property right conditions. The latter do not have fenced camps and therefore cannot practice rotational grazing, where soils and rangeland vegetation may restore with adequate resting time.

Keywords: Aggregation, rangeland management, soil degradation, soil organic matter

THE EFFECT OF GEOGRAPHICAL CONDITIONS ON ARTEMISININ CONTENT OF DIFFERENT *Artemisia annua* VARIETIES

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INTRODUCTION

Artemisia annua is commonly known as sweet wormwood. Due to the importance of the plant and its use against malaria it has been distributed from its Asian origin across the world and much cultivation has been done (Ferreira *et al.,* 1997). The leaves are the organs associated with the production of artemisinin. Artemisinin is used as a valuable anti-malarial treatment. Synthetic production of artemisinin is not yet feasible, not to mention very expensive and the product yields are relatively low. In addition, there is not much information on the influence of geographical conditions on artemisinin content of the plant. A study was therefore conducted using selected high-yielding varieties, at two locations.

MATERIALS AND METHODS

Seeds for different varieties were obtained from the University of Pretoria, the ARC-VOPI and Europe, subjected to the same germination conditions and transplanted in Latin squares design at two different locations with different soil types. Measurements were taken during growth, after harvesting and drying, and statistically analysed using NMR-based metabolomics and statistical software.

RESULTS AND DISCUSSION

It was found that no variety outperformed another per location, there was also very little grouping within a variety. It was, however, found that one location, UP, produced a higher percentage of artemisinin (0.41%) than the other, ARC-VOPI (0.31%). The conditions between the two locations were compared and a difference in soil composition seemed to be responsible with little meteorological differences noted.

CONCLUSION

Proposed chemotypes do not produce as well as they would under their original breeding conditions. Soil nutrient stress (e.g. P, K, Na, Mg) seems to play a greater role in the production of secondary metabolites compared with chemotype.

REFERENCES

Ferreira JFS, Simon JE, Janick J. 1997. *Artemisia annua*: botany, horticulture, pharmacology (a review). *Horticultural Reviews* 19, 319–371.

ACKNOWLEDGEMENTS

ARC, UP

Keywords: Artemisia annua, Artemisinin, artemisinin yield, NMR

IDENTIFYING FLOWPATHS AND STORAGE MECHANISMS IN THE TWO STREAMS CATCHMENT

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INTRODUCTION

The objective was to identify flowpaths and storage mechanisms in the Two Streams catchment. The 73.3 ha catchment is located 70 km north of Pietermaritzburg in a sub humid area, and consists of three hillslopes and very similar, deep, rapidly permeable, recharge type soils overlying deeply weathered Natal sandstone. The hypothesis was that infiltrating rain recharges the deep hillslope saprolite, then flowing laterally, exits into the stream via valley bottom soils.

MATERIALS AND METHODS

Evidence for the validity of the hypothesis was sought in three ways. Firstly, measurements from three nested watermark sensors installed along a downslope transect at a footslope of a representative hillslope. Secondly, from four 5 meter deep neutron water meter measurements located in an adjacent upslope terrestrial area. Thirdly, the shape of the stream hydrograph after heavy rainfall events.

RESULTS AND DISCUSSION

The watermark information shows that infiltrated water drains rapidly, and vertically, within a day to a water content at which hydraulic conductivity is very slow. There was also no water accumulation at the lowest watermark nest, indicating negligible lateral flow. Evidence regarding storage was obtained from deep neutron water meter measurements showing approximately five times more downslope water movement in the saprolite compared to that in the solum. Hydrograph shapes after large rainfall events show sharp overland-flow peaks, followed by negligible “recession” shapes which indicate inflow from hillslope soils. Furthermore, storage in the hillslope saprolite was measured using a water balance procedure during the 2005 hydrological year (HY), giving a value of 256620 m^3, far more than the 4793 m^3 of streamflow during the following final hydrograph recession period. The streamflow-rainfall (SF/P) ratios, defined as the amount of water flowing out of the catchment in relation to rainfall amount, during the 2001-2004 HY’s averaged 0.03, with mature wattles on the hillslopes drawing water from below 4.8 meters. The SF/P ratio increased to 0.07/0.08 during 2005-2008 HY’s, the first two without wattles. Comparing between similar rainfall events from 2001 and 2008 HY’s shows SF/P ratios of 0.03 and 0.08, respectively, logically due to large volumes of saprolite stored water during the 2005-2007 HY’s, compared to saprolite storage depleted by wattles for 14 years before 2001.

CONCLUSION

These results provide reliable quantitative evidence for the validity of the hypothesis, and valuable information for the construction of the representative hillslope hydropedological conceptual model of the catchment.

Keywords: Hydrological year, hydrograph, saprolite, streamflow-rainfall ratio

ROUGING OPTIONS FOR REHABILITATION OF BANANA XANTHOMONAS WILT AFFECTED PLANTATIONS IN KENYA

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INTRODUCTION

Banana Xanthomonas Wilt (BXW), caused by *Xanthomonas campestris* pv. Musacearum, is a devastating disease that can cause up to 100% loss of affected plants and affects all banana (Musa spp.) varieties. The disease was first reported in 2006 in Teso in western Kenya and has spread to most regions of western Kenya. This study was designed to evaluate the performance of single stem rouging options for rehabilitation of severely affected banana orchards in East and Central African countries.

MATERIALS AND METHODS

Five single stem rouging options were implemented in banana orchards with about 80% BXW incidence in Bumala, Busia county, in Western Kenya. The options included removal by uprooting, cutting at the base, injecting with glyphosate herbicide and uprooting the whole mat of the affected plants. Controls comprised of leaving the affected mats untouched.

RESULTS AND DISCUSSION

The rouging options were consistently implemented over a one year period until BXW incidence and severity were reduced to negligible levels. Rouging the affected banana stems by cutting at the base, uprooting and injection of herbicide reduced BXW within six months. Yields of 16.3 t ha^{-1}, 9.4 T/Ha^{-1}, 8.3 T/Ha^{-1} and 4.2 T/Ha-1 were recovered from uprooting affected plants, application of gyphosate herbicide to affected plants and cutting affected plants at the base respectively, while the control treatment gave 2.4 T/Ha^{-1} within one year of rehabilitation.

CONCLUSIONS

Banana orchards highly infected with BXW can be effectively rehabilitated and normal yields recovered within one year, by consistently rouging the infected plants. Though efficient, rouging by use of herbicide is costly and requires technical knowledge, while uprooting is labour intensive.

Keywords: Banana Xanthomonas Wilt

RELATION OF CARBON ISOTOPE DISCRIMINATION TO WATER USE EFFICIENCY AND YIELD FOR EIGHT SWEET POTATO CULTIVARS SUBJECTED TO WATER STRESS

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INTRODUCTION

Sweet potato is an important staple crop and popular in South Africa as a food security crop. Drought tolerance of a crop is of importance in South Africa due to general semi-arid growing conditions. Carbon isotope discrimination can be utilised as an indirect selection tool for plant water use efficiency and yield potential in various crops (Farquhar *et al*., 1982). The objective of this study was to determine the effect of drought on stomatal conductance, as well as the correlation between the carbon isotope discrimination, stomatal conductance, water use efficiency and yield in sweet potato cultivars.

MATERIALS AND METHODS

Cuttings of eight sweet potato cultivars were planted in a rainout shelter and plants were subjected to two irrigation treatments. Stomatal conductance was measured twice during the trial period and leaves harvested twice during the trial before sunrise. Biomass (roots excluded) of the plants was determined, as well as storage root yield. Leaf material was analysed through mass spectrometry to determine carbon isotope ratios.

RESULTS AND DISCUSSION

Stomatal conductance of plants subjected to drought was severely reduced, resulting in reduced growth. The reduced growth had a negative impact on the yield of the selected cultivars. Significant differences in carbon isotope discrimination values were detected between the different water treatments, as well as between the cultivars at specific treatments.

CONCLUSIONS

It is concluded that drought stress affects stomatal conductance and hence yield of sweet potato. The reduction in stomatal conductance had an effect on the ratio and discrimination of carbon isotopes in the leaf material of all the sweet potato cultivars included in this study.

REFERENCES

Farquhar GD, O'leary MH, Berry JA. 1982. On the Relationship between Carbon Isotope Discrimination and the Intercellular Carbon Dioxide Concentration in Leaves. *Australian Journal of Plant Physiology.* 9**:** 121-37.

ACKNOWLEDGEMENTS

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Keywords: Carbon isotope, conductance, sweet potato, yield

PRINCIPLES OF SOIL CLASSIFICATION: THE SOUTH AFRICAN SYSTEM

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INTRODUCTION

The South African soil classification system was developed in mid 1900 and first published in 1977 followed by a second edition in 1991. Although several principles were followed they were not defined. Soil classification principles show strengths and weaknesses that call for a continuation of the core structure and innovations in the third edition. Application of soil surveys shifted from a reconnaissance natural resource survey to detailed and intensive soil assessment for land evaluation. The number of soils with "form" status nearly doubled. Is conceptual classification still good enough and how should the expanding sphere of pedological interest be handled?

RESULTS AND DISCUSSION

User friendliness and scientifically soundness are overarching, non-negotiable principles. As soil classification serves soil survey the first principle is Butler's principle stating '*Develop and use the soil classification that arises from the soilscape itself.*' It leads to recognition of more soils (not necessarily with "form" or "family" status). This is supported by Simonson *'The soil surveys thus generated progressively more knowledge'* typically what the Land Type Survey did. But not all soils fit the current soil forms and question the way "form" or "family" status is awarded to soils. A humic A horizon occurs on hard rock but the Nomanci soil form's lithocutanic B is a poor representative of hard rock. This requires a lateral expansion of the pedological sphere of interest.

Some soils with three and four horizons changed status in the second edition i.e. some soils of the Hutton form changed to the Bloemdal form. It requires application of MacVicar's principle of an *expanded sphere of pedological interest* and a vertical open ended expansion of the structure.

But Buol's priciple that '*Conventional wisdom has, at times and in places, frozen soft, tentative hypotheses into hard dogma, preventing acceptance of new ideas and concepts, leading to rigor mortis*.' has to be taken seriously.

CONCLUSIONS

Structural and conceptual changes need to be made to the South African soil classification system. Failure to continue to develop a natural, generally applicable soil classification system may result in application of Fitzpatric's principle leading to several systems.

Keywords: Soil classification system

SWOT ANALYSIS: A CASE STUDY OF THE TEXAS VEGETABLE AND FRUIT INDUSTRY AND THE TEXAS A&M AGRILIFE PROGRAMS

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INTRODUCTION

Over the past decade, vegetable and fruit acreage has steadily declined in the State of Texas. This decline is attributed to serious problems with insects, diseases, and drought conditions in the main producing areas and increased competition from imported sources. Within this framework and to develop a short- and long-term strategic planning aimed at addressing critical issues that affect the performance of Vegetable and Fruit (V&F) programs in the Texas A&M AgriLife Agency and the Texas V&F industry, we conducted an internal and external SWOT analysis (S=strengths, W=weaknesses, O=opportunities, T=threats). The objective of this project was to determine critical needs and gaps of the V&F industry and resource capacity and programmatic gaps of the Texas A&M AgriLife Agencies.

MATERIALS AND METHODS

Two knowledge-based regional workshops provided the basis for the development of the internal survey aimed at research and extension faculty engaged in V&F programs within the Agency. This was followed by regional industry workshops conducted in four important V&F growing areas in Texas: Lower Rio Grande Valley, Wintergarden, High Plains, and west Texas. A total of 87 internal participants and 80 external stakeholders responded the survey.

RESULTS AND DISCUSSION

The data emphasized the level of programmatic pre- and post-harvest activities, top priority issues (i.e. water use efficiency, IPM, diagnosis and disease control), competitive advantages of the Agency (i.e. faculty capabilities, reputation, dissemination of information to producers), internal limitations that hinder the Agency progress (i.e. personnel doing more with less) and external conditions harmful in achieving goals (i.e. reduction in budgets and personnel). Strengths that contribute to the success of the V&F industry and broad opportunities for achieving success were identified (i.e. technology advances applied to agriculture, applied long-term research, education and outreach, pre- and post-harvest technology advances).

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Keywords: SWOT, regional workshops, long-term research, vegetable industry, surveys

GROWTH, PHENOLOGICAL AND YIELD RESPONSES OF A BAMBARA GROUNDNUT (*Vigna subterranea* L. Verdc) LANDRACE TO IMPOSED WATER STRESS UNDER FIELD CONDITIONS

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INTRODUCTION

Bambara groundnut (*Vigna subterranea* L. Verdc) is an underutilised species with potential to contribute to nutritional and food security. However, the promotion of the exotic groundnut (*Arachis hypogaea* L.) has resulted in *Vigna subterranea* being a neglected underutilised species, despite its potential for planting in arid, semi-arid and other marginal production conditions. It was hypothesised that local bambara groundnut landraces may have acquired tolerance to drought stress through years of natural and farmer selection under often harsh conditions. It was further hypothesised that such drought tolerance may be linked to seed coat colour. The aim of this study was to evaluate growth, phenology and yield of a local bambara groundnut landrace under irrigated and rain fed conditions.

MATERIAL AND METHODS

Growth, phenology and yield of a local bambara groundnut landrace from Jozini, KwaZulu-Natal, characterised into three selections according to seed coat colour, namely – Brown, Red and Light-brown – were evaluated under irrigated and rain fed field conditions at Roodeplaat, Pretoria. Replicated (x3) trials were planted under rain fed and irrigated conditions with seed colour as a sub-factor. Emergence (up to 35 days after planting), plant height, leaf number, leaf area index, chlorophyll content index and stomatal conductance were measured *in situ*. Yield and yield components were determined at harvest. Data were analysed using analysis of variance in GenStat®.

RESULTS AND DISCUSSION

Seedling emergence differed significantly ($P<0.05$) for the Red, Brown and Light-brown landrace selections at 84, 81 and 51%, respectively. However, all three seed colours were slow to emerge, taking an average of 28-35 DAP to emerge. Plant physiological and growth parameters of stomatal conductance, chlorophyll content index, plant height, leaf number, leaf area index and biomass accumulation were significantly ($P<0.05$) lower under rainfed relative to irrigated conditions. Adaptations were landrace selection specific, with Brown and Red landrace selections showing better adaptation to rainfed conditions. Under rainfed conditions, bambara groundnut landrace selections flowered, senesced and matured earlier relative to irrigated conditions. Consequently, there were lower yields under rainfed compared with irrigated conditions. Nonetheless, the 'Red' landrace selection consistently performed well under all conditions and hence may be described as the most stable of the three seed colour selections.

CONCLUSION

Seed colour in bambara groundnut had an effect on crop establishment. The 'Red' landrace selection emerged better than the lighter coloured selections. This implies that seed colour can be a selection criterium for improved growth and vigour in bambara groundnuts. The 'Red' landrace selection showed greater stomatal regulation, smaller canopy size and completed its life cycle earlier under rainfed relative to irrigated conditions. This suggested an association between seed coat colour and drought tolerance in bambara groundnut.

ACKNOWLEDGEMENTS

The Water Research Commission of South Africa is acknowledged for funding through WRC Project No. K5/1771//4 'Water-Use of Drought Tolerant Crops' (WRC, 2009).

Keywords: Bambara groundnut landraces, chlorophyll, drought, stomatal conductance, yield

THE USE OF Vis/NIRS AND CHEMOMETRICS TO PREDICT POSTHARVEST RIND QUALITY OF CITRUS FRUIT

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INTRODUCTION

The use of visible to near infrared spectroscopy (Vis/NIRS) to evaluate fruit defects is topical in postharvest technology. Previous research has shown that 'Nules Clementine' mandarin fruit harvested from inside the tree canopy have a higher incidence of rind breakdown disorder (RBD) and lower dry matter (DM) content in the rind tissue, suggesting a correlation between DM and fruit susceptibility to RBD (Magwaza et al., 2012). This research was conducted to explore diffuse reflectance Vis/NIRS as a non-destructive technique to sort mandarin fruit based on preharvest canopy position.

MATERIALS AND METHODS

Vis/NIRS signals of 380 'Nules Clementine' mandarin fruit from four orchards in the Western Cape Province in South Africa (Citrusdal, Paarl, Porterville and Stellenbosch) were obtained using a LabSpec® spectrophotometer (350-2500 nm). Principal component analysis (PCA), followed by a partial least squares (PLS) variant known as PLS discriminant analysis (PLS-DA) were executed to evaluate fruit according to canopy position and susceptibility to RBD based on Vis/NIRS signals. PLS was used to predict rind DM content.

RESULTS AND DISCUSSION

In all four orchards, the projection of the samples in the PCA score plots displayed clusters that allowed distinction between fruit from different preharvest canopy positions. This clear sample separation was only possible on spectra transformed using the Savitzky Golay second derivative pre-processing method with the second order polynomial. PLS-DA models also displayed clusters that could easily be identified. The cut-off value for PLS-DA discrimination was 0.5. Samples with a predicted value of 0.5 or more were classified as having RBD, while samples with predicted values less than 0.5 were not affected by the disorder. The ability of PCA and PLS-DA to discriminate between fruit from inside and outside the canopy demonstrated that the technology can be used to segregate fruit based on susceptibility to RBD.

CONCLUSIONS

This technology could be used as an in-line tool during packing, to decide on fruit destined for long distance export market (outside canopy fruit) and those destined for short distance or local market (inside canopy fruit).

REFERENCES

Magwaza LS, Opara UL, Terry LA, Landahl S, Cronje PJR, Nieuwoudt H, Mouazen AM, Saeys W, Nicolaï BM. 2012. Prediction of 'Nules Clementine' mandarin susceptibility to rind breakdown disorder using Vis/NIR spectroscopy. *Postharvest Biology and Technology* 74: 1–10.

Keywords: NIR, rind physiological disorders, nondestructive, rind breakdown, multivariate analysis

LETTUCE GROWTH, YIELD AND QUALITY IN RESPONSE TO NITROGEN IN A NON-CIRCULATING HYDROPONIC SYSTEM

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INTRODUCTION

A non-circulating hydroponic system is highly cost effective and productive for leafy vegetables, conserves water and land, and protects the environment from leaching of nutrients into underground water. Nitrogen fertilizer application is important to improve the vegetative growth and quality of plants. However, a better understanding of plant responses to nitrogen application could assist growers to manipulate plant growth, yield and quality. The objective of the study was to determine the effect on nitrogen concentration in a non-circulating hydroponic system for improved yield and quality of leafy lettuce.

MATERIALS AND METHODS

The study was conducted during the winter in a 40% black and white shade net structure at the ARC-VOPI Experimental Farm. Four-week-old leafy 'Lollo Bionda Lobi' lettuce seedlings were transplanted in a modified non-circulating hydroponic system (Kratky, 1993) at a spacing of 20 x 20 cm. Plants were subjected to seven nitrogen concentrations (0, 30, 60, 90, 120, 150 and 180 $mg.L^{-1}$ N) using ammonium nitrate as a source. Experimental layout was a randomized complete block design with six replicates. Data were collected on leaf number, leaf area, leaf fresh and dry mass, root fresh and dry mass, leaf chlorophyll content, and ascorbic acid.

RESULTS AND DISCUSSION

High nitrogen (180 $mg.L^{-1}$ N) and zero nitrogen (0 $mg.L^{-1}$ N) concentrations resulted in significantly lower leaf area, leaf number and leaf dry mass, compared to 30, 60, 90, 120 and 150 $mg.L^{-1}$ N, which performed similarly. Nitrogen concentration did not have a significant influence on leaf fresh mass, and root fresh and dry mass. Leaf chlorophyll content and ascorbic acid were significantly decreased only at a nitrogen concentration of 0 and 30 $mg.L^{-1}$.

CONCLUSIONS

Results indicate that the minimum nitrogen concentration of 60 mg. L^{-1} can improve growth, yield and quality parameters of leafy lettuce grown in a non-circulating hydroponic system.

REFERENCE

Kratky BA. 1993. A capillary, non-circulating hydroponic method for leaf and semi-head lettuce. *HortTechnology* 3, 206-207.

Keywords: Ascorbic acid, chlorophyll, *Lactuca sativa* L., nitrogen, yield

INTERACTIVE EFFECT OF SEAWEED EXTRACT AND INOCULATION ON YIELD AND YIELD COMPONENTS OF TWO COWPEA VARIETIES

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INTRODUCTION

Cowpea is a multifunctional crop that provides food for humans and fodder for animals. The use of seaweed extracts products has recently become popular in the agricultural industry due to their ability to improve plant growth and yield (Cristobel, 2008).

MATERIALS AND RESULTS

A 2X2X3 factorial experiment was carried out at the University of Limpopo's experimental farm, Syferkuil during the 2012/13 planting season to assess the effect of seaweed extract (Technikelp) and inoculation on yield and yield components of cowpea. Three treatment factors namely; Cowpea variety (Brown landrace, Bechuana-white), Inoculation (+I,-I) and Seaweed extract concentrations (0:0 v/v, 1:100 v/v, 1:500 v/v) were combined and arranged in a randomized complete block design. All the treatments were replicated four times. The seaweed extract was applied as root drench at planting, 14 and 28 days after planting. Data were subjected to analysis of variance using STATISTIX program V10.

RESULTS AND DISCUSSION

Independent application of seaweed extract had a significant effect on the number of pods per plant and grain yield, but had no effect on pod length and the number of seeds per pod. There was no cultivar x seaweed extract interaction effect on any parameter measured. Cultivar x Inoculation x Seaweed extract had a significant effect on the number of pods per plant and grain yield. The combination of Bechuana white x Inoculation (+I) x Seaweed extract (1:100 v/v) resulted in the greatest number of pods per plant (31.5) and grain yield (2784 kg ha^{-1}).

CONCLUSIONS

Application of seaweed extract improved yield of cowpea but had no significant effect on genetically dependent traits such as pod length and number of seed per pod. The results from this study also showed that an increase in the concentration level of Technikelp in the presence of Inoculation increases the yield of cowpea significantly.

REFFERENCE

Cristobel, G.J. 2008. Effect of seaweed (*Sargassum wightii* L.) on the germination and growth of green gram (*Phaseolus aureus*). *Journal of Basic and Applied Biology* 2:105-108.

ACKNOWLEDGEMENT

National Research Foundation for financial support

Keywords: Grain yield, inoculation, seaweed extract, yield components, Technikelp

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

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INTRODUCTION

Because particular weed species tend to be associated with certain crop species, the global distribution of weeds is closely linked to that of the crop 'partner'. Furthermore, because of the extensive global distribution network for pesticides, there is significant similarity in the chemicals used for pest 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 and 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 will be disseminated in ways that make science 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, 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 at hand – it may emerge that the issues are broader than weed control *per se*, and can be addressed as such.

ACKNOWLEDGEMENT

Support by the Monsanto/BEatUP Collaborative Research Programme is gratefully acknowledged.

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

REPLACEMENT SERIES APPROACH FOR DETERMINING THE RELATIVE INTERFERENCE OF *Conyza bonariensis* IN RELATION TO LETTUCE AND TOMATO

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INTRODUCTION

In agriculture and forestry, replacement series have regularly been used in studies of weed-crop associations, and the approach is commonly used for evaluating yield advantages in intercrops. Experiments that use multiple densities make it possible to compare monoculture stands, and allow for the determination of the relative extent of intra- and interspecific competition between the interacting species. The objective of this study was to assess the allelopathy of *Conyza bonariensis* in relation to that of lettuce and tomato by incrementally increasing *C. bonariensis* or crop plant density, thus increasing the concentration of putative compounds with allelopathic potential in the growth medium.

MATERIALS AND METHODS

Replacement series experiments were conducted in a greenhouse at the Hatfield experimental farm. The experimental design was completely randomized. *C. bonariensis* plants were collected at the rosette stage on the experimental farm, and were grown in pots in sterilized field soil (sandy loam) together with either lettuce or tomato seedlings. Treatments consisted of combinations of six proportions of *C. bonariensis* and either lettuce or tomato. The experiment was laid out in replacement series as outlined by Radosevich *et al*., 1996. Harvesting of the trial was done four weeks after treatment commenced and dry mass of tops and roots were measured. Relative yield (RY) and relative yield total (RYT) (Radosevich, 1988) were calculated. Data were subjected to ANOVA and separation of means was done with the least significant difference test of Tukey at $p = 0.05$.

RESULTS

Results for dry mass of lettuce and tomato grown at different proportions with *C. bonariensis* showed that there were no significant effects on the growth of the crop species at all proportions. RYT was > 1 at all the combinations, which implies that both crop species and *C. bonariensis* were less affected by interspecific interactions than in their respective monocultures.

CONCLUSIONS

Methodology, growth stage of receiver plant and plant organ of donor plant are the factors suspected to have restricted the phytotoxicity of allelochemicals in this experiment. In the preceding bioassay studies we conducted, the acceptor species were in the seed/seedling growth stages when it was concluded that the leaves of *C. bonariensis* contained allelochemicals of higher potency than the roots. We propose that allelochemicals in the present experiment were either adsorbed on soil colloids and/or were metabolized by soil microorganisms. This theory, however, needs to be substantiated with further investigations.

Keywords: Allelopathy, *Conyza bonariensis*, replacement series

THE USE OF PLANT CYSTATINS AS ANTI-NUTRITIONAL COMPOUNDS TO COMBAT BANANA WEEVILS

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INTRODUCTION

Banana weevils (*Cosmopolites sordidus*) are serious pests of banana and plantain. The weevils feed on the corm of the banana, weakening it and ultimately resulting in the toppling of the plant. A study revealed that banana weevils are sensitive to cystatins. When cystatins are added to the diet of the banana weevils, severe growth delay of the larvae is observed. However, there is no data available on the banana weevil midgut protease complement so there is a need for the characterization of midgut proteases of *C. sordidus* to enable a targeted approach of midgut inhibition through the use of cystatins.

MATERIALS AND METHODS

Banana weevils were collected from Outlook and Briar Glen farms located in Margate, Kwazulu Natal. Insect midguts were dissected and total RNA was extracted using the Trizol method. Transcriptome sequencing will be done on the Illumina platform using 95bp pair end reads (BGI, Hong Kong). Cystatins were recombinantly expressed as GST-fusion proteins in *E. coli* and purified using affinity chromatography.

RESULTS AND DISCUSSION

A total of eight Potato multicystatin domains were recombinantly expressed and purified. Transciptome analysis is currently being done to establish the protease diversity of the weevil midgut. Isolated midgut proteases will be used in combination with purified cystatins to determine the inhibitory potential of the plant cystatins. This will be followed by insect bioassays to measure the effect on insect growth and development.

CONCLUSION

This study will reveal whether is possible to use cystatins as anti-nutritional proteins to combat banana weevil infestation in banana and plantain.

Keywords: Cystatins, *Cosmopolites sordidus*, proteases, insect control

THE POTENTIAL OF WILD GARLIC (*Tulbaghia violacea*) TO SUPPRESS NEMATODES AND ENHANCE GROWTH OF TOMATO PLANTS

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INTRODUCTION

The management of root-knot nematode (*Meloidogyne incognita*) has become a challenging task in tomato production, due to the withdrawal of effective chemical nematicides. Currently, crude extracts of different plant species are being researched as alternative to chemical nematicides, with promising results. The objective of this study was to investigate the effect of wild garlic (*Tulbaghia violacea*) on tomato growth, yield components and population densities of nematodes under greenhouse conditions.

MATERIALS AND METHODS

The experiment was conducted under greenhouse conditions at the Skills Centre, University of Limpopo in summer (October-December) 2012 and repeated in spring (August-October) 2013. Pasteurised sand-soil mix in pots was inoculated with 1000 *M. incognita* race 2 eggs and larvae. Four treatments *viz*. 0, 2, 4 and 8 g of dried crushed wild garlic per pot, were arranged in a randomised complete block design with ten replicates. Tomato seedlings cv. Floradade were planted into pots and harvested after 56 days. Evaluation included plant growth parameters (plant height, stem diameter and number of leaves), yield components (number of clusters, number of flowers and number of fruits per clusters), root galling index and number of *M. incognita* race 2. Statistical analyses were conducted using SAS software.

RESULTS AND DISCUSSION

Wild garlic had a significant effect ($P < 0.05$) on plant growth and yield components of tomato. The materiel increased plant height, stem diameter, number of cluster, flowers, fruits and leaves by 43 - 73%, 108 - 200%, 57 - 81%, 55 - 110%, 170 - 223% and 51 - 66%, respectively. It also increased the root weight and shoot weight by 95% and 96%, respectively. Wild garlic consistently reduced population densities of *M. incognita* race 2 by 50, 64 and 73% in roots and 21, 30 and 58% in soil, respectively.

CONCLUSIONS

In conclusion, wild garlic has the potential to suppress population densities of *M. incognita* race 2 with positive effects on tomato plant growth and yield components.

Keywords: Meloidogyne incognita, plant growth, tomato, *Tulbaghia violacea*

THE EFFECTS OF DIFFERENT PLANTING POPULATIONS AND CORRESPONDING SEEDING RATES ON CHICORY (*Cichorium intybus* L.) YIELD

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INTRODUCTION

Chicory (*Cichorium intybus* L.) roots are used to produce coffee substitute in South Africa. The crop has small seeds, about 2.5 mm in diameter. Such seeds are associated with poor germination and poor plant stands resulting in poor yields. Balan® (Benfluralin), a herbicide controlling grass weed species, is currently the only product registered in South Africa for weed control in chicory. No herbicides are available for broadleaf weed control; therefore, economic yields of 40 tons ha^{-1} are often not achieved. The objectives of the study were to determine the optimal plant population as well as the optimal seeding rate, under two weed management practices (a stale seed bed using Gramoxone® and pre-emergence herbicides, Dual S Gold® and Hammer® as well as post-emergence herbicides Gallant® and Cysure®; controlling both grass and broadleaf weeds).

MATERIALS AND METHODS

Seeds of chicory (cv. Orchies) were planted mechanically using a hand-held planter at 4 kg ha^{-1}; these were later hand-thinned into desired plant populations of 83 333, 111 111, 166 666, 222 222 and 333 333 plants ha^{-1}. Seeds were also planted to specific seeding rates: 127.20 g, 169.03 g, 254.88 g, 339.84 g and 509.76 g per 8 m^2 plots which were equivalent to 83 333, 111 111, 166 666, 222 222 and 333 333 seeds ha^{-1} respectively. Treatments were replicated four times on a split-split plot experimental design.

RESULTS AND DISCUSSION

A plant population of 111 111 plants ha^{-1} and a seeding rate of 333 333 seeds ha^{-1}, in combination with pre and post-emergence herbicides, obtained the highest chicory yields. However, these yields lay below the economic target of 40 tons ha^{-1}, possibly due to excessive plant populations and poor weed control on a stale seed bed.

CONCLUSIONS

Very high plant populations (166 666, 222 222 and 333 333 plants ha^{-1}) did not prove to be an effective strategy to compensate for poor plant stands. The combination of grass and broadleaf herbicides was a more effective strategy to obtain economic root yields.

ACKNOWLEDGEMENTS

The KwaZulu Natal Department of Agriculture and Environmental Affairs: Horticulture and Crop Protection Section.

Keywords: chicory, plant population, seeding rate, weed management

GROWTH, NODULATION AND YIELD RESPONSE OF PROMISCUOUS AND NON- PROMISCUOUS SOYBEAN VARIETIES TO *Bradyrhizobium japonicum* INOCULATION

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INTRODUCTION

Soybean is an important grain legume, oil crop and it is important in livestock feeding and improvement of soil fertility through biological nitrogen fixation. Currently soybean is not widely grown by smallholder (SH) farmers. This has led to breeding of promiscuous varieties to ensure wide adoption of the crop by SH farmers, without the use of inoculants/ expensive nitrogen fertilizers. Promiscuous varieties were reported to nodulate poorly in some locations (Abaidoo *et al*. 2000). This study determined the effect of inoculation, soybean variety and their interactions on growth, nodulation and yield of soybean.

MATERIAL AND METHODS

The study was conducted during the 2012/2013 growing season under supplementary irrigation at the University of Limpopo experimental farm. The experiment was laid out as a split-plot in a randomised complete block design with four replications. Main-plot factor was inoculation with *B.japonicum* strain WB74 at two levels (uninoculated and inoculated) and the subplot factor studied included three promiscuous soybean varieties (TGx-1937-1F, TGx-1740-2F and TGx-1835-10E), and one commercial variety (Dundee).

RESULTS AND DISCUSSION

Variety TGx-1937-1F was the tallest at 82.3 cm and was significantly taller than Dundee. Inoculation had no significant effect on plant height and biomass. Inoculation significantly ($p<0.05$) increased number of nodules per plant and percent of active nodules.TGx-1937-1F achieved the highest number of nodules/plant of 28, while TGx-1740-2F achieved highest number of active nodules at 69%. Inoculation, variety and their interactive effects enhanced 100 seed weight, shelling percentage and grain yield. Dundee achieved a higher 100-seed weight at 18g than the promiscuous varieties. The inoculation × variety interaction was significant and the yield of variety Dundee significantly increased from 1834 to 6189 kg ha^{-1}, while a slight effect was observed for TGx-1740-2F, from 2769 to 3984 kg ha^{-1} and for TGx-1835-10E from 3073 to 4262 kg ha^{-1}. The yield of TGx-1937-1F did not respond to inoculation.

CONCLUSION

The study showed that it is beneficial to inoculate the soybean varieties studied with *B. japonicum* strain WB74, especially the commercial variety Dundee, in order to enhance their nodulation and yield. However TGx-1937-1F performed better without inoculation.

REFERENCE

ABAIDOO, R.C., KEYSER, H.H., SINGLETON, P.W.,& BORTHAKUR, D., 2000. *Bradyrhizobium* spp. (TGx) isolates nodulating the new soybean cultivars in Africa are diverse and distinct from *Bradyrhizobia* that nodulate North American soybeans. *Int. J. Syst. Evol. Microbiol.* 50, 225-234.

Keywords: Promiscuous soybean, *B. japonicum*, inoculation, nodulation, grain yield

NITROGEN APPLICATION AND RHIZOME SIZE ON PRODUCTION AND SECONDARY METABOLITES OF *Siphonochilus aethiopicus* (Schweinf.) B.L. Burtt

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INTRODUCTION

Siphonochilus aethiopicus ((Schweinf.) B.L. Burtt (Zingiberaceae) is one of the most important and threatened medicinal plants of southern Africa (Watt & Breyer-Brandwijk, 1962). Any agronomic practice applied (such as Nitrogen) could potentially influence the active compounds in the plant and these compounds thus have to be monitored to ensure the recommended practices do not negatively influence the required active compounds.

MATERIALS AND METHODS

Three N levels (0,100 and 200 kg·N·ha^{-1}), three rhizome sizes [small (20-35 g), medium (35-50 g) large (>50 g)] were tested in a randomised complete block design with three replications (0.3 x 0.7 m, plant spacing). Fresh rhizome and root mass (kg·ha^{-1}) and number of rhizomes per plant were recorded during harvesting. Five hundred micrograms of the crude extract was applied on silica TLC plates and developed in a TLC tank and viewed under UV light (254 and 366 nm).

RESULTS AND DISCUSSION

Large rhizomes resulted in the higher fresh rhizome, root yield and number of rhizomes per hectare across all N levels, however, 100 kg·N·ha^{-1} outperformed the 0 kg•N•ha-1 and 200 kg·N·ha^{-1} treatments. There was no significant difference in root mass on the non-fertilized plants in all three rhizome sizes. The TLC fingerprint of the dry rhizome extracts showed similarity in secondary metabolites between all three rhizome sizes.

CONCLUSION

African ginger yield was greatest using 100 kg·N·ha^{-1} with large rhizomes, therefore this combination was considered suitable for the production of African ginger. Nitrogen did not influence the presence of secondary metabolites in African ginger.

REFERENCES

Watt JM, Breyer-Brandwijk MG. 1962. The medicinal and poisonous plants of southern and Eastern Africa. 2nd edition. Livingstone, London.

ACKNOWLEDGEMENTS

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Keywords: African ginger, Nitrogen application, rhizome size, secondary metabolites

MAIZE YIELDS FROM THE LONG TERM FERTILIZER TRIAL AT THE HATFIELD EXPERIMENTAL FARM, UNIVERSITY OF PRETORIA

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INTRODUCTION

Maize (*Zea mays* L.) is an important staple food crop in Africa. Unfortunately African producers do not always have access to fertilizers or when they do apply them through organic sources they may not be balanced or supply all the essential nutrients. A maize fertilizer trial was started in 1939 by Prof Haylett on the Hatfield Experimental Farm, which has been repeated annuall ever since. The layout and treatments have remained unchanged and the aim of this paper is to give feedback on the yield results over the past 74 years as affected by applying combinations of N, P and K.

MATERIALS AND METHODS

This rainfed trial is to be found at the Field Trial section of the Hatfield Experimental Farm, UP. The treatments consist out of a control (0), receiving no fertilizer, and combinations of N, P and K namely NPK, NP, NK, PK, N, P and K. A fully randomize design The maize cultivar DKC 7374 BR, containing both the Bt and RR genes has been used in the past five seasons and is usually established by hand during November. Previosly the best yielding dryland cultivars for use in Pretoria were planted. All fertilizers are broadcast and incorporated before planting. The plots are ±36 m^2 in size of which the middle 5 m^2 are used for data collection. Annually 100 kg N, 0 kg P and/or 80 kg K ha^{-1} are applied depending on the treatment combination. Plots usually receive irrigation after planting to ensure they are well established. In very dry seasons, plots will receive additional irrigation during the flowering stage to alleviate the negative impact of water stress on reproduction. The crop is harvested by hand during May/June when the seeds have reached a moisture content of ± 14%.

RESULTS AND DISCUSSION

Yields, regardless of treatment, tended to increase over time due to the availability of improved maize genetics. The impact of improved genetics is evident in the control plots which yield almost 3 t ha^{-1} without having received any fertilizer for more than 70 years. The effect of drought has been reflected in poorer than expected yields during certain years. Plots receiving NPK from the start, out yielded the rest of the treatments year after year. Plots receiving PK and NK produced the second and third highest yields respectively over the last 40 years. Initially plots receiving only P gave good yields but have declined over the last three decades, while yields for plots receiving only K improved over time.

CONCLUSIONS

Applying NPK will always be advisable, but depending on the crop rotation and initial soil nutrient status, applying NK and PK could also play an important role in sustainable crop production in areas where NPK is not always available. Further research is necessary to determine the effect of these treatments on maize quality and seed germination.

Keywords: dryland, nitrogen, phosphorus, potassium

CALIBRATION AND VALIDATION OF THE SWB MODEL FOR ORANGE-FLESHED SWEETPOTATO (*Ipomoea batatas* L. Lam.)

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INTRODUCTION

The Soil Water Balance model (SWB) is the most idealistic approach for irrigation scheduling and crop growth modelling. It is a mechanistic, real-time, generic crop, soil water balance, irrigation scheduling model that assists the user to appreciate the soil-root continuum as mechanistically possible (Jovanovic *et al.,* 1999). The objectives of this study were to determine the crop specific parameters for Orange Fleshed Sweetpotato Potato and to successfully calibrate and validate the Soil Water Balance Model.

MATERIALS AND METHODS

A trial for Resisto OFSP cultivar was conducted at the University of Pretoria Experimental farm; Hatfield, Gauteng under a movable rain shelter. The trial comprised of four irrigation regimens namely T1 (twice a week), T2 (once a week), T3 (once in two weeks) and T4 (rain and supplemental irrigation dependant). Irrigation was applied to field capacity (FC) depending on the water needed from each treatment. A Randomised Complete Block Design was used, with each treatment replicated four times. A neutron probe was used to monitor soil water content weekly. Leaf Area Index and Fractional Interception of Photosynthetically Active Radiation were collected every 2 weeks. Data for crop growth parameters were sourced from a 0.675 m^2 ground surface from T4. Specific weather data were sourced from the weather station on the farm.

RESULTS AND DISCUSSION

Model calibration simulations of Leaf Area Index, Total Dry Mass and Harvestable Dry Mass, and Soil Water Deficit fitted reasonably well with the measured values. Statistical parameters for both Harvestable Dry Matter and Total Dry Matter were within the acceptable limits as recommended by De Jager (1994). Irrigation to Field Capacity was predicted with low accuracy, although it followed the tendency as recommended by De Jager (1994). Generally, data for validation revealed that model simulations for treatment T1 were more adequate compared to treatments T2 and T3. Water deficit simulation for T1 deficit fitted reasonably well with the field measured data. The predicted values for Total Dry Mass simulations of both T2 and T3 deviated considerably higher from the measured data while HDM simulations were lower than the measured values for both treatments.

CONCLUSIONS

Database of crop-specific model parameters, was generated. Soil water deficit simulations to field capacity were predicted, sufficient to be used for irrigation scheduling and planning. SWB model was calibrated and validated for the selected cultivar and from these parameters growth and water use of the crop can be simulated. Caution however, must be exercised as some simulations need to be improved for statistical accuracy.

ACKNOWLEDGEMENTS

Prof Steyn and Prof Annandale for their unyielding support.

Keywords: Crop growth, crop specific parameters, simulating growth, irrigation scheduling, orange fleshed sweetpotato

SYMBIOTIC PERFORMANCE, $\delta^{13}C$ AND P NUTRITION AS AFFECTED BY PLANT AGE OF TWO *Cyclopia* SPECIES OF THE CAPE FYNBOS

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INTRODUCTION

Cyclopia genistoides and *C*. *subternata* are economically important tea legumes adapted to the acidic, sandy soils of the Cape fynbos. The fynbos soils are generally characterised by low nutrient concentrations, with N ranging from 1 to 2 mg N g^{-1} and P from 0.4 to 3.7 µg P g^{-1} (Cramer 2010; Maseko and Dakora 2013a).

The mechanisms used by *Cyclopia* species to supplement the low soil N and P include the formation of symbiosis with N_2-fixing bacteria, and the secretion of phosphatases to make more P available in the rhizosphere for root uptake (Maseko and Dakora 2013b). The *Cyclopia* symbiosis with root-nodule bacteria can contribute over 100 kg N ha^{-1} to the ecosystem (Spriggs and Dakora 2008). The aim of this study was to assess the effect of plant age on symbiotic N fixation, $\delta^{13}C$, and P nutrition in 2- and 10-year old *C. genistoides*, or 5- and 8-year old *C. subternata* plants. Correlation analyses, involving symbiotic performance, water-use efficiency and P nutrition, were conducted.

MATERIALS AND METHODS

Shoots of *Cyclopia* plants sampled from Koksrivier and Kanetberg farms were oven-dried (60 ^{o}C), ground (0.85 mm) and analysed for $^{15}N/^{14}N$ and $^{13}C/^{12}C$ isotopic ratios. Rhizosphere and bulk soils were also sampled for assay of phosphatase activity (Tabatabai 1994) while P in air-dried soil was analysed using the method of Du Plessis and Burger (1964).

RESULTS AND DISCUSSION

Cyclopia genistoides and *C*. *subternata* plants from older plantations showed greater acid and alkaline phosphatase activities as well as higher rhizosphere P concentrations. The older *Cyclopia* plants were also much more water-use efficient and derived a higher proportion of their N from symbiotic N_2 fixation. $\delta^{13}C$ was positively correlated with $\delta^{15}N$ ($r = 0.697^*$), and %Ndfa ($r = 0.692^*$) at Koksrivier and Kanetberg, respectively. Rhizosphere acid phosphatase activity also correlated positively with $\delta^{13}C$ in *C*. *genistoides* ($r = 0.772^*$).

CONCLUSIONS

The increased rhizosphere phosphatase activity by older *Cyclopia* plants suggests that P nutrition was improved by secretion of these enzymes, and the increased P supply in turn promoted N_2 fixation, elevated shoot water-use efficiency, and increased plant growth. These mechanisms suggest that *Cyclopia* farmers should consider applying P fertilizer as the tea plants age to avoid P stripping.

ACKNOWLEDGEMENTS

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REFERENCES

Cramer MD. 2010. Phosphate as a limiting resource: introduction. Plant and Soil 334, 1-10.

Du Plessis SF. Burger RDT. 1964. A comparison of chemical extraction methods for the evaluation of phosphate availability of top soils. South African Journal of Agricultural Science 8, 11-13.

Maseko ST. Dakora FD. 2013a. Plant enzymes, Root exudates, Cluster Roots and Mycorrhizal symbiosis are the Drivers of P Nutrition in Native Legumes Growing in P Deficient Soil of the Cape Fynbos in South Africa. *Journal of Agricultural Science and Technology A* 3: 331-340.

Maseko, ST. Dakora FD. 2013b. Rhizosphere acid and alkaline phosphatase activity as a marker of P nutrition in nodulated *Cyclopia* and *Aspalathus* species in the Cape fynbos of South Africa, *South African Journal of Botany*, 89: 289-295.

Tabatabai MA. 1994. Soil enzymes. In: Weaver RW. Angle S. Bottomley P. Besdicek D. Smith S. Tabatabai A. Wollum A. (Eds.), *Methods of soil analysis*. Part 2. *Microbiological and biochemical properties*. Soil Science Society of America, Madison, pp. 775-883.

Keywords: N2 fixation, phosphatase activity, plant growth, water-use efficiency, fynbos

INFLUENCE OF PHOTOSELECTIVE NETTING ON PLANT GROWTH AND YIELD IN GREEN SWEET PEPPER CULTIVAR HTSP-5

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INTRODUCTION

Photo-selective coloured netting is referred to as a 'new agro-technological' concept adopted to manipulate light quality changes that can induce favourable responses in plants (Shahak, 2008:161). These changes can result in positive effects on plant growth, fruit mass and marketable yield. The objective of this study was to investigate the influence of photo-selective coloured netting on the growth and yield of the green sweet pepper cultivar HTSP-5.

MATERIALS AND METHODS

Green sweet pepper cultivar HTSP-5 was planted under three photo-selective nets (red, pearl and yellow) and black commercial net (control). The treatments were replicated three times in a randomized complete block design with 288 plants per plot or per treatment. Temperature , relative humidity and photosynthetic active radiation (PAR) data were recorded from transplanting to harvest . Data on growth parameters and yield were also recorded and subjected to statistical analysis using GenStat ®.

RESULTS AND DISCUSSION

The leaf chlorophyll content and stem diameter were higher in black (control) nets whereas plant height and internode lengths were found to be higher under red nets. The total leaf area was higher in the plants grown under pearl nets. The total number of leaves per plant was higher under yellow nets. Higher number of flowers and fruits were also produced under the yellow nets during the 4th week. Photo-selective netting modified the light quality and the microclimate, air temperature, and relative humidity. PAR was significantly higher under the black net and lower under the red, yellow and pearl photo-selective nets.

CONCLUSIONS

The findings of this study can be implemented within the protected cultivation industry to improve flowering, fruit production and overall profitability of green sweet peppers.

REFERENCES

Shahak Y. 2008. Photo-selective netting for improved performance of horticultural crops. a review of ornamental and vegetable studies carried out in Israel. *Acta Horticulture.* 770:161–168.

ACKNOWLEDGEMENT

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Keywords: photo-selective netting, sweet pepper, flowering, production

RESPONSE AND RECOVERY OF DUAL-PURPOSE COWPEA LANDRACES TO TERMINAL DROUGHT STRESS

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INTRODUCTION

Smallholder farmers grow unimproved local varieties or landraces of cowpea (*Vigna unguiculata* [L.] Walp.) for their drought tolerance, stable yield and adaptation under dry-land farming. Cowpea landraces are often grown for dual-purposes like grain and leaf biomass. Variable physiological responses to drought stress between landraces can influence their yield responses under drought conditions. Information is limited on the underlying physiological mechanisms that may affect the yield responses of dual-purpose cowpea landraces under terminal drought stresses. The aim of the present study was to investigate the physiological response of dual-purpose cowpea landraces to terminal drought stress and how this relates to yield performance after recovery from drought stress.

MATERIALS AND METHODS

Controlled glasshouse experiments were conducted at the University of KwaZulu-Natal. Eight treatment combinations involving four cowpea landraces (Lebudu, Lehlodi, Sejwaleng and Morathathane) and two water regimes (stress and well-watered) were tested using completely randomized design replicated 20 times. Drought stress was imposed by withholding irrigation at 50% flowering for 12 days. Sampling per treatment was done on leaves after 3, 6, 9, 12 days without water and 3 days after rewatering. Measurements on physiological responses included leaf water potential, relative water content, stomatal conductance, chlorophyll content, proline content and chlorophyll fluorescence. Total-above ground biomass, pod mass, number of pods and seed yield was determined at maturity.

RESULTS AND DISCUSSION

Drought stress decreased leaf water potential, relative water content, chlorophyll content, and stomatal conductance. An increase in proline content was observed while photosynthetic apparatus (*Fv/Fm*) were maintained in all cowpea landraces. Morathathane showed a significantly ($P < 0.05$) higher reduction in leaf water potential and chlorophyll content compared to other landraces. Sejwaleng had a slower decline in relative water content than other landraces. Proline accumulation was high in Lebudu, Lehlodi and Morathathane while Sejwaleng had low proline accumulation. Lehlodi, Sejwaleng and Morathathane showed a reduction in total-above ground biomass after recovery from drought stress compared to Lebudu. Lehlodi and Lebudu showed a reduction in number of pods, pod mass and seed yield after recovery from drought stress compared to Morathathane and Sejwaleng.

CONCLUSIONS

Significant variation exists among cowpea landraces with respect to their physiological responses to water stress; however the variation in the responses could not be associated with the ability of a particular land race to recover from drought stress. Furthermore the variation in physiological responses of the cowpea land races in this study could not be associated with yield performance.

ACKNOWLEDGEMENTS

The University of KwaZulu-Natal and the National Research Foundation for financial support.

Keywords: Cowpea, drought stress, recovery

GREENHOUSE EVALUATION OF MAIZE PERFORMANCE AND CHANGES IN SOIL CHEMICAL PROPERTIES FOLLOWING APPLICATION OF WINERY SOLID WASTE COMPOSTS

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INTRODUCTION

In South Africa, the dumping of winery solid waste without proper treatment has been prohibited by law due to its possible negative impact on the environment. Thus, an effective, economically feasible and environmentally-friendly winery solid waste management approach was required as an alternative to the land-filling disposal technique. The aim of the study was to assess the potential suitability of winery solid waste compost as a nutrient source for crop production, as a management strategy for solid waste generated during wine production.

MATERIAL AND METHODS

Winery solid wastes (WSW) consisting of waste perlite and diatomaceous earth, collectively described as filter materials (FM) were composted together with chopped grapevine prunings and grape marc, through a thermophilic process. The FM was mixed with grape marc and prunings at five proportions (10, 25, 50, 75 and 100% FM). The composts were dried, milled and subjected to detailed chemical analysis when cured; and evaluated in a greenhouse pot experiment at 5, 10, 20, 40 and 80 t ha^{-1} application rates using 12 kg sandy soil pot^{-1} and maize cv. SNK2147 as a test crop. Unamended (control) and NPK fertilizer treatment were included for comparison. Pots were arranged in a completely randomized design, with four replicates. Dry matter (DM) yield, plant tissue N, P and K content, and uptake was determined after 60 days. Post-harvest soil samples were also analysed for selected soil chemical properties. Data generated were subjected to analysis of variance and difference among treatment means was determined. Regression analysis based on quadratic polynomial model $Y= a+b_1X+b_2X^2$ was used to determine the optimum application rate and DM yield.

RESULTS AND DISCUSSION

There were significant ($p<0.0001$) DM yield increases at higher rates of WSW compost application. The WSW composts with $\geq$50% FM applied at 80 t ha^{-1} gave significantly higher DM yield than the NPK check. Quantitative estimates of the optimum rate of various WSW compost mixed preparations for DM production varied greatly, and ranged from 72 to 307 t ha^{-1}.The K content in maize tissue obtained from all compost amended pots exceeded the critical level indicating WSW compost as an excellent K source for plant growth. Relative to the control, the content of organic C, pH, NO_3-N, Bray-1 P and exchangeable K in post-harvest soil samples was increased by WSW compost application.

CONCLUSIONS

The study showed that WSW composts with higher mix rates of FM increased maize DM yield, and thus have potential agronomic benefits for crop production.

Keywords: Maize growth, nutrient uptake, soil quality, waste management, winery solid waste composts

EFFECT OF GAMMA IRRADIATION AND INSECT PROOF BAGGING ON POSTHARVEST QUALITY OF SULFUR DIOXIDE FUMIGATED LITCHI FRUIT (CV. MAURITIUS)

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INTRODUCTION

It is compulsory for the South African litchi industry to SO_2 fumigate and gamma irradiate its' fruit as a quarantine treatment against insect pests for the United States of America (USA) market. Furthermore, the SO_2 residue levels must not exceed 10 ppm in the aril when fruit reach the USA during shipment or air freight. . The Agricultural Research Council's Institute for Tropical and Subtropical Crops (ARC-ITSC) in Nelspruit were contracted to investigate the potential of SO_2 fumigation, insect bagging plastic, plus gamma irradiation as quarantine requirement for the USA market. In addition, the objective was also to evaluate the effect of gamma irradiation on internal quality parameters of litchi fruit after storage.

MATERIALS AND METHODS

Litchi fruit (cv. Mauritius), obtained from a commercial packhouse at Burgershall, were SO_2 fumigated and gamma irradiated (0 kGy with or without insect bag; 0.6, 0.8, 1.0 and 1.2 kGy), and afterwards stored at 12°C for up to 16 days. Fruit were evaluated for insect damage, fungal infection, SO_2 residues, total soluble solids and titratable acids.

RESULTS AND DISCUSSION

All irradiation doses reduced insect and pathogenic fungal infection compared with control fruit. Furthermore, all irradiation treatments showed SO_2 residue levels below 10 ppm as required by the USA market. In addition, gamma irradiation did not negatively affect internal quality of litchi fruit that was subjected to an air-freight simulation post-harvest storage protocol.

CONCLUSION

Sulfur fumigation in combination with irradiation and insect proof netting did not increase SO_2 levels in the aril of the fruit nor did the SO_2 levels exceed the 10 ppm residue limit. It also had no significant effect on fruit quality or fruit colour. It can therefore be concluded that this treatment can be used for fruit to be exported to the USA.

Keywords: Litchi chinensis Sonn; irradiation, SO_2 treatment, insect proof netting

NUTRITIVE ANTIOXIDANT CONTENT IN TRADITIONAL LEAFY VEGETABLES: SUPPLEMENT TO CULTIVATED EXOTIC COMMERCIAL VEGETABLES

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INTRODUCTION

Africa has a wealth of indigenous/ traditional crops. Traditional/ indigenous crops account for approximately 10% of the higher plant population in the world (Odhav *et al.,* 2006). However, due to the modernization of agriculture, the use of these crops has substantially decreased. This has resulted in communities suffering from malnutrition. Traditional leafy vegetables which are perceived to have a high nutritional and antioxidant content are readily available to communities. Scientific research and the commercialization of the currently underutilized leafy vegetables can aid in the issues of food security for these communities. This report aims to look at the nutritional value of indigenous leafy vegetable using commercial vegetables as reference crops, whilst also attempting to promote the cultivation of indigenous crops to address the problem of food security and malnutrition.

MATERIALS AND METHODS

Seeds for *Brassica oleracea* (green cabbage) and *Brassica oleracea var. capitata f. rubra* (red cabbage) were purchased from Hygrotech®, and amaranthus hybridus seeds were collected from Ukulinga research farm. Seedlings were grown under controlled environment and transferred to pots. Plant material was collected for 6 consecutive weeks. Leaf samples were freeze dried, ground to powder and stored at -74°C cold temperatures. Spectrophotometric determination of total antioxidants' capacity (using FRAP and DPPH assays), total carotenoids, and chlorophyll were also analyzed (according to Lichtenthaler, 1987) along with total phenols (according to Eghdami and Sadehgi, 2010). Then the collected data was analyzed using statistical software GenStat 14.1 version.

RESULTS AND DISCUSSION

The result showed that there were no significant differences of non-enzymatic total antioxidants among green cabbage, red cabbage and amaranthus (*Amaranthus hybridus*). All vegetables showed an increasing trend in total carotenoids and chlorophyll content towards maturity. Similarly, the total phenolic content showed an increasing trend throughout the study. The findings are in agreement with Tesfay et al. (unpublished work 2013) where indigenous vegetables reported to have high antioxidants throughout the plant growth.

CONCLUSION

This experiment confirms that amaranthus can be used as a supplement vegetable as it has almost equal antioxidant content and pigments. It can also be harvested sequentially for human consumption beginning from seedling stage.

REFERENCES

Eghdami A, Sadeghi F. 2010. Determination of total phenolic and flavonoids content in methalonic extraction and aqeous extract of *achillea millefolium*. *Org. chem. J.* 2: 81-84

Odhav B, Beekrum S, Akula US, Baijnath H. 2006. Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis* 20 (2007): 430–435.

Lichtenthaler HK. 1987. Chlorophylls and carotenoids: Pigment of photosynthetic biomembranes, methods in enzymology, 148: 148:50-382.

Keywords: Indigenous vegetables, food security, malnutrition, phytochemical contents

THE EFFECT OF DEFICIT IRRIGATION ON CHLOROPHYLL CONTENT, GROWTH AND YIELD OF DRY BEANS (*Phaseolus vulgaris* L.)

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INTRODUCTION

Irrigated agriculture is the primary user of diverted water globally. Global food production is highly dependent on irrigation especially in low rainfall areas. Deficit irrigation is considered to be one of the practices which can reduce the amount of water used without significant reduction in crop yield. Dry bean is an important protein seed crop in South Africa grown mostly for human consumption. There is a need to meet the growing demand for food which requires increased crop production with less water. The aim of the study was to determine if deficit irrigation could be used as a water saving tool in dry bean production.

MATERIALS AND METHODS

A small plot (5m^2 each) rainshelter field trial was conducted at the Hatfield Experimental Farm of the University of Pretoria, Pretoria, South Africa. Dry bean cultivar DBS 360 was subjected to five levels of moisture stress arranged in a Randomized Complete Block Design with six replications. Soil moisture deficit was introduced through withholding irrigation from 36 days after planting (DAP) for 24 days (S2), withholding irrigation from 49 DAP for 24 days (S3), withholding irrigation from 73 DAP to the end of the growing season (S4), irrigating on a fortnightly bases (S5) and a well irrigated control (S1). Before stress was introduced the trial received 44.6 mm. Soil moisture was monitored twice a week, at 0.2m increments to a depth of 1.0m. The chlorophyll content, leaf area and dry matter partitioning data were collected during the growing season. The number of seeds per plant, number of pods per plant, hundred seed mass, grain moisture content and grain yield data were collected at harvest.

RESULTS AND DISCUSSION

Withholding irrigation resulted in a significant reduction in the number of pods per plant, number of seeds per plant and hundred gram seeds at P=0.001. The treatment S2 resulted in a 49% reduction of total dry matter (P=0.001). The treatments S3 and S4 resulted in statistically similar dry matter production. The chlorophyll content was significantly reduced by moisture stress across all stressed treatments. Treatments S2 and S3 resulted in a significant reduction in grain yield of 22 to 42% respectively (P=0.001). There was no significant reduction in grain yield in treatment S4 and S5.

CONCLUSION

Deficit irrigation can be practiced in dry bean production to save water following treatment S4 and S5 without compromising yield.

Keywords: Withholding irrigation, water stress and grain yield

EVALUATION OF FIELD AND LABORATORY AMORPHOUS AL DIAGNOSTIC TESTS FOR HUMIC TOPSOILS

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INTRODUCTION

The in-field classification of humic A horizons poses a number of challenges for pedologists. Measurement of soil pH >8.4 in 1M NaF (1:50) is commonly used for identification of Short Range Order (SRO) Al minerals in podzol B horizons. Field determination of the presence of SRO Al minerals in humic A topsoils by means of a modified field NaF pH-indicator paper test was proposed Ellis & Lambrechts (2012). This study evaluates the suitability of the proposed field NaF pH-indicator and laboratory NaF pH test for identifying SRO Al minerals in humic A horizons.

MATERIALS AND METHODS

Humic A topsoils were sampled from high-lying areas of Kwa-Zulu Natal, Gauteng, Mpumalanga and the Western Cape Provinces (62 samples). Soil chemical analyses included pH in water (1:2.5), 1M KCl (1:2.5) and 1M NaF (1:50), total C & N, EC, and Citrate-Bicarbonate-Dithionite (CBD) extractable Al, Fe and Mn oxides. During field description of the soils, surface horizons were tested for SRO Al minerals using the proposed field NaF method as follows (Ellis & Lambrechts 2012): a pinch of soil was placed on phenolphthalein-soaked filter paper, to which a few drops of 1M NaF was added and colour change was recorded within 2 min. (pink = positive, no colour change = negative). In the laboratory, air-dried samples were tested in a similar manner. The results of the field and laboratory tests were correlated and analysed statistically.

RESULTS AND DISCUSSION

The soil pH(NaF) did not correlate very strongly (R^2 = 0.63) with CBD Al% in the topsoil samples. Furthermore, several samples with relatively high CBD Al% (>1%) had a pH(NaF) <8.4. This was partly attributed to the higher pH-buffer capacity of humic A horizons compared to podzol B horizons. The field NaF test response was compared to soil pH(NaF), and it was found 55% of samples that tested positive (turned pink) using field NaF test had a pH(NaF) >8.4. Almost all samples with a pH(NaF) >8.4 tested positive for the field NaF test. Only 4.9% of samples with with CBD Al% >0.5% tested negative with the field test, whereas, 45.0% of CBD Al % > 0.5% tested negative with the pH(NaF) test. The majority (88.5%) of samples that tested negative for the field NaF test had a CBD Al% of =0.5%.

CONCLUSIONS

It appears that the field NaF test is more sensitive to CBD Al% >0.5% than the laboratory pH(NaF). The threshold value of the field test is CBD Al >0.5 %, whereas, the pH(NaF) was much less discriminating, and samples with high and low Al resulted in a pH <8.4. In the Land Type Survey of South Africa data, the CBD Al% of humic A horizons ranges from 0.1 to over 2%. Therefore, the proposed field NaF test or laboratory pH(NaF) and for identifying amorphous Al in surface horizons are not entirely suitable as a means of distinguishing humic A horizons.

REFERENCES

Ellis, F.& Lambrechts, J.N.N. (2012). Combined Congress 2012, Potchefstroom.

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NRF for funding.

Keywords: Humic soils, amorphous Al, pedology, diagnostic tests

A COMPARATIVE STUDY OF AN INDIGENOUS CROP BLACK JACK (*Bidens pilosa* L.) AND SELECTED COMMERCIAL VEGETABLE CROPS: CARBOHYDRATES VERSUS ANTIOXIDANTS AS HARVESTING INDICES

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INTRODUCTION

Indigenous crops are known as a good source of natural antioxidant constituents. Such antioxidant constituents are known for their redox effect when it comes to protection against major diseases that are associated with oxidative damage such as cancer, neurodegenerative disorders and ageing (Dasgupta and De 2007). However, information on the type and kind of secondary metabolites that contributes to this high antioxidant rate of indigenous crops is not well understood. To gain further knowledge and understanding on this area, a study was conducted to investigate the antioxidant activity of black jack (*Bidens pilosa,* L.) in comparison with commercial exotic vegetables.

MATERIALS AND METHODS

Seeds for black jack (*Bidens pilosa,* L.) were collected from Ukulinga Research Farm. Seedlings were grown under controlled environment and transferred to pots. Non-destructive leaf samples were collected for 6 consecutive weeks. The leaf samples were freeze dried, ground to powder and stored at -74°C cold temperatures. Spectrophotometric determination of the antioxidant activity and composition of black jack was examined using various organic solvents for extraction. A wide range of analytic parameters were investigated using leafy extracts, such as phenolic compounds, flavonoids, total antioxidants, carotenoids and sugars. Data were analyzed using GenStat 14.1 version.

RESULTS AND DISCUSSION

The antioxidant content of black jack was found to be very high, on the first and second week of the experiment. However, it started to decrease gradually as the number of weeks increased. This trend was also observed on the other crops that were used for comparison, although having lower concentration. There was also a positive correlation between total antioxidant activity and total phenolic content. The result is in agreement with Dasgupta and De (2007), they reported positive correlation between total antioxidant capacity and flavonoids. The research also found black jack (*Bidens pilosa* L.) to be high in carbohydrate production at relatively early stage, and this might assist as a potential indictor for its harvesting index.

REFERENCES

Dasgupta N, De B. 2007. Antioxidant activity of some leafy vegetables of India: A comparative study. *Food Chemistry* 101: 471-474.

Keywords: antioxidants, flavonoids, carbohydrates

DISTRIBUTION OF Zn, Cu, Ni, AND Cr IN SOILS UNDER LONG-TERM APPLICATION OF SEWAGE SLUDGE

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INTRODUCTION

Increase in urbanization and industrialization has resulted in large amounts of sewage sludge with high concentrations of heavy metals. High organic matter content and nutrients in sewage sludge suggests that it can be used as a soil amendment in agricultural soils but major challenge is potential pollution of soils, plants and ground water. The study was conducted to determine the effect of long term application of sewage sludge on spatial and vertical distribution of total and available heavy metal concentration in soil.

MATERIALS AND METHODS

The study was conducted at a dedicated sewage disposal site at DWWW in Pietermaritzburg. Sewage sludge has been applied to the land for >20 years. Soils samples were collected from 28 different sampling points, in along six transects, at 0-10, 10-20, 20-30, 30-40 and 40-50 cm depths. The samples were oven dried at 38^{o}C and were ground to <0.2 mm, for analysis of pH and EC and to <0.5mm for analysis of Cu, Zn, Cr and Ni. The analyses were done with ICP, after extraction with aqua regia, DTPA, TCLP and Ammonium Nitrate.

RESULTS AND DISCUSION

Concentrations of heavy metals for all the extraction methods were higher than minimum permissible limits (MPL). Aqua regia extractable heavy metals were up to five times higher than the MPL set by FAO. The trend of heavy metals were in the order Zn > Cr > Cu > Ni. TCLP extractable heavy metal concentrations were two to three times higher than the limits set by the WRC with the trend following the order Zn> Cu > Ni > Cr. NH_4NO_3 results exceeded the limits set by WRC also with the trend following the order Zn > Cu > Cr. Ammonium nitrate and DTPA extractable metals followed the same trend as TCLP. These findings suggest that long term application of sewage sludge results in high concentrations of heavy metals with potential for ground water pollution and uptake by plants.

CONCLUSION

There is a substantial buildup of heavy metals in soils irrigated with sewage sludge, which varied with transect and depth. Effects of such buildup on ground water pollution and plant uptake need to be studied.

ACKNOWLEGMENTS

The University of KwaZulu-Natal is acknowledged for funding the study, through a competitive grant.

Keywords: Heavy metals, maximum permissible limits, sewage sludge, spatial distribution

HEAVY METAL CONCENTRATIONS IN INDIGENOUS VEGETABLES GROWN ON SEWAGE SLUDGE DISPOSAL LAND

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INTRODUCTION

Long term land application of sewage sludge could result in accumulation of heavy metals in soils and plants. Sewage sludge containing high concentrations of Pb, Hg, Cd, Cr, Ni, Zn, Cu and As has been applied on dedicated land for over 20 years near Pietermarizburg. Indigenous vegetables growing on the land are harvested and consumed and/or sold for income by nearby communities. Potentially high concentrations of heavy metals in these vegetables pose serious risks to human health. The objective of this study was to determine heavy metal concentrations in indigenous vegetables growing on a sewage sludge disposal site.

MATERIALS AND METHODS

The study was carried out at a dedicated sewage sludge disposal site at Darvill Waste Water Works (DWWW). Indigenous vegetables (*Amaranthus hybridus*, *Solanum nigrum*, tomatoes (*Solanum lycopersicum*) and pumpkin (*Cucurbita pepo))* were sampled randomly from selected transects, using 1 m x 1 m quadrats, in April 2013. The plant samples were oven dried at 38 ^{o}C to constant mass and ground (<0.5 mm) before analysis for As, Cr, Cu, Hg, Zn, Pb, Cd and Ni with ICP-OES, after aqua regia extraction.

RESULTS AND DISCUSSION

Soil concentrations of As, Hg, Cd, Ni, Cr, Pb, Cu and Zn were higher than maximum permissible limits set by DWAF (Snyman and Waals 2004). Except for Hg, concentrations of all the heavy metals in plants were above the FAO minimum toxic limits. The metal concentrations in plants were in the order: Zn > Cu> Cr > Pb > Ni > Cd > Hg > As, with *Amaranthus hybridus (L*.) having the highest of all the metals. The concentrations varied across transects in response to soil metal levels. In tomato, Zn concentrations were lower in the fruit than the rest of the plants. The results suggest that pollution of the soil has led to elevated levels of heavy metal in vegetables, which poses health risks to communities consuming these vegetables.

CONCLUSION

Long-term land application of sewage sludge has led to high concentration of heavy metals in indigenous vegetables, particularly Amaranthus. Accumulation of heavy metals in indigenous vegetables poses health risks to human consuming these crops.

ACKNOWLEDGEMENTS

The University of KwaZulu-Natal are acknowledged for funding the study, through a competitive grant.

Keywords: Amaranthus, heavy metals, maximum permissible limits, sewage sludge

REVIEW OF COMPLEMENTARY BIOFERTILZERS AND OTHER MICROBIAL REMEDIAL TREATMENTS OF CAUSES OF SOIL AND PLANT STRESS SYNDROME

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INTRODUCTION

Due to increasing input costs of crop production, soil and environmental degradation, this review investigates the feasibility of implementing environmentally sustainable and cost-effective methods of crop production by applying complementary microbial treatments in soil-dependent farming systems.

MATERIALS AND METHODS

The scope is an in depth review of approximately 400 scientific publications which demonstrate functions of plant, soil and applied microorganisms, specifically fungi, bacteria and Mycorrhiza in terms of increasing plant nutrient uptake, improving plant growth and product quality , increasing crop yield, preventing plant diseases, insecticidal action, drought resistance and improved soil quality.

RESULTS AND DISCUSSION

Literature evidence validates that applications of composite microbial preparations, in combination with reduced fertilizer applications, reduce water demand, suppress plant pathogens, create systemic resistance in host plants, control insects, promote formation of plant hormones and plant growth, and increase yield of improved product quality. A more balanced soil, in terms of chemical and physical properties, is created, thereby alleviating the cause of soil and plant stress syndrome.

Crops which have responded positively to microbial treatments include lucerne, maize, cotton, sugarcane, wheat, soya, rice, sorghum, potato and most fruit and vegetables.
Some commercially available microorganism remedies, in combination or singularly include *Pseudomonas fluorescens, Bacillus subtillis (pumilis), Trichoderma viride/harzianum, Bacillus ginsenghumi (*systemic pest resistance to host plant), *Bacillus thuringiensis* var*. kurstaki, Beauveria bassiana, Vericillium lecanii, Metarhizium anisopliae, Paecilomyces fumososeus, (*insect control*),* Vesicular Arbuscular Mycorrhizae*, Bacillus megaterium* var*. phosphaticum, Pseudomonas striata, Trichoderma harzianum, Paenibacillus brasiliensis* (plant pathogenic fungus control, phosphorus solubilization, micronutrient uptake), *Azosporillum sp., Acetobacter liquefaciens, Azorhizobium caulinodans, Sinorhizobium meliloti, Rhizobium gallicum, R. phaseoli* (nitrogen fixation) and *Fraturia aurentia* (potassium mobilization, water demand reduction).

CONCLUSIONS

Applications of microbial preparations alleviate causes of soil and plant stress syndrome in practice, promote healthy plant growth and improve soil quality with the resultant improvement in plant product quality and increased yield. The financial implications are to increase gross margins thus making agriculture in general more economically sustainable. The resultant decrease in the use of fertilizer, insecticides, herbicides and fungicides reduces their toxic impact on the environment thus promoting healthy food production for animal and human consumption.

Keywords: Complementary microbial remedial treatments, crop yield and quality improvement, plant nutrient solubilization, improved soil quality, microbial pest control, soil and plant stress syndrome

SYSTEMATIC APPLICATION OF SOIL CLASSIFICATION, SOIL MAPPING AND PLANT NUTRIENT DIAGNOSIS FOR AGRICULTURAL LAND VALUATION

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INTRODUCTION

Standard business economic valuation methods of comparative farm sales and capital investment analysis methods, using discounted cash flow are in many cases an inaccurate assessment of agricultural land values. Advancement in the computation and prediction of productive value of agricultural land has resulted from the application and interpretation of soil classification, soil mapping, standard soil and plant analysis together with bioclimatic data.

MATERIALS AND METHODS

The method, which is the result of 30 years accumulated information and interpretation, is referred to as Pedometric Land Valuation Method (PLVM) in which new pedometric formulae are applied. PLVM applies measureable pedogenic parameters which are used in the South African Soil Classification System, chemical and physical soil properties used in determining soil classification and soil fertility status as well as plant tissue analysis for plant nutrition diagnosis. From these data the most limiting factors affecting plant performance is determined, within a specific bioclimatic and microclimatic area. The most limiting factors are used as soil mapping units and determine suitability for different enterprises based upon the type, amount and cost of appropriate amendments. The agricultural productive value of particular agricultural land being researched may therefore be computed by the sum of the productive values of each soil mapping unit.

RESULTS

In each of six case studies presented here, (representing pastures, veld, small grains, summer grain crops together with cattle or sheep whichever are applicable, orchards, vineyards and horticultural crops) PLVM accounts for soil productive value variation and enterprise performance. PLVM therefore gives a more accurate assessment of agricultural land productive values than the values determined by standard business economic methods of comparative market value and productive value calculation based upon capital investment analysis using discounted cash flows alone.

CONCLUSIONS

From the derived productive land value it becomes possible to determine the projected net incomes from the agricultural unit, hence the financial feasibility of the property investment. Finally PLVM enables better management decision to be made, as a result of the most financially sustainable enterprises being selected and developed. Further research has been conducted to derive a general PLVM model to facilitate its application by agricultural land valuers and agricultural advisors to any individual property in the future.

Keywords: Agricultural land valuation, Pedometric Land Valuation Methods, soil chemical and physical properties, plant nutrient diagnosis, soil classification, agricultural feasibilities

CONSERVATION TILLAGE SYSTEMS: A REVIEW OF SOME LOCAL AND INTERNATIONAL RESEARCH AND PRACTICAL APPLICATION

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INTRODUCTION

"Conservation tillage is the process of conserving soil, water and energy thereby reducing the impact of tillage on soil degradation, improving water use efficiency, optimizing energy use and carbon emission. "AM-J, January, 2013.

Agricultural soil degradation, increasing farm operation energy costs, time constraints and larger farming units have resulted in conservational tillage being practised worldwide. Various systems are used namely, no till, direct drill, strip tillage, minimum tillage and stubble mulching. This presentation reviews comparative field trial results and practical application of conservational tillage with due reference to conventional tillage systems.

MATERIALS AND METHODS

Local and international literature reviews were conducted with reference to soil conservation, minimizing the impact of tillage on the soil environment, soil structure, soil organic matter, plant diseases, soil compaction, soil water relations, aggregate stability, infiltration rates, hydraulic conductivity , soil/plant nutrition and crop yield differences over long term periods.

Practical application of conservational tillage systems are compared in terms of crop yields and soil quality. Comparisons between various forms of conservational tillage are made with conventional soil preparation in terms of general soil quality and crop performance.

RESULTS

Overall effects of conservation tillage is to

- increase soil organic matter,
- reduce soil compaction,
- improve soil biota populations,
- reduce the severity of soil structure destruction,
- improve soil infiltration rates and hydraulic conductivity,
- temporarily reduce the effect of soil salinity with covariant reduction in actual soil electrical conductivity,
- reduce soil water runoff and soil loss due to soil erosion.

Vertical tine implement stubble mulching has the most beneficial overall effect while the tine implement using a vibrating tine manifested the most economic results in terms of crop yields, energy conservation, stubble disease control and improvement of general soil quality.

CONCLUSIONS

Conventional tillage, namely mould board plough and disc systems, should be phased out of crop farming altogether due to its detrimental effects on soil quality, soil degradation and unnecessary expenditure of energy.

No-till systems can be used successfully on pastures while direct drilling and strip till can be used successfully in combination with stubble mulching on soils which are ameliorated correctly every three to five years provided there is no stubble disease build up or excessive stubble build up. Vibrational tine stubble mulching fitted with specialized tines and coulters not only improves soil quality, due to burial of trash but is also the most economically viable form of conservational tillage.

REFERENCES

To be presented and acknowledged

Keywords: conservation tillage, soil degradation, soil quality, vibrational tine tillage implement, soil biota conservation, carbon emission

ASSESSING THE PERFORMANCE OF ENZYME-BASED SOIL ALTERATION INDEX THREE (AI3) UNDER ORGANIC AND INTEGRATED APPLE PRODUCTION PRACTICES

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INTRODUCTION

Due to their rapid response to changes in soil management, soil enzyme activities are, potentially, useful indicators of soil health. However, the activities of individual enzymes may be difficult to interpret. A solution is to condense data representing the activities of several enzymes into a single numerical value, or index. One such index, soil alteration index three (AI3), has been successfully tested against published enzyme measurement data and is calculated from the activities of *ß*-glucosidase, phosphatase and urease (Puglisi et al., 2006). The present research aimed to test the ability of AI3 to differentiate between apple orchard soils under integrated (inorganic, IP) and organic production protocols, and to relate the indexes to soil organic matter content, growth, and yield.

MATERIALS AND METHODS

Two inorganic (tree rows kept weed-free during active tree growth with herbicide, inorganic nutrients applied) and three organic (tree rows received compost with an overlying straw mulch) treatments were applied in a fully randomised field trial in a 'Cripps Pink'/M7 apple orchard in the Elgin area. *ß*-glucosidase, urease and phosphatase activities were measured and AI3 indexes calculated in tree-row topsoils (0-15 cm) in spring and summer for four years. Cumulative and average increases in stem circumference, cumulative yields, yield efficiencies (yields in kg per cm^2 stem area), and soil organic matter contents (%C), were determined.

RESULTS AND DISCUSSION

Averaged over the trial period organic treatments promoted significantly lower AI3 indices in spring and summer, implying better soil health, than inorganic treatments. Soil carbon contents and stem circumferences were greater in organic than in IP treatments, linking AI3 with soil carbon as a common soil health indicator, and suggesting that AI3 discriminates between soils of relatively greater and lesser ability to promote vegetative growth. However, yields and yield efficiencies were lower in organic than IP treatments due to excessive vegetative growth in organic treatments (Jerie et al., 1989).

CONCLUSIONS

Preliminary findings suggest that the Al3 index could prove to be an effective method for quantifying soil health in Western Cape apple orchards.

REFERENCES

Jerie PH, van den Ende B, Dann IR. 1989. Managing tree vigour and fruitfulness in deciduous orchards. Acta Horticulturae 240: 127-134.

Puglisi E, Del Re AAM, Rao MA, Gianfreda L. 2006. Development and validation of numerical indices integrating enzyme activities of soils. Soil Biology and Biochemistry 38: 1673-1681.

Keywords: AI3, apple, enzyme activities, soil health, organic, integrated production

YIELD RESPONSE OF JUTE MALLOW (*Corchorus olitorius*. L) 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 15^0C to 38^0C. It is one of the indigenous leafy vegetable crops that has long been known in South African rural communities and is consumed with carbohydrate staples. 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 crop yield and productivity. The aim of this study is to investigate the interactive effect of planting density with (1) water availability and (2) nitrogen fertilization, on harvestable yield biomass of Jute mallow.

MATERIAL AND METHODS

This study investigated three abiotic and cultural factors that affect production: Irrigation, fertilization and planting density. Two separate trials were established under rain-shelters, each trial was a two factorial experiment arranged in a randomized completed 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 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}.

RESULTS AND DISCUSSION

Planting density of Jute mallow is directly proportional to the harvestable biomass yield. The highest population density of 330 000 plants ha^{-1} gave the highest yield under water and nutrient non-limiting conditions. 80% of the PAW gave the highest yield but was not significantly different as compared to FC treatment. High yield for the 80% PAW treatment was attributed to increase in root length and volume caused by water stress. This has also led to reduction in nitrate leaching. For the nitrogen trial, 150 kg N ha^{-1} fertilizer treatment gave the highest yield but was not significantly different to 75 kg N ha^{-1} treatment.

CONCLUSION

The recommended planting density of 100 000 plants ha^{-1} is too little for maximum yield under water and nitrogen non-limiting conditions. 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.

Keywords: Jute mallow, nitrogen fertilization, planting density, water application

THE EFFECTS OF APPLYING COMBINATIONS OF INORGANIC FERTILIZERS AND CATTLE KRAAL MANURE ON GRAIN YIELD OF MAIZE IN ACIDIC SOIL OF MFUNDISWENI, FLAGSTAFF, EASTERN CAPE PROVINCE, SOUTH AFRICA

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INTRODUCTION

Maize yields under dry-land conditions of the eastern part in the Eastern Cape Province have declined since the 1930s. Reports show that the average yield between 1918 and 1927 was 636 kg ha^{-1}, 252 kg ha^{-1} between 1974 and 1980 while in 1998 it was 189 kg ha^{-1}. Soils in this region are mostly acidic (pH < 5.5) due to high rainfall (> 600 mm per annum) and require regular application of lime to maintain maximum crop production. Resource poor farmers, who cannot afford to buy inorganic fertilizers, apply kraal manure. Studies conducted elsewhere revealed that when applied to the soil, kraal manure raised soil pH and hence the objective of the study was to select the combination of organic and inorganic fertilizers that will give high maize yield in the acidic soils of Mfundisweni.

MATERIALS & METHODS

A dry-land field experiment was conducted at Mfundisweni for three (3) seasons between 2007 and 2010 with maize cultivar PAN 6480 as test crop. Rainfall during the experimental period ranged between 850 and 1 000 mm per annum, the pH (KCl) was 3.8 and acid saturation percentage 30.42. Dolomitic lime (0, 1.7 and 3.5 t ha^{-1}), NPK fertilizer (0, 0.25 and 0.5 t ha^{-1}) and cattle kraal manure (0, 5 and 10 t ha^{-1}) were mixed in various combinations, after the soil samples were analyzed for chemical composition. The experiment was arranged in a randomized complete block design (RCBD) with three replications. Maize grain was air-dried and weighed at 12.5% moisture level. The data was subjected to GenStat for statistical and the means for maize yields were separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

In 2007/2008 lowest maize grain yield (146.7 kg ha^{-1}) were obtained from control plots while higher maize grain yields (2.9 t ha^{-1}) were obtained when either lime or manure was combined with NPK fertilizer and similar trend was observed in 2008/2009 season but much more improved yields ranging between 1.21 and 4.45 t ha^{-1} were obtained while in 2009/2010 season the yield ranged between 1.18 and 4.22 t ha^{-1}.

CONCLUSION

Control plots where either manure, lime or NPK fertilizer was not included in the combination had the lower yields of = 1.2 t ha^{-1} while treatment combinations resulted in higher maize grain yield of between 3.83 and 4.22 t ha^{-1}. Lime, manure and fertilizer combinations reduced the soil acid saturation percentage from 30.42% to less than 20%.

Keywords: acidic soils, inorganic fertilizer, kraal manure, maize yield

ANALYSIS OF GENETIC VARIATION, HERITABILITY, HETEROTIC PATTERNS AND RELATIONSHIPS BETWEEN GENETIC DISTANCE AND PHENOTYPIC TRAITS IN DENT AND FLINT MAIZE HYBRIDS

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INTRODUCTION

Food security can be greatly enhanced by exploiting heterosis in single cross hybrids. However, breeders require crucial genetic information regarding maize inbred lines to design hybrids. The relationship between genetic distance and heterosis in maize hybrids would make it easy to select superior hybrids. The objectives of the study were to determine heterosis, association between genetic distance and heterosis, and the levels of genetic variation and heritability for phenotypic traits in dent and flint maize hybrids.

MATERIALS AND METHODS

A total of 190 experimental dent and flint hybrids and two standard commercial maize hybrids were evaluated at, Ukulinga (PAN67 and PAN6Q445B), and Cedara (PAN67 and PAN3Q740BR). The experiments were laid out as augmented 10 x 19 alpha lattice designs. The hybrids were developed by random crosses made from 60 inbred lines (dent and flint) at in 2012A at Ukulinga Research farm. The data was analysed using mixed models in SAS.

RESULTS AND DISCUSSION

Significant genetic variation and new heterotic patterns were observed. There was a positive and significant correlation between yield and genetic distance in one environment ($r=0.31$; $P<0.01$) but there is not any significant relationship in the other environment. Grain yield was highly heritable at both sites indicating that direct selection of hybrids for grain yield potential would be very effective. Considerable amount of heterosis was observed at both sites. The main direct factors contributing to yield potential were ear prolificacy, plant height and ear height indicating that direct selection for these traits would be effective to improve grain yield of maize hybrids.

CONCLUSIONS

The results indicated that the association between genetic distance and yield potential in maize hybrids depends on the environment. All the patterns of dent x dent, dent x flint and flint x flint were represented in the top performing hybrids indicating that grain texture could not be readily used to discriminate hybrids for yield potential in this set of hybrids. The main direct factors contributing to yield can be used as primary selection criteria for grain yield in the respective environments. The new heterotic patterns that performed better than the control hybrids can be utilized in heterosis breeding to enhance yield potential of maize hybrids.

Keywords: genetic distance, genetic variation, heritability, heterosis, maize, yield components

IMPROVING THE SOCIO-ECONOMIC CONTRIBUTIONS OF HORTICULTURAL ENTERPRISES: A CASE STUDY OF THE NEWLY ESTABLISHED SWEET POTATO VINE GROWER'S ASSOCIATION (SPVGA) IN SOUTH AFRICA

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South Africa is regarded as one of the developing countries with a high incidence of socio-economic disparities. This is despite its abundance of horticultural resources. In the developing countries, sweet potato is known to be an important vegetable in alleviating major socio-economic challenges, such as high unemployment levels, poverty, malnutrition and food insecurity. The aim of the study was to evaluate the tangible and intangible socio-economic contributions of the Sweet Potato Vine Grower's Association (SPVGA) in the so called poverty stricken rural and peri-urban South African areas. The study used both qualitative (meetings, workshops, face to face interviews with members of the association) and quantitative (closed ended survey questionnaire) methodologies. The study has been designed to be longitudinal (five year period) in nature. It involves constant monitoring and evaluation of the impact of the SPVGA on the alleviation of the socio-economic challenges. The preliminary results revealed that a clearly defined selection of criteria for the selection of nursery and sweet potato entrepreneurs helps in minimizing the risk of selecting against survival entrepreneurs relative to a genuine one. With the latter symbolising the one that sustainably and constantly contributes to the alleviation of the socio-economic challenges, while the former contribute to the alleviation of socio-economic problems in an un-sustained and short-term manner. It is recommended that sustained technical and managerial support to the SPVGA be given by technologically driven stakeholders in South Africa in order to ensure sustainable economic viability of the enterprises in question.

Keywords: SPVGA, socio-economic , sustainable, enterprises, resources

EFFECTS OF ENSO ON THE RAINFALL SEASON IN THE EASTERN FREE STATE

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INTRODUCTION

El Niño-Southern Oscillation (ENSO) phases play an important role in the climate variability of most southern African regions. Rainy season characteristics are normally affected by the ENSO phenomenon which thus influences rainfed agricultural productivity.

MATERIALS AND METHODS

In this study the onset of rains is defined as the last day in which rainfall of 25mm or above has been accumulated over the previous 10 days and also at least 20mm has to be accumulated in the subsequent 20 days (Tadross et al. 2003). The end of the rainy season is obtained by searching for the last day on which the cumulative 25mm over 10 days occurs. The length of the rainy season is calculated by the number of days from the starting date to the end of the rains. Seasonal rainfall for the agricultural season was obtained by summing daily rainfall from 1 November to 31 March for each of the stations in the Free State Province. The average onset, cessation, rainy season length and seasonal rainfall were determined for each station for El Niño years, La Niña years and all years (Moeletsi et al. 2011). The overall means for onset date, cessation date, duration of rainy season and seasonal rainfall were compared with mean values during the El Niño and La Niña years. The differences between the average of the rainy season index obtained from all years and during El Niño or La Niña years were obtained.

RESULTS AND DISCUSSION

The difference in onset dates over the eastern Free State during El Niño years is mostly negative (0 to -9 days), indicating that the onset of rains occurs later than average. During La Niña years, onset of rains is slightly earlier (0 to 5 days) than normal. The cessation of rains is 11 to 20 days earlier than normal in El Niño years. The entire region has later than normal cessation with most places recording between 5 to over 15 days delay during La Niña years. Rainy season duration in most parts of the eastern Free State ranges from 181 to over 200 days. In El Niño years most places experience a decrease of between 11 and 20 days in rainy season length. In La Niña years the rainy season is mostly longer than average by up to 9 days. Seasonal rainfall in El Niño years is mostly between 51 to 75mm less than average, while in La Niña years differences range from -74 to -50mm with the percentage deviations ranging from 5 to 20%.

CONCLUSIONS

ENSO phases have an effect on rainfall characteristics over the eastern Free State. On average El Niño years have a negative impact through delayed onset of rains, early cessation of rains, short rainy season and reduced seasonal rainfall. In contrast rainfall events are enhanced in La Niña years, resulting in positive effects on agricultural production through longer growing period and increased seasonal rains.

REFERENCES

Moeletsi ME, Walker S, Landman WA. 2011. ENSO and implications on rainfall characteristics with reference to maize production in the Free State Province of South Africa. *Physics and Chemistry of the Earth* 36: 715-726.

Tadross MA, Hewitson BC, Usman MT. 2003. The interannual variability of the onset of the maize growing season over South Africa and Zimbabwe. *Journal of Climate* 18: 3356-3372.

Keywords: Onset of rains, cessation rains, seasonal rainfall

FROST WITHIN GROWING PERIODS IN THE EASTERN FREE STATE, SOUTH AFRICA

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INTRODUCTION

Frost causes severe damage to crops, depending on their form (Kassomenos et al., 1997). The extent of frost damage is dependent on plant type and variety, rate of temperature decrease, cloud and wind conditions during the freeze, soil type and water content, duration of frost and crop growth stage (Teitel et al., 1996).

MATERIALS AND METHODS

The data used in the analysis was obtained from the ARC-ISCW Agro-climate Databank. The daily minimum temperature dataset was used in the analysis for determination of frost risk at Bethlehem, in the Eastern Free State. Screen temperatures of greater than 0°C, upper bounded by 2°C, were considered as light frost; minimum temperatures recorded on the screen greater than -2°C, upper bounded by 0°C, were considered as medium frost; while minimum temperatures of -2°C or less represent heavy frost. The number of frost days within the maize growing period was also determined for a short-season maize cultivar (100 days), medium-season maize cultivar (120 days) and long-season maize cultivar (140 days). The frequency of frost days was determined for light, medium and heavy frost for all the agricultural seasons for each station. For each station, the frequency was determined from the array of planting dates starting from the first dekad of September through to the last dekad of February. The number of frost days per growing season for 100, 120 and 140-day cultivars was determined for all the years and the absolute probability of a frost day per season was obtained from the ratio of years with frost over the total number of years.

RESULTS AND DISCUSSION

Frost risk during September is high with values exceeding 90% for light frost for all the maize varieties. The frost risk from September to 1st dekad of November is the same for all the maize varieties because cessation of frost risk is high during these planting months. While planting in November onwards, the length of the growing period determines the risk. The longer the growing period the higher the chances of reaching high frost risk zone in the months of April, May and June. Planting of long-season maize from December onwards is subject to high risk of not reaching maturity before the setting of the frost season. The risk of frost becomes less intensive for medium and heavy frost with extended periods of low probabilities of frost within the growing periods. Due to shorter frost-free period for the light frost threshold, the probability of frost during the season is higher in most planting dekads than in the medium threshold while the heavy frost probability is lower, resulting in longer frost-free periods within the growing periods.

CONCLUSIONS

Absolute probability of frost within the growing period for the medium frost (0°C) showed suitability for a 100-day maize cultivar for planting from the 2nd dekad of October until the 2nd dekad of January with less than 10% chance of frost occurring in the growing period. The 120-day maize cultivar showed low frost risk for planting from the 2nd dekad of October to the 3rd dekad of December. Planting the 140-day maize cultivar has a low risk of frost damage from the 2nd dekad of October to the 2nd dekad of December for most parts of the Free State Province. Farmers are thus encouraged to take into consideration frost damage climatology when planning their agricultural activities.

REFERENCES

P. Kassomenos, A. H. Flocas, S. Lykoudis and M. Petrakis, 1997. A study of frost events in areas characterised by the absence of observations. Meteorol. Atmos. Phys. 1997, 62: 249-256. M. Teitel, U.M. Peiper and Y. Zvieli, 1996. Shading screens for frost protection. Agr. Forest Meteorol. 81: 273-286.

Keywords: Temperature, maize, Bethlehem

VARIATION IN TISSUE ACID PHOSPHATASE ACTIVITY AND P CONCENTRATION OF FIELD-GROWN GROUNDNUT (*Arachis hypogaea* L.) GENOTYPES AT TWO LOCATIONS IN MPUMALANGA PROVINCE

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INTRODUCTION

Groundnut is a major grain legume cultivated in Africa, largely by subsistence farmers. Increased production is however constrained by low soil P. Although groundnut produces organic acids that improve P availability in soils (Ae & Otani, 2002), little is known about this legume's strategies to increase P nutrition under local conditions. Whether groundnut secretes acid phosphatases (APase) for mobilizing soil bound-P, as done by most crop species under low P conditions, remains to be determined. Equally, little is known about P remobilization and translocation from source to sink, especially to the sites of greater P demand in developing organs of groundnut plants. The aim of this study was to assess the role of APase activity in P nutrition of different groundnut genotypes grown under field conditions at two locations in Mpumalanga Province.

MATERIALS AND METHODS

Drought-resistant groundnut genotypes (IDGVT) were planted in the field at Bronkhorspruit and Kwa-Mhlanga using a randomized complete block design with four replicates. At flowering, four plants were carefully dug up and separated into leaves, stem, roots and nodules for assay of APase activity using the *p*-nitrophenol method (Liu et al 2004). Soil were collected and analyzed to clearly understand P content and other minerals in the soil. The data were analyzed using Statistica software.

RESULTS AND DISCUSSION

The data revealed marked differences in APase activity in organs of all five groundnut genotypes from Bronkhorspruit and Kwa-Mhlanga. Of the drought resistant genotypes tested at Bronkhorspruit, ICGV 07404 recorded significantly greater acid APase activity than the other genotypes, while the enzyme activity was higher in nodules compared to other plant organs. Similarly, ICGV 07404 also recorded the highest APase activity at Kwa-Mhlanga compared to the other groundnut genotypes. Nodule P concentration was much greater in genotypes ICGV 07396 and ICGV 07390 relative to the others at Bronkhorspruit.

There was a positive correlation between P concentration and acid phosphatase in leaves, stem, nodules, roots and seeds of the different groundnut genotypes, indicating the role of APases in P mobilization and translocation from organ to organ.

CONCLUSION

The results of this study showed greater APase activity in nodules of drought-resistant groundnut genotypes compared to other organs, an indication that nodules are a high P reservoir in N_2-fixing groundnut plants.

ACKNOWLEDGEMENT

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REFERENCES

AE, N. & OTANI, T. 1997. The role of cell wall components from groundnut roots in solubilizing sparingly soluble phosphorus in low fertility soils. *Plant and Soil*, 196:265-270

Keywords: Bronkhorspruit, Kwa-Mhlanga, APase activity, acid soil, P remobilization and translocation

DOES PROPYZAMIDE INFLUENCE THE EFFICACY OF FOUR COMMONLY USED HERBICIDES IN THE WINTER RAINFALL REGION?

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INTRODUCTION

Weeds cause substantial crop losses in canola. Chemical weed control in canola is hampered by herbicide resistant weeds. The problems caused by these weeds and weed species closely related to canola necessitated the development of herbicide resistant canola cultivars. Triazine resistant and imazamox resistant cultivars are already available in South Africa and genetically modified glyphosate and gufosinate ammonium resistant canola cultivars will probably be imported in the future. Most of these herbicides however have a limited residual action in the soil. Propyzamide is a herbicide with relatively long residual action in the soil. The objective of this study was to determine the effect of addition of propyzamide to mixtures with these herbicides on efficacy of the herbicides.

MATERIALS AND METHODS

Field and glasshouse trials were conducted at Welgevallen experimental farm. In the field trials plots were planted with triazine tolerant (TT) cultivar except for the imazamox trials that were planted with an imazamox resistant (Clearfield) cultivar, Glyphosate, glufosinate ammonium, atrazine and imazamox were applied at recommended doses either with or without propyzamide at the 3-4 leaf canola stage. Propyzamide alone at 1.5 kg ha-1 and trifluralin at 1.5 L Ha-1 were applied pre-emergence with sowing as additional treatments. Percentage weed control was compared with unsprayed control treatments six weeks after spraying and again another four weeks later. A preliminary glasshouse study was carried out to determine whether adding propyzamide to the abovementioned four herbicides would reduce their efficacy on ryegrass and wild radish grown in pots. The ryegrass and wild radish plants were assessed six weeks after treatment. Data was subjected to ANOVA analyses.

RESULTS AND DISCUSSION

Field assessment 6 weeks after treatments (WAT) showed a significant difference among treatments. The best control was observed in plots which were sprayed with atrazine /propyzamide and imazamox/propyzamide mixtures. Addition of propyzamide to glufosinate ammonium significantly improved weed control after 6 weeks. However, 4 weeks later no significant differences among treatments could be determined. In the glasshouse study addition of propyzamide did not reduce efficacy of any of the four herbicides. On the contrary, propyzamide improved efficacy of imazamox on ryegrass probably because the ryegrass population tested was resistant to imazamox.

CONCLUSION

Propyzamide improved the efficacy of glufosinate ammonium in the field and of imazamox in the glasshouse. No negative influence of propyzamide could be detected but it did not appear to improve residual weed control when used in mixture with the selected herbicides.

ACKNOWLEDGEMENTS

Financial support from the Protein Research Foundation is gratefully acknowledged.

Keywords: Efficacy, herbicide, propyzamide

INTRODUCING SWEET POTATO (*Ipomoea batatas* L.) AS AN ALL YEAR ROUND CROP FOR SMALLHOLDER FARMERS IN KWAZULU-NATAL, SOUTH AFRICA

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INTRODUCTION

Inability to produce high quality food crops all year round is one of the challenges associated with sustainable agriculture and poverty mitigation. Sweet potato, an important food security crop has wide adaptation to environments, including soils and low input requirements. New sweet potato lines/cultivars has been bred to address food insecurity, both in terms of energy and micronutrient deficiencies, and they still need to be tested for production by small-scale farmers.The objective of this study was to assess growth, physiological and yield responses of new sweet potato lines/cultivars to varying environmental conditions of KwaZulu-Natal (KZN).

MATERIALS AND METHODS

Three sweet potato lines/cultivars (A40, A45 and 199062.1) were grown at three locations of KZN (Richards Bay, Deepdale and Umbumbulu) differing in altitude, climate and soils. The experiment was arranged in a randomized complete block design with three replications in each location. Winter (May – July) planting was done during the last week of April 2012 and summer (November – January) planting was during the last week of October 2012 in all locations. Plant population, plot size and crop management was similar in all locations. No irrigation or fertilizer was applied. The crop was given one month to establish and thereafter stomatal conductance (SC), chlorophyll content index (CCI), vine length, leaf and branch number were determined bi-weekly up to harvesting time. Yield (biomass and storage root) and harvest index were determined. Harvesting was done after four months in both seasons.

RESULTS AND DISCUSSION

Significant interactions between lines/cultivars and locations were observed in both seasons. Summer crop in Deepdale had significantly higher ($P< 0.05$) stomatal conductance (SC) (38.4%) than Umbumbulu (25.8%) and Richards Bay (16.9%). Umbumbulu only showed the highest stomatal conductance (19.5%) during winter. Cultivar A40 had higher SC (15.1% and 8% higher) than '199062.1' and 'A45', respectively in winter. Line/cultivar 199062.1 recorded significantly ($P< 0.05$) high chlorophyll content index (CCI) during both seasons. It was 28.9% and 26.3% higher than cultivars A40 and A45, respectively in winter and it recorded 10.8% and 4.6% higher CCI than A40 and A45, respectively in summer. Richards Bay and Umbumbulu, respectively, recorded higher CCI in winter (25.1%) and summer (21.5%). Lines/cultivars grown in Deepdale produced significantly ($P< 0.05$) high storage root yield (42.0 t ha^{-1}) than Umbumbulu (29.4 t ha^{-1}) and Richards Bay (5.4 t ha^{-1}), respectively. Richards Bay environment recorded high water deficit as compared to the other two locations thus plants responded those conditions by limiting their growth habits to shorter, less branched and fewer leaves while the opposite was true for Umbumbulu and Deepdale. Deepdale soils contained high K nutrition than the other sites thus contributed greatly to the high yields received. Line/cultivar A45 showed great environmental plasticity and wide adaptation across all three environments. It gave significantly high storage roots yield in both Umbumbulu (38.3 t ha^{-1}) and Deepdale (45.3 t ha^{-1}).

CONCLUSION

Sweet potato cultivars respond differently to variations in growth environments, yield was greatly affected by climatic conditions and soil nutrition. Growing sweet potato in Deepdale during summer season produces higher yields than at Umbumbulu and Richards Bay, even without fertilizer application. Out of the three cultivars A45 demonstrated great environmental plasticity. Future studies should investigate the correlation between crop performance and nutritional value.

ACKNOWLEDGEMENTS

OWDS and Sida for financial support. Small-holder farmers of Richards Bay Deepdale and Umbumbulu.

Keywords: Growth, locations, seasons, sweet potato lines/cultivars

DIVERSITY OF RHIZOBIA, NODULATING GROUNDNUT (*Arachis hypogaea* L.) IN SOUTH AFRICAN SOILS

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INTRODUCTION

Globally, groundnut, or peanut, (*Arachis hypogaea* L.) is an important commercial crop. As a legume, it has the ability to convert atmospheric N_2 into NH_3, through its association with soil bacteria called rhizobia. Depending on its efficiency in N_2 fixation, groundnut can meet most of the plant's N requirements without the use of costly N fertilizers (Bohlool *et al*., 1992). Currently, the use of rhizobia to inoculate legumes has provided an opportunity to improve legume N_2 fixation, and ultimately increase crop yields through strain selection. The aim of this study was to characterize native soil rhizobia that nodulate groundnut in South Africa and, in so doing, select potential strains.

MATERIALS AND METHODS

Nodules were taken from ten farms in Bronkhorstspruit and Kliplaatdrift within Gauteng and Mpumalanga Provinces respectively. At flowering stage, 10 plants per field were excavated and the root nodules collected into a vial containing silica gel. Bacterial isolation and phenotypic characterization were done as described by Vincent (1970). Total rhizobial DNA was extracted by CTAB method. An IGS region of the rhizobial genome was amplified using PCR and a known primer. The primer and PCR product were digested using different restriction endonucleases.

RESULTS AND DISCUSSIONS

Colony characteristics were recorded for all isolates. The isolate colonies were generally round with a domed (69.3%) or flat (21.7%) shape, and exhibited different colours (e.g. milky, watery, or yellow). All bacterial isolates took 7-15 days to occur on YMA plates, and were visually gummy in texture. Biochemically, 71% of the 120 isolates were alkaline-producing, while 27.6% acid-producing on BTB-containing YMA plates. PCR-amplification of IGS region showed a single DNA band on agarose gel. A total of 5 IGS types were observed with a range of 700-1200 bp DNA bands. The IGS-RFLP analysis revealed considerable diversity in the rhizobial population containing the different IGS groups.

CONCLUSION

From the data obtained in the study, it is clear that groundnut is nodulated by a diverse group of rhizobia. We therefore expect these microsymbionts to also have different N_2-fixing abilities on groundnut as host plant, which will be addressed in future research.

REFERENCES

Vincent, J.M. 1970. *A manual for the practical study of root-nodule bacteria*. Oxford, UK: Blackwell Scientific Publications.

Bohlool, B.B., Goerge, T. & Ladha J.K. 1992. *Biological Nitrogen fixation for sustainable agriculture*. Dordrecht: Kluwer Academic Publishers.

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Keywords: Isolate colony, PCR, phenotypic characterization, rhizobia, root nodules

THE EFFECT OF GROWING MEDIA ON GERMINATION BEHAVIOUR OF CAPE ALOE SEEDS

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INTRODUCTION

Cape Aloe is an integral part of rural communities for its medicinal values, especially in the Cape region of South Africa. The advent of the specie's use as a raw material for several industries, other than pharmaceuticals, has increased demand of its harvesting from the wild in order to supply the export and domestic markets. Although aloes are said to germinate on variable soils and potting mixes (Desalegn, 2006), information on the preference of commercial growing medium by *Aloe ferox* (Cape aloe) for germination is lacking.

MATERIALS AND METHODS

Seeds of *A. ferox* were harvested in the wild around Alice in the Spring of 2011 and 2012, when the pods started to dehisce and release the seeds. Six different growing media (Pine bark, Hygro-tech mix, vermiculite, 1:1 combination of pine bark and Hygro-tech mix, 1:1 pine bark and Vermiculite, and 1:1 Vermiculite and Hygro-tech mix) were used in a randomized complete block design (RCBD) to assess their influence on the emergence/germination behaviour of *A. ferox* seeds in a semi-controlled glasshouse.

RESULTS AND DISCUSSION

The results show that there were significant differences on final germination percentage, with the highest (98%) found on pine bark alone, and the lowest (66%) found on both vermiculite and the 1:1 combination of Pine bark and Hygro-mix. The results also show that seeds planted on the pine bark emerged earlier, while both the Hygro-tech mix and combination of pine bark and Hygro-tech mix had a delayed emergence. These results are in agreement with the conclusions by Mukonyi et al. (2011) that aloes may have preferences with regard to the type of growing medium used for germination and establishment.

CONCLUSIONS

The results suggest that *A. ferox* seeds have a preference for a pine bark medium for germination and early emergence.

REFERENCES

Desalegn F. 2006. Taxonomic and demographic studies on three species complex within the Genus *Aloe* L. (*Aloaceae*) in Ethiopia. PhD, Thesis. Addis Ababa University, Ethiopia.

Mukonyi KW, Oeba VO, Chiteva R, Lelon J, and Gathara MW. 2011. Germination and growth performance of *Aloe turkanensis* and *Aloe secundflora* under different substrates. *African Journal of Agricultural Research*, 6(10): 2132 - 2138.

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Keywords: Cape aloe, germination, growing media

REDOX POISE AND MANGANESE SOLUBILITY IN SOILS DERIVED FROM DOLOMITE AND GRANITE IN THE PRETORIA AREA

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INTRODUCTION

Certain hydric soils lack the redoximorphic features that are commonly expressed in saturated or seasonally saturated soils. An example is 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. The obvious difference between the two geologies is the higher manganese content in the dolomite-derived soil which might contribute to redox poise; however, there are less obvious features such as pH buffering and water potential that may explain the differences seen. The study aimed to look at the influence of these factors on the solubility of ions that undergo redox reactions in soils derived from different parent material.

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) placed in a pressure plate extractor and outflow cells at different pressures to establish various negative water potentials. Afterwards samples were extracted using hydroxylamine (which is selective for dissolution of Mn oxides) and then membrane filtered (0.45µm) and analysed by ICP-AES for Mn, Fe, Al and metals co-precipitated with manganese oxides.

RESULTS AND DISCUSSION

The reducible Mn concentration was an average of three replicates and the level at which significant differences were tested was at a = 0.05. In terms of differences between no pressure and a matric potential of -100J.kg^{-1}, only the dolomite air dried soils showed significant differences (p = 0.003). The dolomite field moist soils had a p of 0.165, granite air dry soils had a p of 0.309 and the granite field moist soils had a p of 0.056. All samples showed a higher reducible Mn content when equilibrated at -100J.kg^{-1} than under no pressure, e.g. air dry dolomite at -100J.kg^{-1} = 9706.32mg.kg^{-1} and under no pressure the content was 7113.31mg.kg^{-1}. This could indicate that Mn^{4+} and Mn^{3+} became reduced at this water potential releasing Mn^{2+} into solution. The exception to this was granite air dry samples (Mn content at -100J.kg^{-1} was 114mg.kg^{-1} and under no pressure was 128mg.kg^{-1}). All dolomite samples had a higher reducible Mn content than the granite soils e.g. the air dry granite soil under no pressure had a content of 128mg.kg^{-1} and the air dry dolomite soil under no pressure had a content of 7113mg.kg^{-1}. This is expected due to the mineralogy difference between the soils with dolomite derived soils having a much higher Mn content.

CONCLUSIONS

The extractant suggests that there is more reducible Mn (Mn^{4+} and Mn^{3+}) in the dolomite soil than the granite soil. It is therefore reasonable to expect this to play a major role in the buffering of soil redox reactions. Water potential and the moisture content of the soil used in preparation appeared to have some influence on availability of Mn^{4+} and Mn^{3+}. Based on a review of literature, differences in pH buffering associated with contrasting texture and CEC are also expected to play a role in determining redox poise.

Keywords: Dolomite, granite, manganese, redoximorphic features, redox poise

EVALUATION OF STICKY TRAPS AT VARIOUS HEIGHTS FOR MONITORING WHITEFLIES AND APHIDS IN TOMATO FIELDS

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INTRODUCTION

Whiteflies (*Bemisia tabacci*) and aphids (*Myzus persicae*), obligated phloem-feeding insects, are two economically important pests in tomato production. The monitoring of these pests is important for the development of an integrated pest management strategy. In South Africa, tomato farmers use yellow sticky traps to monitor and predict outbreaks of insect pests. However, the optimal height for trap placement is not well documented. The aim of this study was to investigate the influence of trap height on trap catches of whiteflies and aphids in open field tomato production systems.

MATERIALS AND METHODS

A field study was conducted in winter-spring 2013 at Bangani farm, ZZ2-Bertie van Zyl, Mooketsi, South Africa. Yellow sticky traps were placed at various heights on a 3-m wooden pole i.e. 1, 2 and 3 m above ground level. The experimental design consisted of randomized block design with six replications. Traps were changed weekly, at which time the numbers of whiteflies and aphids were recorded. Data were subjected to analysis of variance using SAS. Mean separation was achieved using Fisher's least significant difference test.

RESULTS AND DISCUSSION

Trap height had a significant effect on the number of whiteflies that were trapped. Traps placed at 1m above ground level captured more than 50% of the total number of whiteflies. The number of whiteflies captured decreased with increased trap height. Similar trends were observed with the number of aphids caught but with no significant differences between treatments.

CONCLUSION

This study showed that traps placed at 1 m are more effective in capturing whiteflies and aphids than those placed at 2 m or higher.

Keywords: Aphids; sticky traps; trap height; whiteflies

ASSESSMENT OF N2 FIXATION BY SIXTEEN GROUNDNUT GENOTYPES (*Arachis hypogaea* L.) PLANTED IN NORTH-EASTERN ETHIOPIA, USING 15N NATURAL ABUNDANCE

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INTRODUCTION

Crop production by most subsistence farmers in Africa is low input, and often depends on inherently low-nutrient soils, lacking N and P. Groundnut (*Arachis hypogaea* L.) is an important food legume grown by subsistence farmers as a source of protein and income. As a legume, groundnut has been shown to meet much of its N requirement from symbiotic fixation, and can even contribute to the N economy of cropping systems. In Ethiopia, there is little knowledge on groundnut's dependence on N_2 fixation for its N nutrition, nor the extent of its N contribution to cropping systems. The aim of this study was to assess 16 groundnut genotypes, which have been bred for grain yield and their N contribution to the cropping system of North-Eastern Ethiopia.

MATERIALS AND METHODS

Seeds of the 16 groundnut genotypes (Roba, Werer-961, Werer-962, Werer-963, Tole-2, NC-4X, Shulamize, Maniputer, Fetene, Fayo, Werer-964, Lote, Sedi, Bulki, Tole-1, and NC-343) were planted during the main cropping season in July 2012 using a randomized complete block design with four replicate plots. At mid-flowering, plants were randomly sampled and separated into shoots, roots, and nodules. The shoots and roots were oven-dried (60 ^{o}C), ground into fine powder (0.85 mm), and analyzed isotopically for $^{15}N/^{14}N$, using mass spectrometry.

RESULTS AND DISCUSSION

The data showed significant (p=0.05) variations in plant growth, N content, %Ndfa and amount of N-fixed between the groundnut genotypes. More specifically, growth and N content were markedly greater in Tole-1, Tole-2, Maniputer and Werer-962 than in Werer-961, Fetene and Lote, which exhibited least growth and N content. Mean $d^{15}N$ was lower in genotypes Werer-961, Bulki and Roba, contrasting with cultivars Sedi, Maniputer, Werer-963 and Tole-2, which recorded much higher $d^{15}N$ values. As a result, the amount of N derived from atmospheric fixation was lower in the latter, and greater in the former. Due to the greater biomass and high amount of shoot N-content the amount of N-fixed by the genotypes Tole-1,followed by Roba, Bulki, Werer-962, Fayo and Tole-2 was significantly greater, than the genotypes NC-4X and Lote which exhibited lower amount of N-fixed.

CONCLUSION

As indicated by different studies groundnut can fix and contribute high amount of N to cropping systems, and this study has also shown the potential of the test genotypes to fix high amounts of N (60 to 105 kg ha^{-1}) that can potentially contribute to improved soil fertility and also reduces the use of chemical N fertilizer.

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Keywords: Plant growth, N-fixed, N contribution, %Ndfa, 15N/14N ratio

PRELIMINARY INVESTIGATION OF ETHREL AND GIBBERELLIC ACID AS CHEMICAL HYBRIDIZING AGENTS IN RICE LANDRACES

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INTRODUCTION

Crop improvement and genetic analyses of traits require creation of large number of pair-wise crosses and progenies. In rice (*Oryza sativa* L.), hand emasculation is often slow and tedious, limiting the number of controlled cross combinations that can be generated at a time. Chemical hybridizing agents (CHA) may facilitate emasculation when appropriately applied on growing plants; but, their efficacy as a breeding tool for rice has been limited, partly due to genotypic differences, doses, and stage of applications (Varmani 1994). In this study, ethrel and gibberellic acid (GA_3) were evaluated at various doses and growth stages of rice to determine their utility for breeding tropical upland rice.

MATERIALS AND METHODS

Five upland landrace rice varieties of Liberia were grown in a controlled environment. Plants were sprayed at flag leaf collar formation and microsporogenesis stages of development with ethrel at 0, 1000, 2000, 4000, or 6000 ppm. At heading, GA_3 was applied onto these plants once or twice as foliar spray at 0, 90 or 150 ppm. Treatment combinations were laid out in the completely randomized design using three replications. Data collected included pollen viability, panicle characteristics, seed set and outcrossing rates. Data were subjected to the standard analysis of variance and treatments were compared using the Fisher's LSD test procedure at the 5 % probability level.

RESULTS AND DISCUSSION

Ethrel and subsequent GA_3 applications induced significant changes in all the traits measured. Pollen sterility ranged from 18.6 – 78.2 % and increased linearly with doses of ethrel. Further, ethrel significantly limited ($P = 0.001$) panicle exsertion and the rate of seed set in all the varieties. GA_3 significantly increased panicle exsertion, thereby enhancing the rates of seed set and outcrossing in ethrel-treated plants, consistent with results reported by Suralta and Robles (2004). Unlike GA_3, ethrel efficacy depended on panicle developmental stage of application, as microsporogenesis proved to be the more sensitive stage for physiological male sterility induction in the plants.

CONCLUSIONS

Male sterility assured by ethrel was acceptable given the level of outcrossing achieved, as aided by GA_3 application. When used complementarily, both compounds could be useful as a breeding tool.

Keywords: Ethrel, gibberellic acid, outcrossing rate, panicle exsertion, rice, seed set.

FOLIAR S-ABA APPLICATION DOES NOT REDUCE SUNBURN IN 'GRANNY SMITH' APPLE

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INTRODUCTION

Sunburn is the major cull factor for apples grown under the Mediterranean-type climate of the Western Cape production region in South Africa. Up to 40% of the crop may be lost. Recent research suggests that abscisic acid (S-ABA) may decrease sunburn in apples (Iamsub et al. 2009). According to (Racscko and Scrader, 2012) further research is needed to determine whether S-ABA will also reduce sunburn in regions (such as South Africa) that experience higher summer temperatures and higher irradiance.

MATERIALS AND METHODS

Experiments were conducted during the 2010/11 to 2012/13 seasons in a 'Granny Smith' apple orchard at Disseldraai farm in Grabouw (Latitude: 34°8'S; Longitude: 19°3'E), South Africa. The orchard was planted in 1993 on M793 rootstock at a spacing of 2 by 4.5 m. S-ABA was applied at various concentrations (250-1000 $mg.L^{-1}$) with application timings (from November until harvest in March). A representative scaffold branch was strip picked at commercial harvest on both sides of the tree providing samples of at least 50 fruit per tree. From this sample, sunburn incidence and severity were assessed using the Schrader and McFerson scale as well as green colour intensity, red blush and stem end russeting. A sub sample of 20 fruit was randomly selected and used to measure fruit size, weight and internal quality. Normal commercial cultural practises where followed during the experiments.

RESULTS AND DISCUSSION

The application of S-ABA had no effect on sunburn incidence and severity. Stem water potential was increased and there was a negative effect on photosynthesis. There was a significant reduction in fruit weight and size with repeated applications of S-ABA at high rates. Repeated applications of S-ABA also caused a significant reduction in both titratable acidity and total soluble solids concentration. Starch conversion was not affected by S-ABA application. A negative effect of S-ABA on green peel colour was noted for some applications while pink blush development and stem end russeting were not affected.

CONCLUSIONS

At the timings and rates applied, S-ABA does not seem to decrease sunburn in apple under South African conditions.

REFERENCES

Iamsub K, Sekozawa Y, Sugaya S, Gemma H, Kamuro Y. 2009. Alleviating sunburn injury in apple fruit using natural and fertilizer forms of S-abscisic acid and its underlying mechanism. *Journal of Food Agriculture and Environment* 7:446–452.

Racsko J, Schrader LE. 2012. Sunburn of Apple Fruit: Historical Background, Recent Advances and Future Perspectives. *Critical Reviews in Plant Sciences* 31:455–504.

Keywords: abiotic and biotic stress, fruit development

CHARACTERISATION OF SELECTED SOUTH AFRICAN COAL FLY ASHES FOR POTENTIAL UTILISATION IN AGRICULTURE AND LANDSCAPING

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INTRODUCTION

During coal combustion at electricity power stations, 70% of the solid residue is fly ash with South Africa generating more than 26 million tons of fly ash annually, posing serious disposal challenges, as only 5% is utilized in the construction industry. However, limited research is available on potential effects and uses of South African fly ashes in agriculture and land reclamation.

MATERIALS AND METHODS

Total elemental concentration was determined using ICP-OES and Skalar CFA following microwave digestion. Plant available elements were extracted using DTPA-TEA and Ammonium nitrate, whilst plant available P was extracted using Olsen method. Elemental release was estimated using an incubation experiment at 0%, 5%, 10% and 20% fly ash incorporation rate to soil.

RESULTS AND DISCUSSION

For all fly ash samples, total P content ranged from 553.3 to 1514 mg P/kg and Olsen extractable P from 130 to 345.5 mg P kg^{-1}. Matla fly ash had a higher total and extractable P of 1028 mg kg^{-1} and 256.15 mg kg^{-1} with the available P being 24.9% of total P. Application of fly ash at 10% incorporation rate raised extractable P content of the soil from a P deficient level to levels above the more than 25 mg kg^{-1} critical for most crops (Johnson et al. 2013). With a few exceptions, the heavy metal content of the fly ash samples followed the order Fe> Cr>Pb> Ni> Cu> Zn. The DPTA extractable levels for the elements were low and less than 2mg kg^{-1} except for Fe which had levels ranging from 4.8 to 136 mg Fe kg^{-1}. Except for Cr, all heavy metals (Cu, Pb, Fe, Ni) showed significantly (P = 0.05) low extractability at all fly ash incorporation rates compared to the soil alone control, suggesting possible precipitation of the elements.The results obtained showed that, excluding Pb, all fly ash samples studied, when incorporated into soil at 10% or less, the heavy metal load was below the maximum permissible levels recommended in South Africa.

CONCLUSION

These results suggest that the South African fly ashes studied can be an important source of essential elements like P with minimum risk to soil contamination from heavy metal release.

ACKNOWLEDGEMENTS

Govan Mbeki Research and Development Center at the University of Fort Hare, ESKOM®, Ash Resources® and Ulula Ash® for providing fly ash samples.

REFERENCES

Johnston, AE, Poulton, PR, White, RP.2013. Plant available soil phosphorus. Part II: the response of arable crops to Olsen P on a sandy clay loam and a silty clay loam. *Soil Use and Management* 29: 12–21.

Keywords: Fly ash, heavy metal load, Phosphorus release, soil contamination

CORRELATION AND PATH COEFFICIENT ANALYSIS OF PHENOTYPIC TRAITS IN THE SINGLE CROSS MAIZE HYBRID SR52

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INTRODUCTION

The importance of maize in Sub-Saharan Africa particularly in Southern Africa where it is a staple cannot be overstated. SR52 which is the 1st commercial single cross hybrid to be released in the world was the backbone of Africa's green revolution. This hybrid gives one of the highest yield per plant and has been utilised in several hybrid breeding programs in Kenya, Malawi, Zambia, Zimbabwe and as far afield as Ethiopia and Cameroon. The aim of this study is to unravel those traits that have a positive contributory role toward SR52's outstanding yield in an endeavour to target them in breeding for high grain yield potential.

MATERIALS AND METHODS

The S1 and backcross generations of SR52 were planted at Ukulinga and Cedara research stations in a randomised complete blocks design during the 2012/2013 season. Ten rows for each of the three segregating populations were planted. Several agronomic and secondary traits for yield were measured on a per plant basis. Pearson's correlations, as well as direct and indirect effects of path co-efficient analysis were performed using SAS (SAS Institute, 2008).

RESULTS AND DISCUSSION

The R^2 values observed were greater than 0.60 for all data analysed. The majority of traits were positively correlated with yield. High positive correlation between traits were observed for time to silk emergence and pollen shed, leaf area and plant height, grain moisture and hundred kernel weight. The traits that exhibited consistently higher direct effects for grain yield were ear length, number of kernel rows on ear, plant height and hundred kernel weight. The same traits along with ear components such as ear girth, and total number of kernels per ear had high correlations with yield. A few major indirect effects were noted with plant height having its total correlation with yield being boosted through indirect associations with traits such as ear length at Ukulinga and kernel rows per ear at Cedara. Days to silk emergence had significant negative correlations with grain yield as well as negative direct effects on the trait at Ukulinga.

CONCLUSIONS

As a result of its high correlation with grain yield, ear length can be used for indirect selection of grain yield in SR52's segregating generations with the hope of coming up with inbred lines with good performance. Hundred kernel weight and number of rows per ear can to a less extent be exploited for indirect selection for grain yield. Positive indirect effects between yield components such as kernels per row and ear length allow for simultaneously improvement of those traits resulting in grain yield improvement.

Keywords: Path-coefficient analysis, Correlation, Grain yield

SCREENING MAIZE VARIETIES FOR TOLERANCE TO LOW SOIL PH IN THE EASTERN CAPE

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INTRODUCTION

Soil pH levels of as low as 3.9 have been reported in some parts of the Eastern Cape Province of South Africa (Mandiringana et al., 2005). Low soil pH primarily retards root development, mainly due to aluminum toxicity. This negatively affects the crops' ability to acquire nutrients and water, resulting in low maize grain yield. Growing of aluminium tolerant maize varieties is one possible solution to increasing maize production in affected areas.

MATERIALS AND METHODS

Fifteen maize varieties, consisting of local and stress tolerant OPV's, and hybrids were evaluated under laboratory and field conditions. In the laboratory, maize seedlings were grown in containers with nutrient solutions with either, 0 or 222 µM Al^{3+}. The experiment was laid out as a completely randomized design. The field experiment was carried out at two sites, Mbinja (31°21'S 28°29'E) and Qumbu (31°9'S 28°52'E), characterized by high acid saturation. The factors tested were liming at two levels (limed and unlimed) and maize varieties. The design was a split plot, with liming as the main plot and maize varieties as the sub-plot, replicated three times.

RESULTS AND DISCUSSION

Significant differences ($p<0.001$) were observed in net seminal root length in the laboratory. Compared to the tolerant check, there was up to 42% decline in seminal root length for susceptible varieties. Most of the stress tolerant OPV's had higher seminal root length in comparison to the tolerant check. Okavango, ZM305 and Obatanpa had the highest scores, whilst stress tolerant OPV's had low scores which were not significantly different from the tolerant check. Across varieties, liming resulted in a 25% and 30% increase in maize grain yield at Mbinja and Qumbu respectively. Maize grain yield was significantly different amongst the varieties at Qumbu ($p<0.05$) and Mbinja ($p<0.001$). Varieties ZM525, ZM501, ZM621, BR933 and AFRIC 1 had yields that were not significantly different from the tolerant check at Qumbu. At Mbinja varieties ZM525, ZM423, AFRIC 1 and ZM501 had yields that were not significantly different from the tolerant check. The least grain yield was from Okavango at both sites.

CONCLUSIONS

Stress tolerant OPV's, ZM525, ZM501 and AFRIC 1 consistently showed high tolerance to low soil pH under laboratory and field conditions. Okavango was the most susceptible genotype. Liming increased maize grain yields by a margin of 25% to 30%.

REFERENCE

Mandiringana OT., Mnkeni PNS., Mkile Z., van Averbeke W., van Ranst E. & Verplancke H. 2005. Mineralogy and fertility status of selected soils of the Eastern Cape Province, South Africa. Communications in Soil Science and Plant Analysis 36: 2431-2446

Keywords: low pH, aluminium toxicity, maize

EXTENT OF CONSERVATION AGRICULTURE ADOPTION BY SMALLHOLDER FARMERS IN THE EASTERN CAPE PROVINCE

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INTRODUCTION

Conservation agriculture (CA) can sustainably address soil degradation and improve crop yields. However, the success of CA under the African smallholder setting is still questionable (Giller et al., 2011). The aim of the study was to find out the smallholder farmer's perceptions on CA, the extent of CA adoption and its impact on soil biochemical properties, in the Eastern Cape (EC).

MATERIALS AND METHODS

A questionnaire, field assessments and soil lab analysis were employed to gather data from the five districts of the EC. Two communities in each district were purposively chosen based on previous CA promotional activities. Soil samples were taken from CA fields at depths of 0-5, 5-20 and 20-30cm. For comparison purposes, an adjacent conventionally farmed (CT) field was also sampled. Soil organic carbon (SOC), total nitrogen, enzyme activity (fluorescein diacetate (FDA) hydrolysis assay) and extractable P, Ca, Mg and K were determined.

RESULTS AND DISCUSSION

All the CA farmers practised no-till (100%), with minimal application of crop rotation (33%) and crop residue retention (45%). Crop residue retention conflicted with the common socio-cultural practice of livestock grazing, whilst crop rotation seemed difficult in light of either maize or cabbage monoculture. Cabbage, maize and beans were the common component crops of choice for the few farmers that intercropped or practised crop rotations. CA fields had significantly higher ($p<0.05$) SOC, FDA and Ca compared to the CT lands, however, no significant benefit was observed with the rest of the parameters tested ($p>0.05$). FDA was significantly correlated ($p<0.05$) with SOC. The improvement of the EC smallholder CA systems seem to be based on the provision of lasting solutions to the major noted challenges of livestock interference, lack of smallholder CA equipment, input support and training.

CONCLUSION

Crop rotation and maintenance of soil cover are the most limiting CA principle(s) under the EC smallholder farmers as such the full benefits of CA are unlikely to be realised at this stage. It is recommended that sustainable key CA entry points in the EC be investigated, bearing in mind the noted impediments to the adoption of the principles.

REFERENCES

Giller K., Corbeels M., Nyamngara J., Triomphe B., Assholder F., Scopel E. &Tittonel P. 2011. A research agenda to explore the role of conservation agriculture in African smallholder farming systems. Field Crop Research,124:468-472

ACKNOWLEDGEMENTS

Special gratitude to the Department of Agriculture, Forestry and Fisheries (DAFF) for funding the study.

Keywords: biochemical properties, conservation agriculture, conventional agriculture, smallholder

MOLECULAR CHARACTERISATION OF MAIZE STREAK VIRUS RESISTANT INBRED LINES USING SINGLE NUCLEOTIDE POLYMORPHISM (SNP) MARKERS

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INTRODUCTION

The maize inbred line LP23 is an important parent of hybrids in Mozambique due to its high productivity and its resistance to downy mildew (DM). Its productivity, however, is compromised by its susceptibility to maize streak virus (MSV). This prompted research to incorporate MSV resistance in this line at the University of KwaZulu-Natal. Hence the aim is to breed maize with resistance to streak virus, to enhance production of uncontaminated maize, free of streak virus.

MATERIALS AND METHODS

The inbred lines CML509 and CML505 were used as donor parents for incorporating MSV resistance genes in LP23. A total of 118 F3 families derived from F2 crosses (LP23 x CML505 and LP23 x CML509) were genotyped using two SSR markers (*bnlg1811* and *umc2228*) and HRM analysis. Background selection was facilitated by 400 Panzea SNPs with an even distribution across the 10 chromosomes of maize and a call rate of 98%. Marker assisted selection was applied to obtain F6 and F7 inbred lines. Another set of 364 SNPs from the GCP Integrated Breeding Platform was used to determine the levels of homozygosity of the lines.

RESULTS AND DISCUSSION

Eventually 89 MSV resistant maize inbred lines were identified for advancement in the program. The Jaccard similarity coefficients between the lines data ranged from 52% to 88%. The progeny lines with LP23 as a common parent were placed in four clusters, with part of the lines derived from CML509 x LP23 clustering with LP23 and CML509, a second set were grouped with CML505. Group I and Group II lines were considered to be parental type because they were very close to genotype of the parents. The third and fourth group did not cluster with any of the three parental genotypes, indicating that they were new recombinant types. There are at least 13 new progeny lines with =80% similarity with the common parent LP23, qualifying them as suitable candidates for use to create new hybrids in lieu of LP23. The level of homozygosity ranged between 68% and 99.7%. However the majority of the lines were 95 to 99.7% homozygous. The parental genotypes were 99.2 (CML505 and LP23) and 97% (CML509) homozygous. Therefore the majority of the lines were considered genetically pure and fixed.

CONCLUSIONS

95-99% of developed lines expressed complete resistance to MSV.

ACKNOWLEDGEMENT:

This research was supported by a grant from the Generation Challenge program (G4008.19).

Keywords: Maize Streak Virus Resistance; Maize; SNP; Molecular Characterization; Genetic Purity

PRE-BREEDING FOR WHEAT RUST RESISTANCE IN SOUTH AFRICA

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INTRODUCTION

Wheat rusts are serious diseases of wheat worldwide and have periodically affected yields significantly in the history of wheat production in South Africa. Stripe, leaf and stem rusts can be chemically controlled but at unavoidably high costs. Continuous usage could also result in environment pollution. Breeding wheat for broad-spectrum/durable rust resistance remains the most effective and sustainable strategy to control rusts. New rust strains are constantly emerging due to mutations and new introductions necessitating the constant need for new gene combinations to prolong the durability of existing resistance sources. Small Grain Institute adopted a strategy of combining adult plant resistance (APR) or non-race specific resistance with race-specific genes in an endeavour to secure durable resistance against all wheat rusts.

MATERIALS AND METHODS

Two crossing blocks were designed to incorporate rust resistant genes into spring and winter wheat lines. Gene donors for these crossing combinations were selected from International nurseries, breeding materials from CIMMYT and the gene bank at ARC-Small Grain Institute. These entries are screened annually at different localities to verify the most durable rust resistant material. The resultant F1s were selved in the glasshouse and F_2 lines were evaluated in the field at Bethlehem (winter wheat) and Tygerhoek in the Western Cape (spring wheat) to identify rust resistant plants.(You need to mention the prevailing rust biotypes).F2 Plants identified with gene combinations were validated using Marker-assisted selection (MAS).

RESULTS AND DISCUSSION

Various gene combinations of the following Stripe,leaf and stem rust resistance genes were evaluated : *Yr3a, Yr3b, Yr4b, Yr5, Yr10, Yr15, Yr18, Yr29, Yr35, Yr38, YrSp, Lr9, Lr19, Lr22, Lr34, Lr35, Lr39, Lr41, Lr46, Lr52, Lr53, Lr56, Sr2, Sr20, Sr22, Sr26, Sr29, Sr31 Sr33, Sr35, Sr40, Sr45* including additional complex gene combinations Twenty seven F2 plants with a combination of *Sr22* and *Yr18/Lr34*; 51 F2 plants with *Sr2* and *Yr18/Lr34*, and 132 F2 plants with *Sr2* and *Sr29* were selected for further exploitation. Further studies will be conducted on selected resistant germplasm to characterise other traits before the germplasm is released.

CONCLUSIONS

Evaluating breeding lines and accessions from the genebank and nurseries has identified promising donor lines to increase genetic diversity and to increase current levels of rust resistance in South African wheat cultivars and breeding lines. Several lines with different gene combinations were developed and these lines will advance to the breeding program at ARC-SGI. The lines are also made available to other wheat breeding programs in South Africa.

ACKNOWLEDGEMENTS

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Keywords: Wheat rust resistance

AGGREGATE STABILITY AND BREAKDOWN MECHANISMS AS AFFECTED BY SOIL TEXTURE AND ORGANIC MATTER IN SOILS DOMINATED BY PRIMARY MINERALS

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INTRODUCTION

Soil aggregates break down due to several physico-chemical and physical forces during rainfall or irrigation which, leads to soil crusting, reduced water infiltration and soil erosion. The objective of this study was to identify the dominant breakdown mechanism in 14 Eastern Cape soils and to relate aggregate breakdown mechanisms to soil texture especially the clay fraction, soil organic matter (SOM) fractions and mineralogy.

MATERIALS AND METHODS

Soil samples with varying properties were collected from the surface 0 to 0.2 m from 14 ecotopes in Eastern Cape Province. Aggregate stability was determined following methods described by Le Bissonnais (1996) i.e. fast wetting (FW), slow wetting (SW) and wet stirring (WSt).

RESULTS AND DISCUSSION

Aggregate breakdown followed the following order; slaking < mechanical breakdown < micro-cracking for most ecotopes except Lujiko Leeufontein and Amatola Jozini where SW and WSt resulted in the least MWD respectively. Aggregate stability was significantly correlated to particulate organic matter POM only for FW and SW and only positive but not significant for WSt.

CONCLUSION

It is important to protect the soils from rapid wetting and raindrop impact as well as micro-cracking by increasing POM content in these soils. This can be achieved through high SOM inputs and farming methods that reduce POM mineralization is likely to increase soil aggregation.

ACKNOWLEDGEMENTS

The study was funded by the Govan Mbeki and Research Centre at the University of Fort Hare.

REFERENCES

Le Bissonnais Y. 1996. Aggregate stability and measurement of soil crustability and erodibility: I. Theory and methodology. *European Journal of Soil Science* 47: 425–437.

Keywords: fast wetting, POM, slow wetting, wet stirring

EFFECTS OF RAINFALL ON CRUST FORMATION IN SOME SOUTH AFRICAN SOILS WITH VARIABLE TEXTURE AND MINERALOGY

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INTRODUCTION

Raindrops break down soil aggregates and set off the process of seal formation, which affects the surface hydraulic properties of soils such as steady state infiltration rate (SSIR) (Bu et al., 2013). The objective of this study was to determine the effects of the rainfall pattern on crust strength, SSIR and erosion in soils with variable texture and mineralogy in South Africa.

MATERIALS AND METHODS

Sandy clay loam (SCL) and sandy loam (SL) soils dominated by either quartz or kaolinite were used. Simulated rainfall of 60 mm h^{-1} was applied either as eight-minute single rainstorm (SR) or four, two-minute intermittent rainstorms (IR) separated by a 48 h drying period.

RESULTS AND DISCUSSIONS

Both IR and SR rainfall patterns significantly ($P< 0.05$) reduced SSIR in SCL and SL quartz dominated soils. Since quartz is inert it allows high mineralisation of soil organic matter (Buhman et al., 2006). In the end, the soils are poorly aggregated resulting in a higher likelihood of breakdown upon wetting and hence crusting. The higher SSIR in SCL than the SL within the intermittent rainfall for kaolinitic soils could be due to the high stability and non-dispersive nature of kaolinite (Wakindiki and Be-Hur, 2002).

CONCLUSIONS

Reduction in SSIR was most influenced by primary minerals such as quartz especially for coarser textured soils regardless of the rainfall pattern.

ACKNOWLEDGEMENTS

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REFERENCES

Bu CF, Gale WJ, Cai QG, Wu SF. 2013. Process and mechanism for the development of physical crusts in three typical Chinese soils. *Pedosphere* 23: 321–332.

Buhman C, Beukes DJ, Turner DP. 2006. Clay mineral associations in soils of the Lusikisiki area, Eastern Cape Province, and their agricultural significance. *South Africa Journal Plant and Soil* 23:78-86.

Wakindiki IIC, Ben-Hur M. 2002. Soil mineralogy and texture effects on crust micromorphology, infiltration and erosion. *Soil Science Society America Journal* 66: 897-905.

Keywords: Penetration resistance, quartz, soil organic matter, steady state infiltration rate

OPTIMIZING RAINFALL UTILIZATION IN DRYLAND CROP PRODUCTION: A CASE OF SHALLOW-ROOTED CROPS

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INTRODUCTION

Rainwater harvesting (RWH) is a promising potential solution to the challenge of extreme climatic conditions and high inter-annual/seasonal rainfall variability which adversely affects agricultural productivity in arid and semi-arid areas. In these regions, optimizing rainwater management through In-field Rainwater Harvesting (IRWH) can contribute to reducing risk for small scale agriculture. Hence, the aim of the study was to investigate whether IRWH can materialize its full potential in dryland crop production to ensure food security and improve the livelihood of the people of drought/hunger-stricken areas through higher yields and improved water use efficiencies (WUEs).

MATERIALS AND METHODS

A field trial to study the effect of IRWH on Swiss chard growth, re-growth, yield and WUE was carried out from May 2010 until November 2011 at the Hatfield Experimental Farm, University of Pretoria. Prior to the rainy season, rainfall was simulated with sprinkler irrigation. The experiment was a randomized complete block design (RCBD) with three replicates, and included three different tillage systems: (1) conventional tillage (CT), (2) tied-ridges (TR), and (3) In-field Rainwater Harvesting (IRWH). IRWH runoff areas were either bare (B) or plastic-covered (P) and this was combined with three different design ratios of runoff area to cropping area. Therefore, there were a total of eight treatments, CT, TR and six IRWH treatments: 1:1B, 1:1P, 2:1B, 2:1P, 3:1B and 3:1P. Seven Swiss chard leaf harvests were conducted manually by carefully harvesting the outer leaves and leaving the growing centre bud and surrounding young leaves for the following harvest.

RESULTS AND DISCUSSION

For IRWH treatments, yields are expressed in terms of either total or net cropped areas. In terms of the total area, TR showed the highest yields (55 t ha^{-1}) and WUE (94 kg ha^{-1} mm^{-1}), followed by CT, 1:1P and 1:1B. The lowest yields (18 t ha^{-1}) and WUE (31 kg ha^{-1} mm^{-1}) corresponded to 3:1B, followed by 3:1P. IRWH treatments generally had lower yields due to fewer plant rows per plot area. In terms of yields expressed per cropped area basis, the IRWH/RWH treatments achieved significantly higher yields and WUE than CT.

CONCLUSION

The experiment showed that if land is limiting, tied ridges and conventional tillage are better choices for the current ecotype, while if land is not limiting, In-field Rainwater Harvesting can significantly improve water conservation and thereby increase crop yield and WUE.

Keywords: Arid and semi-arid areas, design ratios, dryland areas, Rain Water Harvesting, runoff areas

EFFECTS OF LAND USE CHANGE ON SOIL CHEMICAL PROPERTIES OF CEDARA WETLANDS

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INTRODUCTION

Wetlands are vital in the provision of ecosystem services. There are concerns on the effects of land use change and on their functioning and health. Disposal of organic waste slurries on wetlands could result in high nutrient loads, whereas drainage for agriculture, could adversely affect their characteristics, particularly soil properties. This study assessed the effects of land use changes on soil chemical properties of wetlands.

MATERIALS AND METHODS

Three wetlands were studied at Cedara; one receiving sewage effluent and dairy slurry, another drained for cropping, and an undisturbed wetland, on the uplands of the main stream. Soil surveys were carried out to identify soil forms. Soil sampling was done on transects, using augers, at 0–20, 20–40, 40–60, 60–100 cm depths. The samples were analysed for pH (water), clay content, total N and C, CEC, K, Ca, P, Na, Mg, Mn, Zn, Cu.

RESULTS AND DISCUSSION

The dominant soil form in all wetlands was Katspruit, with Pinedene, Clovelly, Griffin and Hutton on the edges. Soils in all wetlands were acidic, with the cropped wetland having the highest pH of 4.4, which was periodically limed. The dairy/sewage wetland had significantly higher P, Zn and Cu than the drained and cropped wetland while undisturbed wetland had the least. Soil P decreased with distance from the dairy. Greater Ca and Mg concentrations were observed in the drained and cropped wetland than the other two. The undisturbed wetland had higher C and N concentrations than the other two suggesting that land use change of wetlands causes a decline in soil C and N. Differences in the measured parameters with depth within wetlands and across transects occurred in the 0-20 and 20-40 cm depths, and less so in lower horizons. These variations could be explained by nutrients added in slurries, fertilizer and lime, and possible gaseous emissions.

CONCLUSION

Addition of dairy/sewage wastes increased P and micronutrient concentrations whereas drained cropped wetlands accumulated Ca and Mg and to a lesser extent P. Both land use changes lowered soil C and N concentrations, potentially contributing to greenhouse gas emissions.

ACKNOWLEDGEMENTS

The National Research Foundation and the KZN Department of Agriculture are acknowledged for funding the study.

Keywords: Drainage, dairy, sewage, soil nutrients, wetlands, land use change

EFFECT OF CULTIVAR, RHIZOBIUM PHASEOLI INOCULATION AND PHOSPHORUS FERTILIZATION ON GRAIN YIELD OF DRY BEAN

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INTRODUCTION

Low yields in dry bean are often reported to be associated with lack of inoculation of seeds prior to planting, which also results in little fixed nitrogen contributed by the crop. Soil phosphorus (P) is another important yield limiting factor in most of the dry bean producing regions (Musandu and Ogendo, 2001). The study aimed to investigate the response of dry bean cultivars to inoculation and P application.

MATERIALS AND METHODS

Two field experiments were carried out as a split split-plot arranged in randomized complete block design with four replications. The study was conducted during 2011/2012 and 2012/2013 growing seasons. Treatment factors were: (i) Main plot factor was dry bean cultivar (red speckled bean and small white haricot), (ii) Subplot factor was *Rhizobium phaseoli* inoculation levels (inoculated and uninoculated) and (iii) Sub-sub plot factor was P application rates (0, 45 and 90 kg P ha^{-1}). Dry bean grain yield data were subjected to ANOVA and significance was accepted at 5 % or less.

RESULTS AND DISCUSSIONS

There were no significant interactions on grain yield in both seasons. Cultivar and inoculation significantly affected grain yield of dry bean during two seasons (P = 0.01). The red speckled bean produced higher grain yield of 1657 kg ha^{-1} and 2547 kg ha^{-1} in 2011/2012 and 2012/2013, respectively. In contrast, the small white haricot bean achieved grain yield of 1396 kg ha^{-1} and 1797 kg ha^{-1} in the respective seasons. Inoculation with *Rhizobium phaseoli* achieved significant increases in grain yield during both seasons. Grain yield was significantly increased by 86.10 % and 78.43 % with inoculation in the respective seasons. Phosphorus application at varying rates did not have a significant influence on grain yield of dry bean during both seasons (P = 0.05).

CONCLUSION

The results of this study strongly indicate that the red specked bean yields better than the small white haricot, with *Rhizobium* inoculation being beneficial for enhancing grain yield productivity of dry bean. Future studies should focus on the response of dry bean to increased rates of P application.

REFERENCES

MUSANDU, A.A.O.,& OGENDO, O.J., 2001. Response of common bean to *Rhizobium* inoculation and fertilizers. *The Journal of Food Technology in Africa* 6:121-125

Keywords: Cultivar, inoculation, phosphorus, *Rhizobium phaseoli*

AGRO-MORPHOLOGICAL VARIATIONS AMONG SELECTED WHEAT VARIETIES AFTER ETHYL METHANESULPHONATE MUTAGENESIS

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INTRODUCTION

Induced mutagenesis is helpful to enhance genetic variation (Ram Din *et al.,* 2008). Desired genotypes from targeted mutations can be selected using suitable selection methods. Often the aim of wheat improvement is to enhance grain yield, a quantitative trait affected by many genetic and non-genetic factors. The objective of this study was to investigate genetic variations in agro-morphological traits of two selected wheat varieties after chemical mutagenesis using ethylmethanesulphonate (EMS).

MATERIALS AND METHODS

Seeds of two wheat varieties (SST56 and SST875) were subjected to EMS mutagenesis using 0.5% v/v EMS at 32.5^{o}C for 1 hr. Field trials were carried out at Ukulinga research farm of the University of KwaZulu-Natal using a randomized complete block design with two replications. Data on nine important agro-morphological traits were collected before and after harvest and analyzed using the analysis of variance (ANOVA), correlation and principal component analyses (PCA) procedures.

RESULTS AND DISCUSSION

Significant variations were found among the agro-morphological traits between M_1 individuals of the varieties after the mutagenesis compared to untreated checks. EMS significantly reduced seedling emergence in the field by 40% in both varieties and delayed days to heading by 8 days. The mutagen caused a shortening of the days to maturity by 13 days in both varieties. EMS treatment also significantly reduced plant height from 121 cm to 18 cm and 21 cm in SST56 and SST875, respectively. Spike length reduced by ~2.5 cm in both varieties compared to the untreated control. Hundred seed weight, flag leaf length and seeds per spike significantly increased in the treated seeds of both varieties. PCA revealed three principal components (PC1, PC2 and PC3) that accounted for 57% of the total variations among the agro-morphological traits in both varieties. PC1 alone contributed to 27.7% of the variation which was correlated well with plant height (0.767), tiller number (0.812), number of seeds per spike (0.599) and seed yield (0.720). PC2 explained 15.6% of the variation and is well-correlated with germination percentage (0.784), spike length (0.554) and flag leaf length (0.772). PC3 accounted for 12.4% of the variation and had negative correlation with days to maturity (-0.730).

CONCLUSION

The study found that EMS has the potential to increase agro-morphological variations in wheat. This could be useful in selecting novel mutants with desired phenotypic traits.

REFERENCE

Ram Din, M.M. Khan, M. Qasim, S. Jehan, M and Iqbal Khan, M. 2008. Induced mutation studies in three wheat (*Triticume aestivum L*.) varieties for some morphological and agronomical characters. Asian Journal of Plant Sciences. 2: 1179-1182.

ACKNOWLEDGEMENT

The study was financially supported by the National Research Foundation of South Africa.

Keywords: Agro-morphological traits, ethylmethanesulphonate, wheat

MAIZE YIELD AS AFFECTED BY CONSERVATION AGRICULTURE SYSTEMS ON A HUTTON SOIL IN THE NORTH WEST PROVINCE

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INTRODUCTION

Conservation agriculture (CA) cropping systems consist of the practices of minimum soil disturbance, maintenance of a permanent or semi-permanent soil cover with crop residue and crop rotation. Soil erosion and degradation are confined through CA, and soil quality and productivity can improve, fostering sustainability. The conversion from conventional tillage mono cropped maize systems to CA has been slow due to uncertainty about the suitability of local soils and climate and the risks involved. The objective of this work was to compare the yield of maize grown in CA and conventional systems in order to evaluate the success of CA on a Hutton soil in the North West province.

MATERIALS AND METHODS

Maize was grown in a field trial on a Hutton soil with 16% clay in the top soil, in the Ventersdorp district from 2008/09 to 2012/13. Treatments were maize in monoculture on ploughed soil (control) and three CA treatments namely, maize in monoculture with no-till, maize following a legume in no-till and maize following millet and a legume in no-till. Either a moldboard- or chisel plough was used for the conventional tillage. No-tillage consisted of soil disturbance 10 cm deep on the 90 cm spaced rows during planting. Fertiliser, herbicides, pesticides and the cultivars used were according to the best recommendations for the area. A completely randomised block design with four replicates was used for the trial layout.

RESULTS

The yield of maize grown in the CA systems was equal or better than that of the control. In 2012/13 when an eight week drought affected crops from late January to the middle of March the yield of maize in the CA systems was up to 2.6 times higher than that of the control.

CONCLUSION

The production of maize in CA in this semi-arid environment on a medium textured Hutton soil was successful. Indications are that CA in comparison with the conventional system can even reduce the impact of drought. A longer period of investigation is however necessary to confirm this results.

Keywords: Conservation Agriculture, maize, yield

THE RESPONSE OF *Sclerocarya birrea* (MARULA) SEEDLINGS TO DIFFERENT FERTILIZERS AND PLANTING METHODS IN THE LIMPOPO PROVINCE

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INTRODUCTION

A lot of research has been conducted and published on the germination of *Sclerocarya birrea* seeds and yet the accessibility of information on seed germination of *S. birrea* at community level is still a challenge. Several methods have been mentioned on pre-treatment and germination of *S. birrea* seeds, but when following such procedures in the laboratory, results obtained are poor. Only a few commercial plantations, nurseries and community gardens exist for marula trees. Communities are experiencing shortages of marula fruits for processing into different products, due to competition with animals and other farmers, as well as conservation of marula trees. To supply communities with seedlings the germination of marula were again addressed. The objectives of the study were to determine the effect of various seed pre-treatment methods on germination of marula seed, evaluate the efficient planting method for producing marula seedlings and determine the performance of marula seedlings after the application of different fertilizers.

MATERIALS AND METHODS

Marula seeds collected at Makonde Village in October 2011 and stored at room temperature until October 2012 to overcome the reported dormancy period (Van Staden *et al.* 2000) were used. Seeds were surface sterilized and soaked in water for 24 h at ARC VOPI. The operculum was removed from the seeds and seeds were germinated at four different temperatures (25, 30, 35 and 40^{0}C) The experimental layout was a Latin square design replicated four times over a four month period. The second CRD experiment was conducted in October 2012 at Makonde with three planting methods (direct seed sowing M1, seedlings transplanted M2 and vegetative propagation M3) replicated four times on a spacing of 10 x 10 m amounting to 100 trees ha^{-1} and irrigated daily with 600 ml of water until root development to determine the best planting method of marula. Data on number of radicles protruded, survival of transplanted seedlings and survival of vegetative cuttings was collected on 10 randomly selected plants of each plot. In February 2013 the CRD experiment was conducted with four levels of soil fertilizer types 3:2:1(30) NPK (F2), compost (F3), kraal manure (F4) and control (F1 = soil) and replicated four times. The plant height was measured with a measuring tape and number of leaves was counted from emergence stage until branches had developed. The rates of fertilizers being 0 (control) kg ha^{-1}, 187.5 kg ha^{-1} of 3:2:1 (30) NPK and 2000 kg ha^{-1} of compost which were mixed well with both top and sub soils.

RESULTS AND DISCUSSION

The highest germination rate was obtained at 25^{o}C, but large scale seed contamination was experienced. Higher temperatures led to increased contamination rates. There was no difference between the transplanted seedlings and vegetative planting methods while the direct seed sowing method indicated that the seeds emerged within fourteen days. The *Sclerocarya birrea* trees fertilized with NPK and organic compost survived well at Makonde farm, were greener and were taller than the stunted, half green half brownish *S. birrea* trees that were fertilized with kraal manure and the control.

CONCLUSIONS

The *Sclerocarya birrea* seed contamination during the germination period is still a challenge. Therefore there is still a need for the development of a simple application for germination at community level. Domestication of *S. birrea trees* is easily achievable and communities should no longer experience shortages of marula fruits for processing into different products, due to competition with animals and other farmers.

Keywords: Sclerocarya birrea, indigenous knowledge systems, crop production

IDENTIFICATION OF DROUGHT TOLERANT POTATO VARIETIES IN SOUTH AFRICA

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INTRODUCTION

Water is the most important factor limiting crop productivity. Improvement of moisture stress tolerance through breeding could make a major contribution towards increasing and/or stabilizing potato production in developing countries. Many emerging farmers in the world farm in rain fed systems where water supply is often unpredictable and periods of moisture stress is common. There has been little effort to select for drought tolerance for the targeted rain fed environments. The main objective of the present study was therefore to identify potato genotypes with some tolerance to moisture stress during the growing season that could be utilized in the development of new potato varieties with improved drought tolerance.

MATERIALS AND METHODS

Two greenhouse pot trials were conducted: the first trial was planted in April 2007 and the repeat in February 2013. Well sprouted seed of 12 potato varieties were planted in plastic pots filled with a mixture of topsoil, sand and vermiculite fertilized with 3:2:1 (25) and LAN. The experimental design used for these trials was a split-plot design with main- and sub-plots. The two irrigation regimes, fully irrigated and stressed, were the main plots and variety the sub-plot treatments each randomly allocated to the main plots. The variety Up-to-date was included as drought stress indicator due to its known sensitive to drought. Four weeks after plant emergence, irrigation of the stressed replications was stopped, while irrigation continued as scheduled in the irrigated replications. When the Up-to-date in the stressed replications indicated severe symptoms of drought stress, scheduled irrigation of the stressed replications was resumed. Potato fresh and dried foliage and fresh tuber weight were collected and analyzed using the statistical program GenStat.

RESULTS AND DISCUSSION

In the 2007 pot trials the varieties Caren, BP1, Hertha, Darius and 890/20 had significantly higher fresh- and dried foliage weight than the other varieties tested. However, only three of the varieties evaluated, Darius, Pentland Dell and 890/20 had significantly higher fresh tuber weight than the other varieties tested in 2007. In the 2013 pot trials only three of the varieties evaluated, Pentland Dell, Darius and BP1 had significantly higher fresh tuber weight than the control variety Up-to-date and the other varieties tested. The variety Darius with its high fresh foliage- and fresh tuber weight in both years evaluated in the greenhouse trials seems to be one of the more drought tolerant potato varieties currently available in South Africa.

CONCLUSION

The potato varieties Darius, Pentland Dell, BP1, 890/20 may be recommended for future use in the development of drought tolerant potato varieties suited to the growing conditions in Southern African countries. Further research and field trials will be conducted to confirm the results obtained.

Keywords: Drought, moisture, potato, stress, tolerance

EFFECT OF TEMPERATURE ON PREMATURE SEED-STALK DEVELOPMENT AND GROWTH OF CABBAGE (*Brassica oleracea* var. Capitata) PLANTS

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INTRODUCTION

Cabbage production in South Africa is of great importance. Understanding the responses of cabbage plants to temperature will assist in maintaining and increasing cabbage production in the country. Low temperature has a direct effect on cabbage bolting and growth. In the year 2011, farmers in areas which included Greytown, Pretoria and Delmas experienced severe losses in cabbage production due to bolting, but not in Bloemfontein. The aim of this study was to determine whether cabbage bolting is triggered by low temperatures during the seedling stage, cupping stage or during the heading stage and why bolting in 2011 occurred in some production areas.

MATERIALS AND METHODS

Cabbage plants were exposed to different low temperature regimes during the seedling, cupping and heading stages for a minimum of eight weeks to simulate winter conditions before transplanting into the open field under ambient conditions. Maximum and minimum temperatures for Bloemfontein, Greytown and Pretoria obtained from the South African Weather Service (SAWS) for 2010, 2011 and 2012 were analysed to determine possible correspondence with regards to cabbage bolting.

RESULTS AND DISCUSSIONS

Cabbage seedlings exposed to low temperature had normal growth and heading, and showed no bolting signs after being transplanted to the field. Plants exposed to low temperatures during the cupping or early heading stage and fully headed stage had retarded growth, some had normal heading, with no visible bolting while some had inflorescence buds in leaf axils.

Comparison of production areas showed that constant minimum temperatures during June-August followed by sudden rise in temperatures during September in Pretoria and Greytown in 2011 probably induced bolting while undulating (irregular) minimum temperatures during the same period and gradual rise in temperature during September resulted in no bolting in Bloemfontein.

CONCLUSION

Although no visible bolting was observed in any of the treatments, this study indicated that cabbage plants are not triggered to bolt during the seedling stage but during the cupping or early heading and heading stages of growth.

ACKNOWLEDGEMENTS

The National Research Foundation (NRF) and Sakata Seed Southern Africa (Pty) Ltd are highly appreciated for their continued financial support.

Keywords: bolting, heading, temperature, inflorescence buds

THE USE OF MOLECULAR GENOTYPING AS A TOOL TO MANAGE HERBICIDE RESISTANT RYEGRASS (*Lolium* spp.)

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INTRODUCTION

Weeds are a major biotic factor hampering effective and profitable crop production. In cereals, it has been documented that yield reduction solely due to invading weeds is estimated at 33% for wheat. Herbicide resistant ryegrass (*Lolium* spp.) has been reported in many parts of the world. In South Africa, the Western Cape is well-known for its ryegrass resistance problems. Over the past 5-10 years a number of weed resistance cases have been studied at the DNA level. The primary advantage of DNA-based tests for herbicide resistance is a yes/no answer for a specific mutation which confers resistance to a particular group of herbicides with the same mode of action and can be obtained within 48 hours. However, what must be considered is that the DNA tests can only identify the resistance in which the mechanism or mutation conferring resistance has already been identified. It is possible that a single resistant genotype has a novel new resistance mechanism that cannot be identified with normal testing. It is essential to test all major resistant mechanisms already identified for a specific weed species, such as *Lolium*, to make genotyping of biotypes as accurate as possible. In this study, a number of ACCase and ALS codon amino-acid substitution mutations were screened to determine if the PCR-based tests can be used to speedily and accurately identify herbicide resistance in rigid ryegrass in the South African wheat industry.

MATERIAL AND METHODS

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

RESULTS AND DISCUSSION

Numerous samples are received and processed in duplicates weekly. To date 13 bulked samples received from farmers have been processed. The two most common occurring mutations identified are the ALS 197 mutation, which confers high levels of resistance to SU's (sulfonylureas) and TP's (triazolopyrimidines) and low levels of resistance to IMI's (imidazolinones) and the ACCase 2078 mutation, which confers resistance to all APP (aryloxyphenoxypropionates) herbicides and all CHD (cyclohexanediones) herbicides (including Clethodim). These two mutations have also been identified in combination.

CONCLUSION

The PCR-based test for detecting ACCase and ALS herbicide resistance in ryegrass is proving to be a fast and accurate way of determining the resistance status of ryegrass biotypes.

Keywords: ACCase herbicides, ALS herbicides, dCAPS, DNA, herbicide resistance, ryegrass

DOES PHOSPHORUS FERTILIZER HAVE AN EFFECT ON THE GROWTH AND YIELD PARAMETERS OF PIGEONPEA UNDER DIFFERENT CROPPING SYSTEMS?

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INTRODUCTION

Intercropping is widely practiced by mostly subsistence farmers in many parts of the arid and semi-arid tropics; but information on appropriate fertilization practices is still limited. In addition, the high phosphorus (P) demand by most leguminous crops, coupled with its complex chemistry in many soils, often results in P management challenges on most croplands. The aim of the study was to determine production yield of pigeonpea intercropped with maize under variable phosphorus rates.

MATERIALS AND METHODS

A phosphorus fertilizer trial under dryland condition was conducted at University of Limpopo Experimental farm, Syferkuil during 2009/10 and 2010/11 growing seasons. Five P rates (0, 15, 30, 45, and 60kg P ha^{-1}) were applied to both sole and intercrop plots. Maize variety SNK2147 was planted with pigeonpea in the intercrop plots and treatments were laid out in a 2x5 factorial arrangement fitted in a randomized complete block design with four replications. Soil from the trial site was analyzed prior to planting for available P content and other nutrients. Data collected at harvest were subjected to analysis of variance using Statistix 9.0 version.

RESULTS AND DISCUSSION

Grain yield of pigeonpea increased with an increase in P rates from 294 to 781 kg ha^{-1} in 2009/10 and 467 to 894 kg ha^{-1} in 2010/11. Janboonme *et al.,* (2007) also reported that grain yields of pigeonpea increased with the increase in P (37, 56 and 75 kg ha^{-1}) application rate from 1.56 t ha^{-1} up to 1.83 t ha^{-1}. Cropping system had only significant influence on grain yield during 2010/11 whereby intercrop plots increased yield by 37.1 % as compared to the sole plots. Optimum pigeonpea grain yield was achieved at 45kg P ha^{-1} under sole and intercrop plots in both seasons. A significant P rate x cropping system interaction effect on number of pods per plant was observed for both sole and intercrop during 2009/10.

CONCLUSION

Results from the study indicated that P application increased yield significantly in both sole and intercrop plots. The results suggest an optimum P application rate of 45 kg per hectare.

REFERENCE

JANBOONME, S., TIPPAYARUK, J., DHUMMARANGSI, P., AND BANTILAN M.C.S. 2007. Impact of pigeonpea research in enhancing sugarcane production in Thailand. Journal of SAT Agricultural Research, 3 (1): 1-19.

ACKNOWLEDGEMENT

The authors thank the University of Limpopo for the financial support.

Keywords: Cropping system, Pigeonpea, P rates

EFFECT OF 1-METHYLCYCLPROPENE AND STORAGE DURATION ON AVOCADO FRUIT QUALITY

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INTRODUCTION

'Reed' is a Guatamelan cultivar that matures late in summer in South Africa and has been shown to maintain good fruit quality at advanced maturity. Generally, avocado is one of the fastest ripening fruits. It has a very short shelf life, and advanced fruit maturity can further reduce the ripening period of the fruits. 1-Methylcyclopropene (1-MCP) is a new product that is being used to improve the storage potential and maintain quality of avocado fruits. Research has shown that this inhibitor of ethylene perception can prolong the shelf life of the fruits and also reduce the incidence of postharvest disease and physiological disorders that occur on cold stored-fruits. The aim of this study was to investigate the effects of 1-MCP and storage period on fruit quality of Reed avocado harvested at different maturities.

MATERIALS AND METHODS

Avocado fruits obtained from ZZ2 commercial farm were harvested at three different times, a month apart from each other. Fruits were harvested at commercial maturity (October), a month later (November) and two months later (December). Treatments were arranged in a randomized complete block design, with five replications. At each harvesting time, six cardboard boxes per replicate were either untreated or treated with 500ppb 1-MCP in a 200L plastic container for 16 hours. Fruits were then stored at 6°C for up to 6 weeks and one 4kg box was taken out of the cold room weekly for ripening. Days to ripening, incidence of stem-end rot, anthracnose, grey pulp, vascular browning and lenticel damage was recorded.

RESULTS AND DISCUSSION

1-MCP strongly inhibited fruit softening during first two harvesting times regardless of the storage period, while both treated and untreated fruits softened during storage after 4 weeks for the last harvest. 1-MCP increased the occurrence of anthracnose and stem-end rot in the October and November harvests, while control treatments were highly infected in December. The incidence of vascular browning increased with storage period at all harvesting times. Delayed harvest with prolonged cold storage increased fruit lenticel damage on both treated and untreated fruits. Incidence of spots on the fruit skin was high on treated fruits when storage time was shortened. There was no significant effect on grey pulp.

CONCLUSION

The study shows that 1-MCP has potential to extend the shelf life (delayed ripening) of avocado. However, fruit softening is inversely related to fruit maturity and storage period. Application of 1-mcp had no influence on the occurrence of post harvest diseases.

Keywords: 1-Methylcyclopropene, avocado, cold storage, harvesting time, softening, quality

EFFECT OF GROWING MEDIUM MIXTURES ON YIELD AND QUALITY OF TOMATO CULTIVARS GROWN IN A TUNNEL AT BATHURST EXPERIMENTAL STATION

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INTRODUCTION

Hydroponic cropping systems have gained popularity in South Africa due to the number of advantages that they have such as shorter growth cycles, higher yields and good quality of crops (Maboko, *et al*, 2009). Growing media such as peat moss, pine bark, perlite, etc. is mainly used in these cropping systems. Most research on growing media has concentrated on the effect of growing media on growth and quality of seedlings of different vegetables and very little is known about the overall effect on yield and quality of the fruit as influenced by growing conditions of seedlings before transplanting. Hence, this study was initiated.

MATERIALS AND METHODS

The trial was conducted at Bathurst experimental station under a plastic tunnel. Seedlings of three tomato cultivars were raised in a growing medium comprising of pine bark (Pi), peat moss (Pe) and vermiculite (Ve) in a ratio of 1:2:1 (Pi:Pe:Ve), 2:1(Pe:Ve) and 1:1 (Pi:Pe). After six weeks, seedlings were transplanted in 10 L plastic bags filled with sawdust. Nutrient solution comprising of macro and micro elements was used to fertigate the seedlings. At maturity, fruits were harvested weekly and data collected on yield, total soluble solids (TSS) and pH of tomatoes. Data were analyzed using Genstat 14 for analysis of variance (ANOVA) and Fisher's unprotected test was used to determine least significance differences (LSD) at p=0.05.

RESULTS AND DISCUSSION

There were statistically significant differences in yield, TSS and pH. The highest yield of 11.9 kg per plant was obtained from Star 9032 raised in the 1:1 (Pi:Pe) growing media while the lowest yield of 5.2 kg per plant was obtained from Star 9034 raised in 2:1 (Pe:Ve) growing media. TSS was higher with Star 9034 raised in the 1:2:1 (Pi:Pe:Ve) media. Tzortzakis and Economakis (2008) also concluded that substrate had an effect on total tomato yield, number of fruits and fruit quality

CONCLUSIONS

Growing medium mixtures had a significant effect on yield and quality of tomatoes as measured by TSS and pH of the juice. Cultivars tested also responded differently when grown under these mixtures.

REFERENCES

Maboko MM, Du Plooy CP, Bertling I. 2009. Comparative performance of tomato on soilless vs in-soil production systems. *Acta Horticulture*. 843: 319-326.

Tzortzakis NG, Economakis CD. 2008. Impacts of the substrate medium on tomato yield and fruit quality in soilless cultivation. *Horticulture Science*, 35(2): 83-89.

Keywords: Tomatoes, growing media, fruit quality, yield

CALIBRATION OF AQUACROP MODEL FOR AMARANTH AND SPIDER FLOWER

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INTRODUCTION

South Africa is classified as the 30th driest country in the world. Improving water productivity of crops is a key priority. Traditional leafy vegetables (TLV's) (Amaranth and Spider flower) are **''wild vegetables''** collected by rural poor households in the bush or fallow fields. Most studies claimed that these TLV's are highly nutritious in micronutrients and Vitamins and they require minimum inputs to grow well. Introducing these crops into existing food systems calls for scientists to understand their interactions with the environment. However, food systems are complex, and therefore experimentation combined with crop modelling can play a major role in understanding these interactions. The objective of the study was to calibrate AquaCrop model for selected TLV's.

MATERIALS AND METHODS

Experiments were conducted under rainshelters at ARC-VOPI. A completely randomized design was used for selected TLV's. The factorial design used consisted of three water (W1= irrigating to field capacity, W2= mild stress (50%) and W3= severe stress (80%)) and four nitrogen fertilisation levels (0, 100, 150 and 200 kg N ha^{-1}). For calibrating the model, data sets including meteorological data, soil water content and dry mass were collected. Other parameters such as base and upper temperature were adapted from literature.

RESULTS AND DISCUSSION

Results suggested that there was a good relationship between observed and simulated values for selected crop parameters (canopy cover, biomass/ or yield, evapotranspiration and water productivity. However, the model under predicted canopy cover during the first twenty days after planting for Amaranth and Spider flower, but indicated a good match between simulated and observed values near the end of season. The root mean square error was lower (0.11 – 13.2) which suggests that the model had performed very well except for Amaranth and Spider flower water productivity values which were deviating from actual values by approximately 25%.

CONCLUSION

The model was calibrated very well for selected parameters. However, there is a need to validate it with independent data sets which will be collected during 2013/14 season.

Keywords: Amaranth; Spider flower; AquaCrop; water scarcity

EFFECT OF IRRIGATION WITH ANAEROBIC BAFFLED REACTOR (ABR) EFFLUENT ON SWISS CHARD BIOMASS PRODUCTION AND NUTRIENT LEACHING UNDER FIELD CONDITIONS

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INTRODUCTION

Current urban water and waste management systems are unsustainable. There is a need to develop alternative waste management systems to ensure environmental sustainability and affordability. The Decentralized Wastewater Treatment Systems (DEWATS) technology may be suitable for communities living beyond main sewer systems but does not remove nitrogen and phosphorus that could impact negatively on water courses causing algal blooms. Agriculture has the potential to turn the nutrient load into a resource that can be harnessed for irrigation. This study investigated the effect of irrigation with ABR effluent on Swiss chard biomass production and the leaching of N and P from the soil.

MATERIALS AND METHODS

Field experiments were conducted at Newlands Mashu Permaculture Centre, Durban (30°57'E, 29°58'S) to compare ABR effluent irrigation (ABR), tap water with fertilizer (TWF) and rain-fed with fertilizer (RFF). Treatments were applied to 3 x 3 m^2 plots using a randomised complete block design. Wetting front detectors were installed in the soil to determine N and P concentrations at 30 and 50cm depth intervals. Data was collected on fresh mass, dry mass, yield and leached N and P.

RESULTS AND DISCUSSION

Highly significant differences were observed with respect to fresh ($P < 0.001$) and dry mass ($P< 0.05$) in response to ABR and RFF. The TWF treatment differed significantly with RFF ($P < 0.05$) on fresh mass and yield. No significant differences were observed between ABR and TWF on all growth variables (fresh mass, dry mass and yield). Significant differences were observed on nitrate concentration between the 30 and 50cm depths. Nitrates at 50 cm depth could not be conclusively linked to ABR irrigation since nitrate concentrations among the three irrigation treatments did not differ significantly. Phosphorus was mainly concentrated at the 30 cm depth and non-significant amounts were detected at 50cm depth.

CONCLUSIONS

These results clearly show the potential of ABR effluent both as a nutrient and a water source for irrigation particularly during the dry season (winter). The movement of nitrates and phosphates in the soil profile could not be attributed to ABR irrigation because TWF and RFF showed similar concentrations at the 50 cm depth.

ACKNOWLEDGEMENTS

The Water Research Commission is acknowledged for financial support.

Keywords: ABR effluent irrigation, nitrogen, phosphorus, leaching

DYNAMICS OF Zn, Cd, Ni AND Pb IN SLUDGE-AMENDED SOILS PLANTED TO DRYLAND MAIZE AND IRRIGATED MAIZE-OAT ROTATION

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INTRODUCTION

Long-term sludge application in agricultural lands is limited mainly by the accumulation of heavy metals in the soil. To our knowledge, little is known about heavy metal dynamics with respect to the relationship between total, plant available, and water soluble fractions on soils that received sludge according to crop N demand for more than 5 years under contrasting cropping systems (dryland vs. intensive irrigated). The objective of the study was to test three hypotheses: 1) that in the short to medium term (5-10 years) the use of agricultural quality sludge (class A1a) according to crop N requirement will not result in significant increases in water soluble heavy metals in soil; 2) mobility and uptake of heavy metals for irrigated maize-oat rotation will be higher than the dryland maize, and 3) the concentration of heavy metals in plant tissue could reach phytotoxic levels before the soil reaches environmental threshold levels.

MATERIALS AND METHODS

Field experiments were conducted at the East Rand Water Care Works (ERWAT), Johannesburg, Gauteng, South Africa. The soil of the experimental site is a clay loam, with pH (H_2O) of 5.73. Plots of 25 m^2 were arranged in a RCBD comprising four replications of three treatments. The treatments for dryland maize and irrigated maize-oat rotation consisted of two sludge rates (8, and 16 t ha^{-1} yr^{-1}), and a zero rate control. During the 2010/11 growing season plant and soil samples were taken for chemical analysis after seven years of sludge application.

RESULTS AND DISCUSSION

A large fraction of Zn, Ni, and Pb in the soil profile was EDTA extractable (46-79%), while the EDTA extractable fraction of Cd, and saturated paste extractable concentrations of Cd and Pb were below the method detection limit (<1 ppb). The increase in total Ni concentration towards the bottom of the soil profile, under irrigated 8 and 16 t ha^{-1} treatments are clear indicators of potential leaching below the active root zone (1.2 m). Plant uptake of Zn, Cd, Ni, and Pb was higher under irrigation. Concentrations of these selected metals in the plant tissue of both cropping systems remained well below phytotoxic levels, except for Zn under dryland maize that received 16 t ha^{-1} yr^{-1} of sludge. However, concentrations of selected metals in the soil profile after 7 years of sludge application were far below the total maximum threshold levels.

CONCLUSIONS

Monitoring the upper 0.3 m plough layer for potential heavy metal accumulation based on the soil threshold levels set in the current South African sludge guideline may not necessarily indicate low heavy metal uptake by plants and negligible potential heavy metal leaching.

ACKNOWLEDGEMENTS

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Keywords: Sludge; heavy metals; phytotoxicity; soil threshold level, maize

GLYPHOSATE RESISTANCE IN *Conyza bonariensis*

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INTRODUCTION

The introduction of glyphosate-resistant crops caused a significant increase in the use of glyphosate. Basically, the high weed control efficacy and consequent popularity of glyphosate has led to overreliance on this herbicide as a sole weed control method in cropping systems, which promoted the evolution of weed resistance to the herbicide. In South Africa, *Lolium rigidum, Conyza bonariensis* and *Plantago lanceolata* have been reported to have evolved resistance to glyphosate. There have been reports that *Conyza bonariensis* has become increasingly difficult to control especially in no-tillage or minimum-tillage systems (orchards and vineyards), even with the use of herbicides with more than one mode of action. A study was carried out at the University of Pretoria for screening different *Conyza bonariensis* populations to assess levels of glyphosate tolerance in different populations from diverse cropping systems in various regions of the country.

MATERIALS AND METHODS

Seeds of *Conyza bonariensis* were collected from 24 different geographical sites in the summer and winter rainfall regions. Seed collection locations are distributed in both the summer and winter rainfall regions. Seeds were planted 0.5 cm deep in a sand-coir mixture in 12 cm-diameter pots in a greenhouse under controlled temperature conditions. Plants were watered and fertilized as required and thinned to two plants per pot. At the 4-6 leaf stage, plants were treated with glyphosate (Roundup Turbo) at rates of 0, 0.25, 0.5, 1, 2 and 4 times the label recommended rate (2 L/ha). Seven and fourteen DAT, plants were visually evaluated for herbicide damage. Twenty one days after treatment, all the plants were clipped at the soil surface, and fresh mass recorded before being oven-dried to constant weight at 65 ^{0}C and later weighed to obtain dry biomass. Data were subjected to ANOVA using SAS statistical package. GR_{50} values were used to distinguish resistant, tolerant and susceptible biotypes.

RESULTS

Glyphosate rate by location interaction was highly significant. Using GR_{50} values, *Conyza bonariensis* populations were categorized into three categories: ‘susceptible’, ‘tolerant’ and ‘resistant’.

CONCLUSION

Conyza bonariensis with differential tolerance to glyphosate occurs in both the winter and summer rainfall regions. The presence of resistant biotypes poses a serious problem in annual and perennial cropping systems. It is therefore important that mitigation measures be put in place, and existing ones be improved, to not only contain resistance to glyphosate but to also prevent its evolution in locations where resistance has thus far not been reported.

ACKNOWLEDGEMENT

Funding by Monsanto and OWSD is highly appreciated.

Keywords: Conyza bonariensis, glyphosate, weed resistance

THE SEARCH FOR AN EASY PARAMETER FOR DETERMINING AVOCADO FRUIT MATURITY AND EATING QUALITY

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INTRODUCTION

Harvesting fruit at full physiological maturity is essential as it plays a vital role in the eating quality and shelf life of fruit. A variety of maturity parameters exist and in avocado, mesocarp oil (MO) and mesocarp moisture content (MC) are commonly used as such indicators. However, their unreliability can result in unpalatable fruit reaching the consumer. Other maturity indices might be used for judging the quality of avocado. Previous research indicated that 'percentage oil' is neither a reliable indicator of fruit maturity nor quality in late-harvested 'Hass' avocado. The effect of harvesting time on MO and MC was therefore investigated in 'Hass' and 'Fuerte' avocado fruit and the possibility of using total soluble solids (TSS) as a maturity and quality indicator was studied.

MATERIALS AND METHODS

Two cultivars ('Hass' and 'Fuerte') were harvested during the early, mid and late harvesting period from avocado orchards in the cool subtropical area of KwaZulu-Natal, South Africa ($30^{o}161´$E, $29^{o}28´$S). The TSS of freshly harvested fruit was determined by freezing the samples and squeezing liquid out of the thawed fruit which was measured using a digital refractometer (PR-101 ATAGO); MO and MC were analysed according to Blakey (2011).

RESULTS AND DISCUSSION

There were significance differences between harvesting times with respect to percentage MC ($P<0.001$), percentage MO ($P<0.001$) and TSS ($P<0.001$) in both cultivars. In agreement with the findings of Hofman et al. (2000), MO increased between the early and mid-harvest, but declined during the late harvesting period for both cultivars. A similar trend was recorded for TSS; however, the percentage MC consistently decreased from early to the mid to the late harvesting period.

CONCLUSION

Results indicate that MC is a parameter better reflecting avocado fruit maturity than MO; TSS may be used as an alternative to MO as a maturity indicator of avocado fruit.

REFERENCES

Blake R. 2011. Management of avocado postharvest physiology. PhD thesis, University of KwaZulu-Natal, South Africa.

Hofman PJ, Jobin-Décor, Giles MJ. 2000. Percentage of dry matter and oil content are not reliable indicators of fruit maturity or quality in late-harvested 'Hass' avocado. *HortScience* 35:694-695.

Keywords: Avocado, maturity, eating quality, total soluble solids

INTERACTIONS BETWEEN STREAM CHANNEL INCISION, SOIL WATER LEVELS AND SOIL MORPHOLOGY IN A WETLAND IN THE HOGSBACK AREA, SOUTH AFRICA

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INTRODUCTION

Wetland degradation in the form of channel incisioning can significantly alter the hydrological functioning of a wetland. A study was done in a small headwater wetland in the Hogsback area, Eastern Cape Province. In this study the influence of channel incision on water levels and soil morphology are studied on a stream with varying degrees of channel incision. This research will address two important questions 1) how do the degree of channel incision influence water levels, 2) are changes in the water regime evident in the soil morphology.

MATERIALS AND METHODS

The data was collected from 29 piezometers in the study area is a wetland of approximately 5 ha in the Hogsback region. Soils were described and classified, with specific reference to micromoprhology. Samples were collected at fixed depth intervals for laboratory analyis. Rainfall was recorded with a David rain gauge (0.2 mm tipping bucket) and temperature with a Barologger Edge (Solinst), both installed next to a rehabilitation weir in the south-eastern corner of the study site.

RESULTS AND DISCUSSION

The relationship between depth of water tables and depth of channel incision is in line with the understanding of changing hydraulic head by lowering the outlet with an inverse linear correlation ($R^2 = 0.89$). The response of the observations some piezometers did however not relate to the degree of channel incision implying localised hillslope aquifers supply water at a high rate, balancing the water levels. Gleyic colour patterns occur deeper in profiles impacted by channel incision and are related to the current water table level as the zone of aeration moved lower down the profiles. Reduction morphology was absent in soils with water tables at the surface presumably because high OC contents overshadow reduction/oxidation morphology. OC contents decreased exponentially with an increase of the depth of water tables.

CONCLUSIONS

Soil morphology is a useful indicator of ancient and recent soil water regimes of wetland soils Future studies should focus on quantification of the redox-potential of the water in relation to soil morphological properties.

ACKNOWLEDGEMENTS

The authors acknowledge the Govan Mbeki Research and Development Centre (GMRDC) and the National Research Foundation (NRF).

Keywords: Hydromorphic properties; water regime; wetland hydrology

HERITABILITY OF N_2 FIXATION AND RELATED TRAITS IN ADVANCED BREEDING GROUNDNUT LINES FROM GHANA

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INTRODUCTION

Groundnut is the most important grain legume in Ghana both in terms of production and area under cultivation. Groundnut is known for its high protein and oil. Another attribute of this legume is its ability to fix high levels of atmospheric N_2 when in symbiotic association with soil rhizobia (Dakora et al. 1987). Groundnut can thus serve as biofertilizer in cropping systems to improve soil fertility. It is therefore important that groundnut improvement programs select for superior N_2-fixing traits, in addition to grain yield. However, effective selection for a trait depends on sufficient additive genetic variation for that trait, expressed as its heritability (Sikinarum et al. 2007). The aim of this study was to assess the heritability of N_2 fixation and its related traits in 21 advanced groundnut breeding lines in the Guinea savanna of Ghana.

MATERIALS AND METHODS

A total of 21 advanced breeding lines were arranged in a randomised complete block design at three locations during the 2012 cropping season. Plant sampling was done At flowering, about five plants were dug up per plot, and separated into shoots, roots and nodule. The shoot of each plant was oven-dried (60^oC), weighed, and ground to fine powder (0.50 mm) for $^{15}N/^{14}N$ isotopic analysis. Nitrogen fixation was quantified using the ^{15}N natural abundance method. Percent N derived from atmosphere (%Ndfa) was estimated using the method of Shearer & Kohl (1986) N-fixed per plant calculated as the product of biomass per plant and %Ndfa. Using the REML feature of Genstat 11®, variance components were estimated and heritability as well as genetic correlation was calculated for the traits under study.

RESULTS AND DISCUSSION

The results showed highly significant differences ($p < 0.001$) among the lines for dry matter, N content and N-fixed per plant. Both N-fixed and N content per plant were highly heritable with $h^2 = 0.90$ and $h^2 = 0.88$, respectively. The genetic correlation between N-fixed and dry matter per plant was positive and highly significant ($r_g = 0.85$).

CONCLUSION

The high heritability of these traits suggests that selection can be done to identify high N_2-fixing genotypes. The strong positive genetic correlation ($r_g = 0.85$) observed between N-fixed per plant and dry matter per plant also suggests that dry matter can be used as a surrogate for N_2-fixation in the test lines. This is particularly important in places where technology for accurately measuring N-fixed is not available.

ACKNOWLEDGEMENT

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REFERENCES

Dakora, F.D. et al., 1987. Assessment of N2 fixation in groundnut (*Arachis hypogaea* L.) and cowpea (*Vigna unguiculata* L. Walp) and their relative N contribution to a succeeding maize crop in Northern Ghana. Mircen Journal of Applied Microbiology and Biotechnology, 3(4), pp.389–399. Available at: http://link.springer.com/article/10.1007/BF00935697 [Accessed November 19, 2012].

Shearer, G. & Kohl, D.H., 1986. N_2-fixation in field settings: Estimations based on natural 15N abundance. *Australian Journal of Plant Physiology*, 13(6), pp.699–756. Available at: http://www.aanro.net/VPUBLICATION.html?s=1001,publicationID=83459.

Sikinarum, J. et al., 2007. Heritability and correlation for nitrogen (N2) fixation and related traits in peanut (Arachis hypogaea L.). *Pak. J. Biol. Sci*, 10(12), pp.1956–1962. Available at: http://www.aseanbiotechnology.info/Abstract/23006700.pdf [Accessed June 7, 2012].

Keywords: groundnut, Ghana, heritability, genetic correlation

DEVELOPING STORAGE PROTOCOLS FOR THE SOUTH AFRICAN MACADAMIA INDUSTRY

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INTRODUCTION

In 1990 the 'fledgling' South African macadamia industry marketed 340 tons of kernel – only 3.5% of total world production. By 2011, 6 million trees on 20 000 ha produced 8 500 ton of kernel, making South Africa the biggest macadamia producer in the world. This rapid growth of the industry results in periods where resources for the timeous handling of the crop are insufficient. Nuts spend longer periods in the orchard and are stored for extended periods before processing. The effect of such handling on kernel quality is unknown. Processed kernel is also stored for long periods before consumption, and data to determine optimum storage conditions and the maximum safe storage period is insufficient. It is known that broken kernel is more prone to oxidation than whole kernel, but it is yet to be determined whether this warrants alternate storage protocols. Lastly, the industry lacks protocols for applying reliable sell-by dates to packaged product. The current study aims to address these challenges.

MATERIALS AND METHODS

Commercially packed whole (style 1) and chipped (style 5) kernel were sourced from a macadamia processor in the early, middle and late parts of the 2009 season. Kernel from each combination of style and sampling date (n = 3) was stored at -5°C, 5°C, 15°C or ambient for 6, 12, 18 or 24 months. After storage, the packages were opened to expose the kernel to ambient atmosphere, and held at ambient temperatures for 20 weeks. During this period kernel was monitored for peroxide development (n = 6). An accelerated oxidation test (at 120°C), using expressed oil, was evaluated as a means of predicting shelf life and applying sell-by dates.

RESULTS AND DISCUSSION

Kernel quality declined through the season, with late-processed kernel having a shorter shelf life than those processed early in the season. It was also shown that chipped kernel has a shorter shelf life than whole kernel. All kernel stored at 5°C or less was marketable after 24 months, regardless of style or harvesting time. Kernel could be held at 15°C for up to 18 months with the exception of late season kernel. Chipped kernel could not be stored above 5°C for 24 months, regardless of harvesting time. While the current recommended kernel storage temperature (15°C) was shown to be adequate for whole kernel, lower storage temperatures are required for broken kernel. The accelerated oxidation test showed good correlation with shelf life and may offer a means for applying sell-by dates to individual batches.

CONCLUSIONS

The industry standard of 15°C storage results in kernel quality decline when produce is stored for more than 18 months, particularly for chipped kernel. A temperature of 5°C would better maintain kernel quality when storage is expected to exceed 12 months. The accelerated oxidation test may provide a means for setting kernel sell-by dates.

ACKNOWLEDGEMENTS

The ARC, SAMAC and THRIP are gratefully acknowledged for funding this work.

Keywords: Macadamia, quality, cold storage, peroxide

RESPONSE OF QUALITY PROTEIN MAIZE INBRED LINES TO SEEDLING DROUGHT STRESS

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INTRODUCTION

The Eastern Cape is predominately semi arid and characterized by erratic rainfall and drought. Production of maize in the province is therefore constrained by drought stress. Screening for drought tolerance has mostly been focused on the vegetative to flowering stages, with little attention being paid to tolerance at seedling stage. Occurrence of drought at seedling stage results in reduced plant populations and yields. Genetic variation has been identified for seedling traits that are associated with tolerance to drought in maize (Meeks et al, 2013). The objective of this study was to identify maize genotypes that are tolerant to seedling drought stress.

MATERIALS AND METHODS

The study was conducted at the University of Fort Hare in a glasshouse under drought stress (DS) and well watered (WW) conditions. Six drought indices based on total dry weight (TDW) were assessed for their suitability to discriminate genotypic responses to drought. The indices were, tolerance index (TOL), mean productivity (MP), geometric mean productivity (GMP), drought susceptibility index (DSI), yield index (YI) and stress tolerance index (SSI). Data was subjected to analysis of variance (ANOVA), correlation analysis and principal component analysis using JMP.

RESULTS AND DISCUSSION

Significant variation ($P< 0.05$) was observed among inbred lines and drought indices under DS and WW conditions. The following indices; STI, MP, GM, DSI and YI were significantly ($P < 0.05$) correlated with TDW under DS, while TOL, STI and MP were significantly ($P < 0.05$) correlated with TDW under WW conditions. Inbred lines L2, L3, L6, L9, L10, L11, and L16 were the most drought tolerant. Among inbred lines that were previously classified as drought tolerant at flowering stage, 29% exhibited drought tolerance at seedling stage. This necessitates identification of drought tolerant genotypes at both stages to enhance whole crop tolerance.

CONCLUSIONS

Drought indices MP and STI were the most useful indicators of drought tolerance. Drought tolerant inbreds that were identified can be used as parents in breeding programs targeting drought prone areas.

REFERENCES

Meeks M, Murray SC, Hague S, Hays D, 2013. Measuring maize seedling drought response in search of tolerant germplasm. *Agronomy*. 3, 135-147.

ACKNOWLEDGEMENTS

Govan Mbeki Research and Development Centre is acknowledged for funding the project.

Keywords: Maize seedling, drought stress, drought tolerance index

RADIO AS A WEATHER FORECAST INFORMATION DISSEMINATION TOOL: A CASE STUDY OF THE LIMPOPO AND NORTH WEST PROVINCES

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INTRODUCTION

Poor communities have few resources for day-to-day subsistence, with limited reserves for emergencies, which makes them vulnerable to natural disasters related to weather and climate. Efficient communication of uncertainty of the seasonal forecast is vital to such communities. It allows them to make better decisions that are attuned to the reliability of the forecast. Well-timed and correct dissemination method also helps to manage the expectations of users for accurate forecasts received (Archer *et al.,* 2007).

MATERIALS AND METHODS

In an attempt to disseminate weather forecast information to communities in the Limpopo and North West Provinces, two radio stations were selected, namely Capricorn FM which broadcasts in English and Sepedi in Limpopo, and North West FM which broadcasts in English and Setswana in North West. A 30-minute talk show was broadcast during the second week of each month for a period of 6 months on each station. The efficiency of using radio as one of the methods to disseminate weather forecast information was evaluated. A web-based questionnaire was developed to evaluate the impact of the information discussed on the radio. The questionnaire was hosted on the ARC's website and the seasonal weather forecast discussed was also uploaded after the show.

RESULTS AND DISCUSSION

A total of 96 properly completed questionnaires were captured on the system. The number of people accessing the website and the questionnaire increased during the week of the talk show, because of the continuous of awareness on the radio. The percentage of questionnaire respondents endorsing television as a preferred method of weather forecast communication were 43%, secondly radio at 35% and thirdly cell phone at 22%. Radio as a method of weather forecast information dissemination indicted a high percentage of weather and agricultural content relevance as compared to television. The understanding of meteorological phenomena was clearly a limiting factor to many users as a high number of respondents did not understand what "normal rainfall" is.

CONCLUSION

In order to communicate weather forecasts effectively so that benefit is derived from such information, basic training in the form of radio programmes is recommended.

REFERENCES

Archer, E., Mukhala, E. and Walker, S., 2007. Sustaining agricultural production and food security in southern Africa: an improved role for climate prediction. *Climate Change* 83:287-300.

Keywords: seasonal weather forecast, climate

DIVERSITY OF NODULE-FORMING BACTERIA ISOLATED FROM ROOIBOS TEA PLANTS (*Aspalathus linearis* subsp*. linearis*) GROWN IN THE CAPE FYNBOS

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INTRODUCTION

Aspalathus linearis subsp*. linearis*is a legume endemic to the Cape Fynbos and is grown as a source of beverage called Rooibos tea. As a legume, *A. linearis* can contribute over 100 kg $N.ha^{-1}$ via symbiosis with diverse soil bacteria. This level of N contribution helps to improve soil fertility, in addition to growing the South African economy by over R500 million annually (Joubert et al*.* 2011). A number of studies have evaluated plant growth, mineral nutrition, nodulation and N_2 fixation in *A. linearis* within limited sites in the Cape. The aim of this study was to isolate, characterize, and assess the symbiotic ability of soil bacteria nodulating *A. linearis* across the Rooibos tea-growing region of South Africa.

MATERIALS AND METHODS

Five plants per farm were arbitrarily sampled from 2 natural and 18 cultivated sites covering the major Rooibos tea-growing areas in South Africa. At each farm ten nodules per plant were collected and kept at 4°C prior bacterial isolation. Bacterial isolation, biochemical and phenotypic characterization were done on yeast-mannitol agar (YMA) and observed over the period of two weeks. To test the ability of bacterial isolates to infect *A. linearis* authentication was carried out as described by Vincent (1970).

RESULTS AND DISCUSSION

Out of the 702 bacterial strains isolated from root nodules of *A. linearis*, 62.1% were fast-growing, 23.5% intermediate in growth rates, and 14.1% slow-growing, based on bromothymol blue pH indicator and number of days they took to appear on YMA. Furthermore, bacterial isolates exhibited variation in shaped, appearance and exo-polysaccharide production. In total, 9 fast-growers, 10 intermediate, and 6 slow-growers were symbiotically effective in forming root nodules on *A. linearis* plants, an indication of the diversity of bacteria that nodulate this host plant. The remaining isolates failed to induce nodulation on *A. linearis*. The non-nodulating bacterial isolates were either external contaminants, nodule endophytes or rhizobia that had lost their nodulation ability.

CONCLUSION

Whatever the case, the phenotypic characterization from this study suggests that the bacteria nodulating *A. linearis* are quite diverse.across the Rooibos tea-growing region of South Africa, a finding that has ecological and economic implications.

ACKNOWLEDGMENTS

The South African Research Chair in Agrochemurgy and Plant Symbioses, the National Research Foundation, and Tshwane University of Technology are acknowledged for their financial support.

REFERENCES

Joubert, E., De Beer, D., 2011. Rooibos (*Aspalathus linearis*) beyond the farm gate: from herbal tea to potential phytopharmaceutical. SAJB 77, 869-886.

Keywords: Aspalathus linearis, root nodulating bacteria, soil fertility, South African economy

SYMBIOTIC PERFORMANCE AND WATER-USE EFFICIENCY (WUE) OF INOCULATED BAMBARA GROUNDNUT (*Vigna subterranea* L. Verdc.) GENOTYPES

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INTRODUCTION

Soil moisture and mineral nutrients are the most limiting factors affecting crop production in Africa. Grain legumes are important food and nutritional security crops because of the high dietary protein and minerals in their edible grain. In Africa, Bambara groundnut is the second most important indigenous food grain legume, after cowpea. However, it has remained under-utilized.

The aim of this study was to evaluate Bambara groundnut landraces for their response to inoculation, as well as measure water-use efficiency in the Guinea Savanna of Ghana.

MATERIALS AND METHODS

Four Bambara genotypes; Blackeye, Simisogla, Dagbangsimie and Simipilaa, were planted in a split plot design with inoculation and variety as the main treatment and sub-treatment, respectively. At 75% flowering, gas exchange measurements were taken using an infra-red gas chromatograph (LI-6400XT Portable Photosynthesis System). Five to 10 plants per plot were sampled for nodulation assay, and measurement of growth, gravimetric water-use efficiency, and symbiotic N_2-fixation.

RESULTS AND DISCUSSION

Nodule number, nodule mass, $d^{15}N$, %Ndfa, and amount of N-fixed varied significantly among the genotypes. Simisogla recorded the lowest $d^{15}N$ value, and therefore fixed the highest amount of symbiotic N (54 kg ha^{-1}). The genotypes also differed in their WUE, as well as in shoot dry matter, shoot C content, $d^{13}C$ and C:N ratio. Although the genotypes did not respond to inoculation, applying inoculants to Bambara groundnut plants decreased gravimetric water-use efficiency.

CONCLUSION

The Bambara groundnut genotypes showed marked differences in plant growth, nodulation, symbiotic performance and water-use efficiency.

Keywords: Nodulation, N2 fixation, d13C and amount of N-fixed

OPTIMISING CULTIVAR CHOICE FOR FROST-PRONE ENVIRONMENTS IN SOUTH AFRICA: INSIGHTS INTO BREEDING STRATEGIES, FROST TOLERANCE, AND POST-FROST DETERIORATION

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INTRODUCTION

Frost in the midlands region of South Africa often limits sugarcane (*Saccharum* spp.) yields. Advanced breeding trials do not cater for frost conditions, and information on frost tolerance of cultivars is lacking. The objectives of this study were to (i) evaluate the performance of quick maturing cultivars suited to warmer regions compared to standard temperate cultivars in frost areas; (ii) determine cultivar differences in post-frost cane deterioration; (iii) gain insights into site similarity (frost sites on sandy vs. humic soils) and standard cultivars to develop breeding strategies; and to (iv) investigate temperature differences within cultivar canopies as a possible mechanism for frost tolerance.

MATERIALS AND METHODS

Four cultivar trials established at frost-prone sites were analysed. Trials were established in RCBDs with 4-6 replicates. Cultivar sets tested in each trial varied, but could be categorized into control and test groups. Cane yield (TCANE), estimated recoverable crystal (ERC), and ERC yields (TERC) were determined at each harvest (3 to 5 ratoon crops per trial). Genotype + genotype x environment (GGE) Biplot analysis was used to investigate site similarities and identify suitable check cultivars for future breeding trials. Sucrose samples were taken at 2-3 week intervals after each major frost event to determine rates of quality deterioration of different cultivars.

RESULTS AND DISCUSSION

Cultivar x season interactions were significant ($P<0.05$) for TCANE, ERC and TERC in all trials. As a group, test cultivars showed 4, 9, and 2% reductions in TCANE compared to standard cultivars in three trials. In contrast, ERC and TERC of test cultivars were 24, 15, and 29; and 21, 6, and 27% higher than the standards. Rates of post-frost deterioration in three crops were 0.7, 1.3, and 1.7 g ERC/stalk/week for test cultivars compared to 1.5, 1.7 and 2.1 g ERC/stalk/week for controls, respectively. Cultivar N36 showed significantly higher daily minimum temperatures at the apical meristem compared to other cultivars. This was coupled with slower rates of sucrose deterioration compared to other cultivars. The GGE biplot analysis showed that frost pockets on both humic and sandy soils are necessary when developing a breeding strategy, and that cultivars N36, N41 and N48 will be suitable test cultivars for use in future breeding trials.

CONCLUSIONS

Cultivars developed in warmer regions of the industry showed superior performance to standard, temperate cultivars developed for the midlands region. Such cultivars should be used as checks in future breeding trials, which should be established on both sandy and humic soil types.

Keywords: frost, genotype x environment, post-frost deterioration, sugarcane

OCCURRENCE AND DISTRIBUTION OF SUNFLOWER DISEASES IN SOUTH AFRICA DURING 2012/13 SEASON

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INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the most important oilseed crop in South Africa and is used as a primary rotation crop planted in maize/alternate crop systems in the drier western crop production areas. Diseases like *Sclerotinia* stalk and head rot, *Alternaria* leaf spot, Downy mildew and Sunflower rust can cause moderate to high yield losses. These diseases are potential risks to sunflower production depending on seasonal conditions and geographic locality. Recently, increased queries and reports from producers, regarding possible shifts in sunflower disease dynamics, have necessitated the need for seasonal surveys to determine which diseases predominate in which areas and on which cultivars.

MATERIALS AND METHODS

A minimum of 24 sunflower production sites were screened and rated for diseases. The sunflower disease survey was conducted on cultivar trials managed by the ARC and various seed companies as well as sunflower producer's farms. Where cultivar trials were surveyed, four cultivars (SY4045, PHB65A25, SY4200 and PAN7049) were selected and incidence and severity of the predominant diseases quantified. In producers' fields, 30 plants were randomly selected at three sites within the same field. Disease incidence and severity was quantified for each disease observed. A questionnaire pertaining to sunflower farming practices was compiled and completed by farmers during the survey.

RESULTS

Diseases such as *Alternaria* leaf spot, *Sclerotinia* head rot and White rust occurred in different surveyed sunflower production areas, whereas diseases such as Brown rust and *Phoma* stalk rot were observed to be particularly damaging at specific localities. Results obtained from cultivar trials indicated that disease severity caused by *Alternaria* leaf spot on all four cultivars ranged between 44-54% in Bainsvlei, 50-61% in Delmas and 51-81% in four plantings in Potchefstroom. Results of the severity of *Alternaria* leaf spot quantified in farmers/producers fields ranged between 18-60% in all areas surveyed. Other prominent diseases in specific farmers/producers fields such as Brown rust (84%-Arlington), *Sclerotinia* head rot (31%-Delmas) and *Phoma* stalk rot (96%-Naboomspruit) were observed. The questionnaire data showed that diseases, poor emergence and drought are the major constraints to sunflower producers.

CONCLUSION

It is well known that disease incidence and severity are seasonal in nature due to changes in seasonal climatic conditions. This continual variation in disease incidence and severity highlights the significance of multi-seasonal surveys which will identify and prioritise diseases of major concern to sunflower producers over time.

Keywords: Sunflower, diseases, survey

WEED RESISTANCE TO GLYPHOSATE: CASE OF MISTAKEN CLASSIFICATION OF A *Chloris virgata* POPULATION

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INTRODUCTION

More than 400 weed species have developed resistance to herbicides across the spectrum of existing mechanisms of action. Considering the extensive use of glyphosate since commercialization about four decades ago, relatively few weeds have developed resistance to it. Globally, glyphosate resistance has been proven for 24 weed species, of which three also occur in parts of the Western-Cape. It is imperative that cases of mistaken or false weed resistance not confound this highly important issue. A case in point is an investigation conducted at UP to determine if rumors of glyphosate-resistant *Chloris virgata*, which emanated from certain crop producers in the Springbok Flats region, were true or not.

MATERIALS AND METHODS

Seeds of *C. virgata* were collected from three different geographical locations: Naboomspruit (Limpopo), Oudtshoorn (Western Cape) and Lichtenburg (North West Province). Seeds were planted in a sand-coir mixture in 12 cm diameter pots in a temperature-controlled greenhouse at the UP phytotron facility. Plants were watered and fertilized to avoid water and nutrient stress. At the 3-5 leaf stage, plants were treated with glyphosate (Roundup Turbo) at rates of 0, 0.25, 0.5, 1, 2 and 4 times the label recommended rate (2 L/ha). Plants were visually evaluated for herbicide damage. The plants were clipped at the soil surface at 21 DAT, and fresh mass recorded before oven-dried at 65 ^{0}C for dry biomass measurement. Data were subjected to ANOVA using SAS statistical package, and means were compared using Tukey's test.

RESULTS

The Naboomspruit population was significantly more tolerant towards glyphosate than both the Lichtenburg and Oudtshoorn populations. At 7 DAT, at the 1x glyphosate rate, the Naboomspruit population were showing clear glyphosate injury symptoms, whereas the other two populations were close to death or dead at the same herbicide rate. Death of the Naboomspruit plants occurred after 14 DAT.

CONCLUSION

Chloris virgata from the Naboomspruit district was not resistant to glyphosate but clearly can be considered 'hard to control'. It would require that farmers adhere strictly to label recommendations for Roundup Turbo, or any other glyphosate-containing product. The investigation reconfirms the need for proper scientific investigation of glyphosate resistance that must be performed by researchers who follow scientifically sound protocol.

ACKNOWLEDGEMENT

The study was done in the Monsanto/BEatUP Collaborative Research Programme at the University of Pretoria.

Keywords: Chloris virgata, glyphosate, herbicide resistance

WEED RESISTANCE TO GLYPHOSATE: OVERVIEW OF THE MONSANTO/BEATUP COLLABORATIVE RESEARCH PROGRAMME

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INTRODUCTION

Glyphosate is the most popular and arguably the most effective herbicide the world has ever seen, and Roundup Ready crops have been lauded as the most significant technological development in agriculture in 100 years. Compared to other important herbicides, weed resistance to glyphosate is limited (24 weeds globally), given the total number of resistant weeds to all herbicides combined exceeds 400, with more than 180 of these resistant to ALS inhibitors alone. The Monsanto/BEatUP Collaborative Research Programme (3-year duration) was launched in Sept 2012, with core research focus the gaining of more knowledge about glyphosate-resistant weeds in the whole of South Africa, including the elucidation of plant mechanisms contributing to glyphosate resistance, as well as mechanisms causing tolerance towards the herbicide.

MATERIALS AND METHODS

Research approach is to firstly screen selected weed species for tolerance/resistance towards glyphosate. Weed seeds of selected species are collected from diverse geographical locations in both the summer and winter rainfall regions for testing in the greenhouse. Based on growth responses to a range of glyphosate rates the different populations of a particular species are grouped into three categories: sensitive, tolerant, and resistant. Further investigation seeks to identify plant mechanisms involved in conferring sensitivity/tolerance/resistance on a particular population. Research covers the key steps in glyphosate mode-of-action, i.e. from absorption by leaves, translocation in the plant system, to the site-of-action.

RESULTS

Research findings will amend current and perhaps even inform the development of new strategies aimed at the curtailment and avoidance of evolvement of glyphosate-resistant weeds. An outcome with direct bearing on weed management at farm-level is the ‘Best Management Practices’ that are bound to flow from the research findings.

CONCLUSION

Generation of new knowledge is likely to boost understanding of weed resistance towards glyphosate, which would make possible the fine-tuning of existing resistance management strategies, and even the development of new approaches to contend with this daunting challenge.

ACKNOWLEDGEMENT

Funding by Monsanto is gratefully acknowledged.

Keywords: glyphosate, weed resistance, herbicide resistance, weed control

SOIL MICROBIAL ENZYMATIC RESPONSES TO FERTILISER MIXTURES IN TWO SOILS UNDER MAIZE PRODUCTION

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INTRODUCTION

Maize production relies heavily on fertilisers for secure food production. The nutrition and production of these crops cannot be understood by only focussing on fertilisers, but also the biology of the soil (Adesemoye & Kloepper 2009). Overuse of fertilisers may have detrimental impacts on the soil microbial life. The use of different chemical fertiliser mixtures may lessen harmful effects on microbial activity in our agricultural soils leading to probably a more diverse and balanced microbial composition (Sarathchandra et al. 1993). An increased and diverse microbial population may cycle nutrients more efficiently. The study aimed to assess the effects of various chemical fertiliser mixtures on soil microbial enzyme activity in two soil types under local maize production.

MATERIALS AND METHODS

A maize pot experiment comprising of a sandy and loamy sand soil, typical of local maize producing areas were conducted. Treatment combinations of ammonium gas (simulated), ammonium sulphate, black urea, urea, LAN, MAP, superphosphate, potassium chloride and potassium sulphate applied at two rates (zero and optimal recommended rate) were administered to the soil. Soil samples were collected periodically till 90 days after planting. Only soil samples collected at day 90 were subjected to microbiological tests that included enzyme assays *viz.* ß-glucosidase, and urease.

RESULTS AND DISCUSSION

In the loamy sand soil, the highest ß-glucosidase activity was detected at optimal rates in the combination comprising ammonium sulphate, superphosphate and potassium sulphate, whilst no significant differences were detected in the sandy soil. The highest urease activity was detected at the optimal N (simulated ammonium gas) and P (MAP) rates combined with zero K (potassium sulphate) in loamy sand soil. But when N (simulated ammonium gas) and K (potassium chloride) were applied optimally with zero P (MAP) rates, the highest urease levels were detected in the sandy soil.

CONCLUSIONS

Soil microbial enzyme activity was not always enhanced by the addition of fertiliser. Microbial enzyme activities increased when N and P sources such simulated ammonium gas, and MAP were applied to various soil types. Biomass was positively affected by the addition of N sources such as simulated ammonium gas, ammonium sulphate and LAN.

REFERENCES

Adesemoye, AO, Kloepper JW, 2009. Plant-microbe interactions in enhanced fertilizer-use efficiency. *Applied Microbiology and Biotechnology*, 85: 1 - 12.

Sarathchandra SU, Lee A, Perrot KW, Rajan SSS, Oliver EH, Gravett IM, 1993. Effects of Phosphate Fertilizer applications on Microorganisms in Pastoral Soil. *Australian Journal of Soil Research*, 31: 299 - 309.

ACKNOWLEDGEMENTS

Maize trust for financial support.

Keywords: fertiliser mixtures, maize production, soil microbial enzymes

CROP NUTRITION AND SOIL TEXTURAL EFFECTS ON *Eldana saccharina* DAMAGE IN SUGARCANE

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INTRODUCTION

The stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (eldana) causes substantial economic losses in the South African sugar industry. Increased nitrogen (N) application, especially when crops are stressed, reportedly leads to increased eldana damage. In contrast, silicon (Si) provision (in soils with low available Si levels) can reduce eldana damage and ameliorate abiotic stress, including moisture stress. Sugarcane growers in eldana-prone areas are thus often encouraged to apply Si, and reduce N application rates by 10-30 kg/ha. Reducing N rates, however, can result in serious yield losses. The objective of this study was to use field trial and survey data to elucidate the effects of soil properties on eldana damage, and to revisit the justification for reducing N rates to limit this damage.

MATERIALS AND METHODS

Data from 17 harvested crops in ten N response trials, with N rates varying from zero to well in excess of crop requirements for optimum growth, were used to evaluate the effect of N rate on eldana damage. In addition, a survey was carried out in 23 fields on ten commercial sugarcane farms in the KwaZulu-Natal North Coast and Midlands South regions, to investigate associations between soil characteristics, soil Si levels and eldana damage.

RESULTS AND DISCUSSION

Only three of the 17 crops harvested in the N-response trials showed an increase in eldana damage with increasing N application rate. None of these is likely to have shown any reduction in damage if N rates had been reduced by the 10-30 kg/ha currently recommended (assuming linear extrapolation between N rates).

The field survey revealed that eldana damage was higher in sugarcane grown on soils with < 10 mg/L Si (Figure 1A). Damage increased markedly on soils with decreasing clay and soil organic matter (SOM) content (R^2 = 0.76, n = 23, Figure 1B), as reflected by higher soil density. This relationship has not previously been reported.

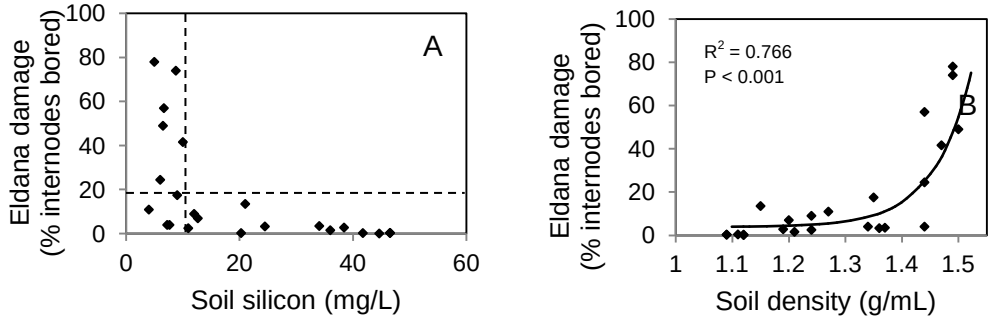

Figure 1: Relationship between eldana damage and (A) 0.01 M $CaCl_2$-extractable soil Si and (B) soil density (measured after sieving to = 1 mm).

CONCLUSIONS

These findings indicate that: 1) sugarcane crops grown on soils with Si > 10 mg/L and high clay and SOM contents are less likely to experience high levels of eldana damage, and 2) the current practice of curtailing N application rates in an effort to reduce eldana damage inevitably results in yield reductions and appears unwarranted.

Keywords: Eldana saccharina, organic matter, nitrogen, silicon, soil texture, volume weight

GROUNDNUT (*Arachis hypogaea* L.) CULTIVAR RESULTS FOR THE PERIOD 2006-2012

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INTRODUCTION

The Groundnut Industry of South Africa relies on a constant supply of high quality groundnut seed to provide prospective buyers with a reputable product. To the producer on ground level, the important factors that are taken into consideration to produce groundnuts are the yield obtained and what the value of that yield will be. The value of the crop is influenced by the grading quality obtained. A review of the performance of groundnuts in the National Groundnut Cultivar Evaluation Trials will be conducted by evaluating best performers per season as well as overall best performers in regards with the yield obtained and the quality of the yield over the period from 2006 to 2012.

MATERIALS AND METHODS

Over the past six growing seasons, starting in 2006, groundnut cultivar trials were conducted at twelve localities across the major groundnut production areas of South Africa. Fourteen cultivars and lines were tested. Each year up to 17 trials were divided into three groups; irrigated/sprayed (7), irrigated/not sprayed (3) and dry land trials (7). The irrigated/sprayed and dry land trials were given preventative applications of fungicides for foliar diseases whereas the irrigated/not sprayed trials weren't given the preventative applications of fungicides. Standard agricultural practices were used for cultivation. The trials were harvested and yield- and grading qualities were recorded. Data acquired were statistically analyzed to acquire data of relevance within a significant probability of 95%.

RESULTS AND DISCUSSION

Results indicated that over a six year period Anel, Tufa and ARC-Opal constantly performed well under dry land and irrigated conditions. Groundnut production under dry land is bound to vary considerably over seasons and localities. The erratic nature of rainfall necessitates a cultivar well adapted to erratic climatic behavior. Statistical analysis of the yield stability for the 14 lines and cultivars tested, indicated a high probability of yield stability for Anel and ARC-Opal over the past six years.

CONCLUSIONS

Long term testing of cultivars and lines increases the quality of data obtained as well as the inclusion of different seasonal conditions under which testing was done to ensure high quality data. Large data sets enable better selection of lines for registration and ensuring high quality and stable yielding cultivars for the groundnut industry.

Keywords: quality, yield, dry land, irrigation

PERFORMANCE OF COMMON BEAN IN RESPONSE TO INOCULATION AND P APPLICATION IN ETHIOPIA

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INTRODUCTION

The supply of mineral nutrients, especially P, is crucial for plant growth, grain yield and N_2 fixation in legumes (O'Hara, 2001). Rhizobial inoculation of common bean plants especially where P is applied, can improve symbiotic performance and yield (Zaman-Allah et al., 2007). In nutrient-poor soils that are typical of Ethiopia, studies of rhizobial inoculation and P supply are necessary for increased yields of common bean. This study evaluated the effect of *Rhizobium* inoculation and P application on symbiotic performance and yield response of two common bean genotypes grown at three sites in Ethiopia.

MATERIALS AND METHODS

Three split plot field trials were carried out at Hawassa, Ziway and Galalicha in Ethiopia under rainfed condition during the 2012 cropping season. The treatments consisted of four levels of P (0, 10, 20 and 30 kg P ha^{-1}) allocated to the main plots, three inoculation levels (uninoculated, inoculated with strain HB 429 and TG 9) and two common bean genotypes (Hawassa-Dume and Ibbado) applied to sub plots. At mid-flowering stage six plants per plot were sampled to determine nodulation, nodule number, growth and symbiotic performance. The plants were separated into shoots, roots and nodules, oven dried at 60 °C for 48 hr, after which dry matter was determine. The dried shoots were ground into fine powder (0.85 mm sieve size) for ^{15}N isotopic analysis. Yield data were taken from 10 plants from the three central rows at physiological maturity. The data was analysed using SAS 9.0. Where significant differences were shown, the means were separated using Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$.

RESULTS AND DISCUSSION

The inoculated Hawassa-Dume genotype recorded greater nodule number and nodule dry matter per plant when grown with 30 kg P ha^{-1} at Hawassa. However, the dry matter yield of roots, shoots and whole plants were much greater in the Ibbado genotype. %N was higher in Hawassa-Dume than Ibbado at the Hawassa site, while inoculation had no significant effect on %N. A 4-way ANOVA showed low $\delta^{15}N$ in shoots of Hawassa-Dume plants at Galalicha, and these values were lowest with *Rhizobium* stain HB 429 and 30 kg P ha^{-1} supply. As a result, Ndfa percentage of Hawassa-Dume was higher at Galalicha when inoculated with strain HB 429 and supplied with 30 kg P ha^{-1}. At Ziway, the amount of N-fixed by Hawassa-Dume was greater with strain HB 429 and supplied with 30 kg P ha^{-1}. Similarly, at Hawassa, the yield of inoculated Hawassa-Dume genotype supplied with 30 kg P ha^{-1} was significantly higher than that of Ibbado genotype.

CONCLUSION

These findings suggest that inoculating Hawassa-Dume with *Rhizobium* strain GT 9 with the application of 30 kg P ha^{-1} can improve the symbiotic performance and grain yield of common bean in these or other similar environments in Ethiopia.

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Keywords: Common bean, grain yield, nodulation, phosphorus, *Rhizobium* inoculants

SHOULD ORGANIC N BUDGETS INCLUDE RESIDUAL N?

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INTRODUCTION

Manures supply N for several seasons of crop production. Soil organic N from manures continues to mineralize during off-season periods adding inorganic N to the residual N pool that could benefit subsequent crop production. Environmental factors such as temperature and soil moisture affect the amount and rate of residual N mineralized in the soil. Our study objectives were to (i) determine the amounts of residual N mineralized from poultry manure applied to winter wheat (*Triticum aestivum* L.) and summer cotton (*Gossypium hirsutum*) – corn (*Zea Mays* L.) cropping systems, (ii) evaluate the effects of temperature on poultry manure residual N mineralization and (iii) quantify the fate of N from poultry manure applied to winter wheat and two summer crops in developing N budgeting on a mass balance basis.

MATERIALS AND METHODS

Post-harvest soil samples (0 – 15 cm) from plots that received poultry manure for winter wheat or cotton-corn summer crops were incubated in the dark at 10, 20 and 30 ^{0}C in constant temperature incubators for 112 days. Inorganic N (NH_4^+ + NO_3^-) mineralized from these soil samples were determined over time.

RESULTS AND DISCUSSION

The largest amounts of residual N were mineralized from poultry manure at 30 ^{0}C. Residual soil mineralizable N accounted for 3 – 9 % of the applied N with no significant difference between poultry manure types. First year crop N removal was less than 50% (e.g. wheat 27 – 31%, cotton and corn 6 – 28%) of the applied N, but only a fraction of the remaining N can be detected in residual soil N mineralizable forms.

CONCLUSIONS

A large proportion of poultry manure N unaccounted for could be either lost from the system or remain in recalcitrant soil forms.

REFERENCES

Savala, C.E.N. 2013. Verification of poultry manure nitrogen availability and fertilizer nitrogen equivalence coefficients for crop production in North Carolina soils. PhD Dissertation, North Carolina State University, USA.

ACKNOWLEDGEMENTS

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Keywords: Manures, mineralizable, nitrogen, organic, residual, temperature

CMAPPING: MIND MAPPING WITH A TWIST. A USEFUL TOOL FOR UNDERGRADUATE TEACHING AND POSTGRADUATE TRAINING

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The use of mind, bubble or concept maps is by no means a new idea and they are commonly used by students during studies or project design. However, the way concept maps are constructed has been adapted ever so slightly, which has decidedly improved the applicability to undergraduate and postgraduate education.

Have you ever wondered if your postgraduate student truly understands the conceptual nature of their research? Whether they have made the connections between data collected and research question(s) asked, and how the chapters of their thesis fit together contextually? Cmapping proves to be a very useful tool to assess postgraduate insight into their projects and how they conceptualise their entire thesis.

As an undergraduate lecturer I struggle to make students understand the link between knowledge taught at the beginning of a module and that taught at the end, as well as across modules. Cmapping has helped to de-compartmentalise student learning, by allowing them to see the linkage between informational pockets.

The goal of this presentation is to introduce the idea of Cmapping and associated software, as well as to discuss the potential uses of Cmapping as a tool for postgraduate and undergraduate education.

Keywords: lecturing, Cmapping, Mind maps,

MAIZE-COWPEA ROTATION AND INTERCROPPING EFFECTS ON COWPEA YIELD

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INTRODUCTION

Cowpea is traditionally grown by small scale farmers as mixed or relay crop in association with cereals. The practice of increasing yield by crop rotation has been known for many years. The positive effect of crop rotation on yield arises from the added nitrogen from legume in the cropping system. The aim of the study was to determine the effect of cropping system, site and nitrogen fertilization on cowpea yield.

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. It featured three cropping systems namely maize and cowpea monocropping, a maize cowpea rotation and a maize cowpea intercropping. Nitrogen fertilizer was applied in plots of cowpea at two rates of 0 and 20 kg N ha^{-1} at Potchefstroom, 0 and 23 kg N ha^{-1} at Taung and 0 and 17 kg N ha^{-1} at Rustenburg, due to the recommended dosages after soil analysis per location. The experimental design was 3 x 3 x 2 factorial experiment laid out in randomized complete block design with three replications. The measured yield parameters were pod length, seed per pod; pod mass at harvest, biomass and grain yield, harvested from an area of 12 m^2 per plot.

RESULTS AND DISCUSSION

Cropping system, location and season had significant effects ($P < 0.05$) on cowpea seed per pod; pod mass at harvest, grain and biomass yield. Monocropped cowpea and maize-cowpea rotation had significantly higher seed number per pod at harvest, grain yield and field biomass yield than intercropped cowpea. These higher yields could have been attributed to lack of competition for resources. Cowpea yields at Taung were significantly ($P < 0.05$) higher than that of cowpeas at Rustenburg and Potchefstroom. The higher yield at Taung was due to the fact that, many cowpea varieties are better adapted to warm conditions and sandy soil, which were found in this area.

CONCLUSIONS

Continuous planting of cowpea on the same land or in rotation with maize produced significantly higher yield than in an intercropping system. The study confirmed that cowpea yield was lower due to competitive effect of maize in the intercropping system.

ACKNOWLEDGEMENTS

The author would like to thank the ARC-Field Crops Division and University of KwaZulu-Natal for allowing the study to take place. The study was funded by Agriculture Research Council (ARC) and National Research Foundation (NRF).

Keywords: Cropping system, intercropping, monocropping, rotational

YIELD RESPONSE OF MUSTARD SPINACH (*Brassica juncea*) TO APPLICATION OF VERMICASTING IN TWO TYPES OF SOIL

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INTRODUCTION

In intensive vegetable production systems, nitrogen (N) fertilization is the main input to achieve optimum marketable yield and quality. Vegetables, in general, have a short growing period and they generate high quantity in biomass at a very short period of time and this leads to high demand in nutrients (FAO, 1984). Information in vermicasting as a source of nutrients on mustard spinach is quite scanty and therefore a pot trial experiment was initiated to determine yield response of mustard spinach to vermicasting in two types of soil.

MATERIALS AND METHODS

Pot trials were carried out at the ARC-VOPI in winter 2013 under shade net (%) with the aim to determine optimum ratio of vermicomposting and different ratios of vermicasting were applied to sand (4 clay %) and sandy-clay loam (44 clay %) soils. Five soils: vermicasting ratios were used: 0: 100; 25:75; 50:50; 75:25 and 100:0. A factorial experiment of two soil types and five ratios, a total of ten treatment combinations, were assigned in a randomised complete block design, with three replications. One mustard spinach was planted in a 7 litre garden pot with perforations at the bottom. Soil samples were sent to a laboratory for analysis, and vermicasting was also sampled and analysed. Plants were watered at field water capacity, and the leachates collected were measured and put back into the pot. Fresh marketable leaves were harvested by the tipping method and fresh mass was recorded, leaves were oven dried at 60°C for 72 h to obtain dry leaf mass. The leaf area (cm^2) was measured using a leaf area meter (LI-3100 area meter, Nebraska, USA). Data was 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 5% level of significance.

RESULTS AND DISCUSSION

Fresh, dry biomass and leaf area index response to vermicasting differed among soil types and proportions of soil: vermicasting. Overall, highest growth and marketable yield were observed from the 50:50 ratio in river sand and 75:25 in sandy-clay loam soil. Significantly less marketable yields were harvested in soils where vermicasting was not applied.

CONCLUSION

Application of different ratios of vermicasting in river sand and sandy-clay loam soils as a pot growing medium is more efficient than using soil without any nutrient supplement. Vermicasting has the potential to increase biomass of leaves in mustard spinach, and therefore intensive studies have to be executed on optimum rates of vermicasting needed for optimum yields in mustard spinach.

REFERENCES

FAO (Food and Agriculture Organization) 1984. Fertilizer and Plant Nutrition Guide. Bulletin No. 9, FAO, Rome, 172 p.

Keywords: Marketable yield response, vegetable production, fresh mass

INFLUENCE OF PHOTO-SELECTIVE NETTING ON POSTHARVEST QUALITY OF HTSP-5 GREEN SWEET PEPPER

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INTRODUCTION

Photo-selective coloured netting is referred to as a "new agro-technological" concept adopted to manipulate light quality changes that can induce favourable responses in plants (Shahak, 2008). These changes can result in positive effects on postharvest quality and bioactive compounds during postharvest storage. Therefore, the objective of this study was to investigate the influence of photo-selective coloured netting on overall postharvest quality of green sweet pepper, cultivar HTSP-5.

MATERIALS AND METHODS

Green sweet pepper cultivar HTSP-5 was planted under three photo-selective nets (red, pearl and yellow; 40% shading) and black commercial net with 25% shading (control). Temperature, relative humidity (RH) and photosynthetic active radiation data were recorded from transplanting to harvest period. Disease-free uniform shaped or sized fruit without any injuries were selected and a set of six green peppers were packed in commercial polypropylene packaging (with 2 cm holes) and then stored at 7°C and 85% RH for 21 days and thereafter for 2 days at 25°C to simulate market shelf conditions (postharvest storage). The fruits were laid out in a completely randomised design. At the completion of the postharvest storage, the fruits were evaluated for firmness, colour, soluble solid concentration, titratable acidity, bioactive compounds such as ascorbic acid, lycopene, ß-carotene, total phenol, flavonoid concentration and antioxidant scavenging activity.

RESULTS AND DISCUSSION

During postharvest storage, fruits grown under black net showed a greater decrease in fruit weight, firmness and ascorbic content. However, lycopene and ß-carotene content increased in fruits grown under black nets. Fruits from black nets also showed initiation of red colouration (ripening). Fruits grown under pearl nets showed reduced weight loss and a higher ascorbic acid concentration. Fruits from yellow nets showed a moderate increase in lycopene and ß-carotene content and remained green in colour.

CONCLUSIONS

This study showed that HTSP-5 green peppers grown under black nets have a reduced postharvest storage life mainly due to the initiation of red colouration and fruits produced under the yellow photo-selective nets were moderately rich in bioactive compounds and retained the green colour in order to meet the market requirements.

REFERENCES

Shahak Y. 2008. Photo-selective netting for improved performance of horticultural crops. A review of ornamental and vegetable studies carried out in Israel. *Acta Horticulturae* 770:161-162.

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Keywords: ß-carotene, ascorbic acid, fruit quality, bell pepper, protected cultivation

THE ROLE OF METHYL JASMONATE AND SALICYLIC ACID IN MAINTAINING SHELF-LIFE AND IMPROVING QUALITY ATTRIBUTES RELATED TO CHILLING RESISTANCE OF 'EUREKA' LEMONS [*Citrus limon* (L.) BURM.F.]

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INTRODUCTION

Cold storage of 'Eureka' lemons causes an accumulation of reactive oxygen species (ROS) which attack membranes. Membrane damage through ROS, results in lipid peroxidation, rapid alterations in membrane permeability, respiration rate and an increase in mass loss which leads to chilling injury (CI). Postharvest methyl jasmonate (MJ) together with salicylic acid (SA) have shown potential to mitigate CI in lemons, however, the physiological mechanisms to enhance tolerance are not yet understood. Therefore, the aim of this study was to investigate the potential and the physiological mechanism of MJ and SA to maintain fruit quality whilst enhancing chilling tolerance in lemon fruit.

MATERIALS AND METHODS

Lemon fruit were treated with MJ and SA solutions, which included, 10 µM MJ, 2 mM SA or 10 µM MJ plus 2 mM SA. Fruit were stored either at -0.5, 2 or 4.5°C for up to 28 days and at 23°C for a week (shelf-life simulation). After shelf-life simulation, fruit were evaluated for CI, respiration rate, mass loss, electrolyte leakage, membrane lipid peroxidation, vitamin E and total carotenoids.

RESULTS AND DISCUSSION

The development of CI in lemon fruit varied with farm location, MJ and SA concentration, storage temperature and duration. Lemon fruit from New Venture Farm (moderate sub-tropical) were more chilling tolerant than those from Tala Valley Citrus Estate (warm temperate). The CI symptoms were manifested as pitting, necrosis and red blotch. These CI symptoms were effectively reduced by treatment with 10 µM MJ plus 2 mM SA. This treatment effectively maintained membrane integrity, thereby retarding electrolyte leakage and membrane lipid peroxidation, as well as mass loss and respiration rate. This treatment was also effective in inducing antioxidants, such as vitamin E and carotenoids. The production of antioxidants could have been part of a defence system against chilling damage, thereby maintaining fruit quality.

CONCLUSIONS

The role of postharvest treatment with 10 µM MJ plus 2 mM SA in enhancing chilling tolerance in lemons may be attributed to its ability to maintain membrane integrity and vitamin E and carotenoid content, as well as to retard mass loss and respiration rate.

Keywords: carotenoids, chilling injury, lipid peroxidation, mass loss, respiration rate, vitamin E

ADSORPTION OF AMMONIUM AND NITRATE BY BIOCHARS WITH CONTRASTING PHYSICOCHEMICAL PROPERTIES

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INTRODUCTION

We previously reported that pine wood biochar can significantly reduce the amount of NH_4NO_3 fertilizer leached from a sandy soil (Sika and Hardie 2013). However, it was also found that the biochar reduced the amount of exchangeable inorganic N, especially NO_3^-, in the sandy soil. To better understand this phenomenon, we selected six contrasting biochars and investigated their NH_4^+ and NO_3^- adsorption capacities. The aim of this study was to determine which biochar properties control NH_4^+ and NO_3^- adsorption, so that low N adsorbing biochars can be selected for soil amendment.

MATERIALS AND METHODS

The six different (corn stover, grape pip, grape skin, pine wood, rubber tyre and sugar cane pith) biochars were selected and characterised for their physicochemical properties by determining pH, surface acidity and alkalinity, BET specific surface area (SSA), proximate analysis and elemental contents. A NO_3^- and an NH_4^+ (5 – 100 mg L^{-1}) batch equilibrium adsorption experiment was conducted with the biochars at room temperature. Ammonium and nitrate concentrations were determined colorimetrically. All experiments were performed in triplicate.

RESULTS AND DISCUSSION

The adsorption isotherms were linear, indicating that biochar had a very high affinity for the ions and that a partitioning mechanism was involved. The biochars showed a higher affinity for NO_3^- (K_p ranged between 16.9-19.3) compared to NH_4^+ (K_p ranged between 1.4-2.1), supporting our previous study's findings. The NO_3^- affinity of the biochars was as follows: rubber tyre > grape skin > corn stover > pine wood > grape pip > sugarcane pith, whereas, the NH_4^+ affinity was: grape skin > pine wood > corn stover > grape pip > sugarcane pith > rubber tyre. Nitrate adsorption was weakly negatively correlated with biochar pH(H_2O) (R^2 = 0.53). Biochar contains acidic functional groups that become increasingly negatively charged as pH increases which could repel NO_3^- ions. Ammonium adsorption was strongly negatively correlated with biochar O/C (R^2 = 0.99) and surface acidity (R^2 = 0.90), and positively correlated with biochar pH (R^2 = 0.73). This could be due to NH_4^+ loss through volatilisation at higher biochar pH values.

CONCLUSIONS

The biochars adsorbed NH_4^+ and NO_3^- via a partitioning mechanism, and showed a higher affinity for NO_3^- than NH_4^+. Nitrate sorption appeared to be controlled by biochar pH, whereas, NH_4^+ sorption was mostly influenced by O/C, surface acidity and pH. The lowest NH_4^+ sorbing biochar was rubber tyre, while the lowest NO_3^- sorbing biochar was sugarcane pith.

REFERENCES

Sika, M. P. and Hardie, A. G., 2013. Effect of pine wood biochar on ammonium nitrate leaching and availability in a South African sandy soil. Eur. J. of Soil Sci.. doi: 10.1111/ejss.12082

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Keywords: Ammonium, biochar, nitrate, nitrogen, physicochemical properties

EFFECT OF COMPOST AND FOLIAR SPRAYS ON ROOIBOS TEA GROWTH AND YIELDS

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INTRODUCTION

The authors previously showed that the decline in rooibos yields with long-term cultivation can be attributed to a decrease in the soil organic carbon, and concomitant decline in microbial nutrient cycling and CEC. Long-term cultivation also led to an increase in the soil and plant P levels resulting in rooibos P toxicity (J.F.N. Smith, 2013, MSc dissertation, Stellenbosch University). Thus, the aim of this study was to evaluate the addition of rooibos compost and micronutrient foliar sprays on soil and plant quality.

MATERIALS AND METHODS

Compost and foliar spray treatments were applied separately to two-year old rooibos plants on one of the oldest (>30 years) continuously cultivated rooibos plantations (Vaalkrans, Clanwilliam) in December 2012. Two compost treatments, consisting of rooibos residues only (RR), and rooibos residues and chicken litter (RR+CL), were applied at 2 and 20 t/ha. Two foliar micronutrient sprays were applied; Mazinbor applied at 2 and 10 L/ha and Goemar applied at 2 and 4 L/ha. The treatments and control were replicated in triplicate in a block (2.5 x 3 m) design. After 6 months the following parameters were determined: soil pH, total C and N, CEC, macro and micronutrients, bulk density, microbial biomass, and plant total above and below-ground biomass, foliar macro and micronutrient levels, as well as levels of mycorrhizal colonization and root nodule formation.

RESULTS AND DISCUSSION

The compost treatments at 20 t/ha generally increased the soil pH, CEC, Bray II P (RR+CL only) and B, but had no effect on other soil properties. Although not statistically significant, the RR+CL compost 2 t/ha treatment resulted in the greatest increase in above- (26.7 %) and below-ground (37.6 %) biomass, whereas the 20 t/ha application resulted in smaller increases in above- (14.0 %) and below-ground (22.4 %) biomass. This could be attributed to possible P-toxicity, as the 20 t/ha treatment increased soil Bray II P to above 30 mg/kg soil, whereas all the other treatments (including the control) remained around 15 mg/kg P. The increase in soil P due to the RR+CL compost led to a significant increase in foliar P and resulted in a decrease in root mycorrhiza and Zn. The RR compost treatments resulted in a slight decrease in biomass yields, this could be attributed to the wide C:N ratio (26:1) of the RR compost which slightly decreased foliar N. The foliar sprays had no significant effect on plant properties.

CONCLUSIONS

The compost treatments led to several positive changes in the soil fertility, although only the RR+CL compost applied at 2 t/ha had a strong positive effect on the above and below ground biomass. We concluded that rooibos yields can be increased with RR+CL compost, as long as the soil P levels are not significantly elevated. The RR compost should be enriched with N before it is applied. The Mazinbor and Goemar Plus sprays had no effect on the biomass yields.

ACKNOWLEDGEMENTS

SA Rooibos Council for the funding.

Keywords: Rooibos tea, soil quality, soil health, compost

THE EFFECT OF LONG-TERM CONSERVATION AGRICULTURE ON SOIL ORGANIC MATTER FUNCTIONAL POOLS (W.CAPE, RSA)

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INTRODUCTION

Total soil organic matter (SOM) and its different functional pools (free particulate, aggregate-occluded, mineral-bound) are important indicators of soil quality and are seen as key factors in the evaluation of the sustainability of management practices. Until now, limited information was available regarding SOM accumulation and stabilization under no-till management in the Western Cape grain production regions of South Africa.

MATERIAL AND METHODS

Long-term field experiments investigating different crop and pasture rotation practices under no-tillage were initiated in 2002 at the Tygerhoek Experimental farm (Riviersonderend, Overberg). The following five dryland cropping systems ranging from 100 % pasture to 100 % crop were investigated; permanent lucerne, Medic-Medic-Wheat (MMW), Medic-Medic-Wheat-Wheat (MMWW), Wheat-Barley-Canola-Wheat-Barley-Lupine (WBCWBL4) and Wheat-Barley-Canola-Wheat-Barley-Lupine (WBCWBL1). Natural vegetated soil acted as a reference for this study. Soil samples were taken at 0-5, 5-10, 10-20, 20-30 cm. The effect of the cropping systems on total soil organic carbon (SOC) content and C and N stored in the functional pools [free particulate organic matter (fPOM), occluded POM (oPOM) and mineral fraction] were investigated. The soil C stabilizing mechanisms were also examined.

RESULTS AND DISCUSSION

After 11 years, the medic-wheat rotations had the highest total SOC content (15.2-18.6 g kg^{-1} in 0-30 cm depth) compared to the continuous cropping (13.3-14.1 g kg^{-1} in 0-30 cm depth), permanent lucerne pasture (15 g kg^{-1}) or natural vegetated soil (13.2 g kg^{-1}). Higher below-ground C inputs and the lower extent of disturbance in the 0-10 cm depth are the main reasons for higher total C content in the wheat-medic systems. The fPOM fraction (labile fraction) plays an important role in soil microbial nutrient cycling and is highly sensitive to soil management practices. The medic-wheat rotations had the highest fPOM C (1.37 - 1.74 g kg^{-1} in 5-10 cm depth) and N (0.107 - 0.110 g kg^{-1}) contents of the cultivated treatments. The % C in the fPOM pool in the cultivated treatments (6-9 %) was lower than the natural vegetated soil (13 %) at the 5-10 cm depth, which is mainly attributed to soil disturbance, fertilization, and residue quality. Furthermore, compared to the natural vegetated soil, the cultivated treatments had lower oPOM C and concomitantly a lower aggregate stability. On average, the oPOM fraction only contributed 0.4-2.4 % of SOC content at all sites. The major part (85-95%) of SOC was associated with the mineral fraction (stable fraction) with the MMWW treatment containing the highest C content (18.7 g kg^{-1}, 5-10 cm depth) in this fraction. Significant correlations were found between mineral-bound C and clay content (R^2=0.74) and Fe oxide content (R^2 = 0.57). Therefore, the main mechanism of C stabilization in these soils is most likely ligand exchange with clay minerals (mainly kaolinite, illite and Fe oxides) and to a minor extent via physical occlusion in aggregates.

CONCLUSIONS

Findings in this study enabled us to conclude that due to effect of cropping system and soil properties, the MMWW treatment had the highest total SOC content, which included highest labile C and N content and highest stabile C content.

Keywords: Conservation agriculture, SOM functional pools, stabilization mechanisms

CHALLENGES FACING AROMATIC, MEDICINAL AND HERBAL BEVERAGES IN SOUTH AFRICA: PERSPECTIVES TOWARDS A COMPETITIVE INDUSTRY

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INTRODUCTION

The introduction of the New Growth Plan (NGP) and the New Industrial Policy Framework have created an opportunity for the industrialisation of indigenous medicines. The aim is to create a local and sustainable industry which creates jobs as well as improves the balance of payments. The National Growth Plan highlights some of the opportunities for industrialization as well as creation of decent jobs.

METHODOLOGY

There is increasing pressure on the harvesting of wild indigenous plants. The establishment of a local pharmaceutical and nutraceutical industry remains a challenge despite some sectors in the economy doing well. The paper will report on some qualitative assessments and challenges facing the establishment of medicinal and aromatic plants in South Africa. Comparative findings from BRICS will also be reported.

RESULTS AND DISCUSSION

Our results demonstrated that there is continuous exploitation of several medicinal plant species from the wild and substantial loss of their habitat. Poor standards for raw materials, lack of research and development linking industry driven revenues, demand exceeding supply, regulatory risk, community risk, lack of understanding of judicious agronomic practices, ethical challenges, liquidity risk as well as political instability fail to attract foreign direct investments.

CONCLUSIONS

For the establishment of a viable local pharmaceutical and nutraceutical industry, there are serious hegemonic challenges which will require multi stake holder analysis. However, for the South African (SA) industry to be competitive, detailed feasibility studies need to be done comparing SA with other BRICS countries. Research and development strength, linking into industrial development, the incentivising of the pharmaceutical manufacturing and institutional industry, and programmes for production and dissemination of key species for cultivation is of critical importance.

Keywords: Sustainable harvesting, economic growth, job creation, plant trade, commercialisation

EFFECT OF COVER CROPS, THEIR KILL TIME AND SOIL TILLAGE ON SOIL MOISTURE AND SUBSEQUENT MAIZE SILAGE PRODUCTION

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INTRODUCTION

Winter cover crops after no-till maize are a widely used management practice in many parts of the world where they are known to reduce soil erosion, enhance soil fertility, conserve soil moisture and aid weed suppression. The kill time of winter cover crops influences the soil moisture at planting time. However they are not commonly grown in KwaZulu Natal and little is known about their survival and effects in this environment.

MATERIALS AND METHODS

This study was conducted at Cedara Research Station in KwaZulu-Natal from 2002 to 2006. Stooling rye, oats, lupins, serradella and hairy vetch were planted after maize had been harvested for silage. Control treatments of conventional tillage and no-till were included in a randomized complete block design with three replications. Cover crop treatments were split for kill time of 4 and 8 weeks before planting maize which was drilled into the dead material. The maize was rainfed. Maize silage yield, cover crop dry matter yield and maize height at 9 weeks after planting were measured. Soil moisture from 10 to 100 cm was measured with a moisture probe at killing and planting dates and at varying intervals over the years. Soil samples were taken and weed cover percentage measured by visual assessment.

RESULTS AND DISCUSSION

The only difference in silage maize yield was a decrease after stooling rye which was correlated to a decrease in plant population in the first year. At 9 weeks after planting, a 50 cm difference in maize plant height was found between cover crop plots and conventional till plots. A significant correlation between height and dry matter yield of the winter cover crops and the soil moisture at 0-10 cm in December was observed. Soil moisture content was higher after cover crops compared to conventional tillage. Late cover crop kill dates decreased soil moisture content for the follow-up maize crop.

CONCLUSIONS

Stooling rye can suppress maize germination if killed close to maize planting. Oats, stooling rye and vetch provide the most cover and can be useful to improve soil characteristics, increase soil moisture content and suppress weeds.

ACKNOWLEDGEMENTS

Murray Tessendorf, Kim Lawrance and James Arathoon .

Keywords: Maize silage, Winter cover crops, KwaZulu-Natal, Soil moisture

ENVIRONMENTAL FOOTPRINTS OF SOUTH AFRICAN POTATO PRODUCTION SYSTEMS

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INTRODUCTION

Potatoes are produced in 16 geographical regions of South Africa, differing in climate, soil, production practices and distance to markets. These factors affect the amount of input resources required to produce a ton of potatoes, and therefore, the carbon (C), land, water, and nutrient footprints which indicate sustainability of production. The objective was to assess and benchmark potato production areas regarding their use of land, water, nutrients and energy to produce potatoes. The outcome of the study will allow exploitation of conditions to make production systems more efficient and to ensure economic and environmental sustainability.

MATERIALS AND METHODS

Farmer surveys were conducted in all potato production regions by interviewing at least three farmers per production system (e.g. seed, table, processing, dryland, irrigation). The collected information enabled calculation of land, water and C-footprints. The Cool Farm Tool-Potato (Haverkort & Hiller, 2011) was used to assess the current footprint status for each production system per region. Footprints were calculated for farm gate and factory/retail point. Attainable crop yields per region and system were determined with the LINTUL-POTATO crop growth model (Franke et al., 2011). This enabled comparison of actual with attainable yields (land footprints) so that yield limiting factors could be identified.

RESULTS AND DISCUSSION

The total amount of CO_2-equivalent greenhouse gases produced per ton of potato ranged between approximately 150 kg/t (rainfed production) to 300 kg/t (high input and irrigation). Fertilizers, irrigation and grading / storage are the greatest contributors to C-footprints. Energy for pumping was not directly related to the amount of water applied, but rather to the depth and distance of pumping. Long distance travel of produce to retail points contributes substantially to the C-footprints in some regions. Water and nutrient footprints differed vastly between regions and were not directly proportional to the water requirements and yields achieved. Actual yields ranged between 25 and 85% of attainable yield, suggesting that significant improvements are possible by improving management practices.

CONCLUSIONS

The study revealed the amount of resources currently used for specific potato production activities. It furthermore highlights activities that contribute most to footprints, and suggests that there is room to improve practices to reduce footprints and costs.

REFERENCES

Haverkort AJ & Hillier JG. 2011. Cool Farm Tool – Potato: Model Description and Performance of Four Production Systems. *Potato Research* 54: 355–369

Franke, A.C., Steyn, J.M., Ranger, K.S. & Haverkort, A.J. 2011. Developing environmental principles, criteria, indicators and norms for potato production through field surveys and modelling*. Agr. Syst*., 104, 297–306.

Keywords: carbon emissions, water footprint, water use efficiency, potato

WHEAT YIELD COMPARISON OF DIFFERENT SHORT ROTATION CROP AND CROP/PASTURE SYSTEMS AT LANGGEWENS IN THE SWARTLAND

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INTRODUCTION

Rainfed agricultural production systems in the Western Cape have been based on winter cereals since the 1700s. In the Swartland, located in the west coast region of the Province, wheat has been the main crop for the past century and was produced in monoculture with an occasional break with bare fallow or oats pasture. The establishment of annual legume pastures was encouraged during the land improvement scheme of the 1970's& 1980's with limited success, despite extensive research showing the benefits of including such pastures (annual Medicago and annual clover species) into a farming system in rotation with wheat. In this paper wheat yields obtained in a large-scale, long-term experiment that comprises several crop and crop/annual legume pasture rotation systems, were compared to determine the potential implications of including annual legume pastures in rainfed grain production systems of the Swartland.

MATERIAL AND METHODS

Conservation agriculture production practices were used for all crops in the experiment. Wheat yield data from the 2002 to 2012 seasons were included in the analysis (excluding 2003 due to severe drought). Eight, 4-year rotation systems were compared, viz. 1-wheat monoculture (WWWW), 2-WWWC, 3-WCWL, 4-WWLC, 5-WMWM, 6-WMCM, 7-WMcWMc-1 and 8-WMcWMc-2 (where W = wheat, C = canola, L = lupin, M = medic & Mc = medic /clover mixed pasture), in a randomised block design that was replicated twice.

RESULTS AND DISCUSSION

Wheat yield in rotation systems containing a legume pasture tended to be significantly higher than wheat monoculture. Average yield ranged from 2854kg/ha to 4072kg/ha. System 6 (WMCM) showed the highest average wheat yield over time, although not significantly different from 5 of the other systems. By including a single year of crops such as lupins, canola or medics/clover in a short rotations with wheat, improved the wheat yield by 11% on average. This increase tended to be even higher (up to 43% on average) in systems where the proportion of wheat declined to 2-years in the 4-year rotation cycle.

CONCLUSIONS

The inclusion of alternative crops in rotation with wheat improves wheat yield on a per ha base. Although the inclusion of these crops means that a lower percentage of a farm is planted to wheat it does not meant that the farm income is reduced, because the improved wheat yields obtained from these rotations and income from the alternate crops and the increased animal production where pastures were included, help to offset this loss in total wheat area.

Keywords: wheat yield, crop rotation, conservation agriculture, sustainability

INTERPRETATION OF SOIL PENETRATION VALUES UNDER VARIOUS CULTIVATION PRACTICES: A CASE STUDY

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INTRODUCTION

Conservation agriculture (CA) is advocated as a management system for sustainable productivity while preserving the environment (FAO 2011). It is important to incorporate all the key principles (permanent soil cover, minimum tillage, multi-cropping, and recently the FAO added controlled trafficking) for the CA system to function optimally (Friedrich et al. 2012; Hobbs et al. 2008). In a medium-term CA dryland field trial, maize grain yields under the reduced tillage treatments were unexpectedly poor. It was hypothesised that topsoil compaction in the absence of tillage was the cause. In this study, soil penetration resistance and other variables were investigated to give insight into suboptimal performance of maize production under CA.

MATERIAL AND METHODS

Twenty-four plots were selected from the Zeekoegat CA trial, north of Pretoria. The treatments included tillage practices (reduced tillage (RT) vs. conventional tillage (CT)), cropping systems (maize monoculture vs. maize/cowpea intercropping) and fertilizing level (high vs. low). Penetration resistance was measured with a penetrometer at 10 mm intervals to a maximum depth of 850 mm, where possible. Prior to the measurements, the soil profiles were wetted to field capacity. Statistical interactions were tested with ANOVA using Genstat.

RESULTS AND DISCUSSION

In the 0 – 40 mm soil layer, penetration resistance under RT was lower compared to CT. However, between 50 – 220 mm depth the resistance under RT was slightly higher. At an average of 972 kPa for RT and 790 kPa for CT, this is not expected to influence seed germination and root development, but it can be argued that this effect could contribute to the decreased yield and biomass production observed between RT and CT. At deeper soil levels (> 250 mm) penetration resistance under both RT and CT increased sharply with depth. This corresponded with an increase in concretions.

CONCLUSION

Higher penetration resistance values were observed between 50-220 mm in the RT treatments, and although not significant, this could partly contribute to reduced yields. For these relatively undisturbed soil profiles, the sharp increase in penetration resistance in the deeper soil layers were confirmed by a strong correlation with the presence of concretions. It can be concluded that concretions can increase soil penetration resistance, together with other known variables such as soil water content, texture and bulk density.

REFERENCES

FAO. 2011. Save and Grow: A policymakers' guide to sustainable intensification of smallholder crop production. Food and Agriculture Organization of the UN, Rome, 116pp.

Friedrich T, Derpsch R, Kassam A. 2012. Overview of the Global Spread of CA. Field Action Science Reports Special Issue 6.

Hobbs PR, Sayre K, Gupta R. 2008. The role of CA in sustainable agriculture. *Phil. Trans. R. Soc B* 363, 543-555.

Keywords: Conservation agriculture, penetration resistance, soil strength, traffic control

GENOTYPING SOUTH AFRICAN WHEAT CULTIVARS FOR ALUMINIUM TOLERANCE GENE *ALMT1*

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INTRODUCTION

Dryland wheat production in the Free State province of South Africa (SA) accounted for approximately 20% of the mean national wheat crop of 1.9 million metric tons in 2012. However, this contribution to wheat production in SA varies considerably due to the high-risk nature of production. Significant yield losses occur annually in the Eastern Free State due to high aluminium (Al) concentrations in the soil. Root development is inhibited by Al and leads to decreased water and nutrient uptake. An evaluation of soil analysis results over a two year period indicated that the $pH_{(KCl)}$ of 94% of soils in the Eastern Free State are lower than 4.8. A common management strategy on acid soils has been the combined use of Al tolerant cultivars with liming. However, to be able to breed genotypes with improved Al tolerance, reliable and efficient screening methods must be available. Several screening methods, from molecular genotyping to soil bioassays and field evaluations, have been employed for this purpose. In this study sixty wheat cultivars were genotyped for the presence of aluminium tolerance gene *ALMT1* types and compared to the acidity levels of soils in different production areas of SA.

MATERIALS AND METHODS

Data obtained from the ARC-SGI Soil Laboratory was used to gain an indication of the percentage soils with $pH_{(KCl)}$ results lower than 4.8 in the different production areas. Sixty cultivars (29 SA, 4 International checks and 27 CIMMYT lines) were planted (five seeds per line/pot) in the glasshouse for genotyping. Bulk fresh leaf material of each cultivar was harvested and DNA isolation performed with a CTAB method. DNA was quantified and diluted to 50ng/µl final concentration. *ALMT1* gene specific and promoter type markers were used during PCR.

RESULTS AND DISCUSSION

Of the 29 SA cultivars screened *ALMT1* gene types I, II, IV and V were identified. Twenty-three (80%) of the 29 SA cultivars had *ALMT1* types I and II which confer very low aluminium tolerance. Just six cultivars could be identified as high to highly tolerant aluminium tolerant types IV and V. These results compare favourably with the international checks and CIMMYT material screened.

CONCLUSIONS

Soil acidification is a very real problem in SA and the single most important cause of declining soil fertility. Certain SA cultivars that were conventionally developed for production areas known to have acid soils had indirectly better Al tolerant genotypes. In general limited Al tolerant genotypes are present in the South African cultivar spectrum tested. Breeding for Al tolerance needs be an important selection criterion for the release of new cultivars. Marker-assisted selection for aluminium tolerance gene *ALMT1* types, especially highly tolerant types IV, V, and VI should make wheat production on acidic prone soils more stable.

Keywords: ALMT1 gene, Aluminium tolerance, PCR, pH, production regions, wheat

CALIBRATING SAP FLOW SYSTEMS: IS IT REALLY NECESSARY?

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INTRODUCTION

The determination of accurate figures for orchard water use is critical for improved irrigation scheduling and for the issuing of water licenses. Under or overestimations can have serious implications for yield and water resources in water scarce countries, such as South Africa. In order to meet this need for more definite water use figures the Water Research Commission solicited a project on fruit tree water use, which included the use of the sap flow methods to estimate transpiration in fruit tree orchards. The advent of sap flow methods to determine tree water use have largely circumvented many of the problems associated with traditional water balance methods, but these systems tend to underestimate transpirational losses when not properly calibrated.

MATERIALS AND METHODS

Sap flow systems were calibrated in citrus, pecan and macadamia orchards against the residual of evapotranspiration (eddy covariance) and evaporation (microlysimeter) measurements. Various sap flow methods were further calibrated in citrus in glasshouses, using potted trees and weighing lysimeters, and in the laboratory using the stem perfusion method.

RESULTS AND DISCUSSION

Measurements in the field and in the laboratory suggest that if calibration is not performed transpiration will be underestimated. In the macadamia orchard sap flow volumes would have been underestimated by an average of 40% throughout the two seasons of measurement. A more serious underestimation of transpiration (150%) would have occurred in the citrus orchard if calibration had not occurred. It was also evident that these calibrations are species specific, largely due to a difference in xylem anatomy between the various species.

CONCLUSIONS

Accuracy of sap flow measurements depend on adequate species-specific calibration of the methods. Without calibration transpiration could be seriously underestimated which could have serious implications for irrigation scheduling and the allocation of water licenses based on these measurements.

ACKNOWLEDGEMENTS

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Keywords: Sap flow, evapotranspiration, evaporation, transpiration, lysimetry, stem perfusion

MORINGA PROLINES AND PHENOLS IN SEED GERMINATION AND PLANT DEVELOPMENT

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INTRODUCTION

This study was designed around the hypothesis that proline-associated phenolics may play a crucial role under temperature stress in moringa seed germination. It is known that phenolic phytochemicals can effectively counter oxidative stress within the cell through phenolic biosynthesis and stimulation of antioxidant compounds. *Moringa oleifera*, a typical tropical plant, is known for its potentially high plant-antioxidant pool. Tropical plants regularly face adverse growth conditions, such as drought and high temperatures. Plant stress responses under these conditions are a dynamic process that involves complex cross-talk between different regulatory levels, including adjustment of metabolism (e.g. polyols and proline) and gene expression for physiological and morphological adaptation (Krasensky & Jonak, 2012). The objective of this study was to investigate the effect of growth temperature on the specific antioxidant compounds in moringa leaves.

MATERIALS AND METHODS

Moringa oleifera seeds were germinated in a controlled environment, and the seedlings were subjected to three different growth temperature regimes (25/12°C, 30/15°C, 35/18°C day/night), simulating the natural growth conditions in the tropics and sub-tropics. Leaf samples were taken on a weekly basis for five consecutive weeks. The samples were freeze-dried and used for analysis of total antioxidants, phenolics, proline and carbohydrate. Statistical analysis was carried out using GenStat®, version 14.1.

RESULTS AND DISCUSSION

During germination, prolines and phenols in moringa seeds showed a simultaneous increase. It is speculated that seed germination or seed quality might be associated with proline as an elicitor, followed by accumulation of phenols and radicle emergence. Temperature significantly ($P<0.05$) affected leaf phenolics, proline and fructose. The 35/18°C treatment had the highest total phenolic concentration, followed by the 30/15°C and 25/12°C treatments respectively. Similar results were also found for total proline concentrations. However, the 30/15°C treatment increased the total non-structural soluble carbohydrates the most. Although high temperature has been related to increased respiratory consumption of sugars, which are essential substrates to plant phenol accumulation (Rodrigues *et al*., 2011), the findings of this study did not confirm loss of soluble sugars and phenols.

CONCLUSION

The regulatory system of the moringa plant phenols and prolines can be detected by their accumulation (or production) in response to seed germination as well as exposure to high temperature. A future study will investigate seed quality, as seed quality can be affected by phenolic compostion.

REFERENCES

Krasensky, J. & Jonak, C., 2012. Drought, salt, and temperature stress-induced metabolic rearrangements and regulatory networks. *Journal of Experimental Botany*, doi: 10. 1093/jxb/err460, 1-60.

Rodrigues, AS, Pérez-Gregorio, MR, García-Falcón, MS, Simal-Gándara, J & Almeida, DPF, 2011. Effect of meteorological conditions on antioxidant flavonoids in Portuguese cultivars of white and red onions. *Food Chemistry* 124, 303–308.

Keywords: Moringa oleifera, proline, phenols

RESPONSE OF COWPEA ROOT CHARACTERISTICS AND YIELD ATTRIBUTES TO VARIABLE PHOSPHORUS AND MOISTURE STRESS CONDITIONS AT UKULIMA FARM, LIMPOPO PROVINCE

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INTRODUCTION

The problems of low soil phosphorus (P) and drought stress constitute abiotic stresses that threaten crop production, and hence, global food security. Root architecture, spatial configuration of the root system, exerts significant influence on the underground nutrient and water acquisition by plants (Lynch, 1995). This study aimed to assess the potential adaptation of eight cowpea (*Vigna unquiculata* L. Walp) lines to low soil P and moisture stress under field conditions.

MATERIALS AND METHODSA field experiment was planted at Ukulima farm near Modimolle, Limpopo Province during 2012/13-summer growing season. Treatments comprised of two levels each of soil P (low and high) and moisture (water stress and well-watered); and eight cowpea genotypes comprising of seven imported lines (Tvu4632, Tvu6365, Tvu9848, Tvu15445, Tvu16408, Tvu15143 and Oloyin) and one locally registered new line (IT00K-1217). The cowpea root traits measured included number of basal roots, tap root diameter at 5, 10, 15 and 20 cm; lateral root branching density at depths of 5, 10 and 15 cm, nodule score, and 1.5 branching density at 5 and 10 cm depths. Yield attributes measured included number of pods per plant, number of seeds per pod, grain weight, and hundred seed weight (HSW). All treatment factors were combined as split-split plot arrangement and fitted into a randomized complete block design with four replicates. Data were subjected to analysis of variance using Statistix 8.1 software and treatment means were separated using Tukey's HSD-test at 5% probability level. **RESULTS AND DISCUSSION**Results indicate that branching density at 5 and 15 cm differed significantly ($p=0.05$) across the different genotypes. A significant moisture level x genotype interaction effect on 1.5 branching density at 5 and 10 cm depths, taproot diameter at 10, 15 and 20 cm depths and nodule score were observed. A significant P rate x genotype interaction effect on taproot diameter was also observed at 10 cm depth. Phosphorus level and genotype variation exerted significant ($P<0.01$) effects on pod length. The differences in mean number of pods per plant, pod weight and number of seeds per pod among cowpea genotypes were highly significant ($P=0.01$). Moisture state and genotype variation exerted significant ($P<0.05$) effects on grain yield and HSW. **CONCLUSIONS**The results of this study revealed that root architecture exerted significant effects on water and P acquisition, as well as the nodule information of the various cowpea genotypes including the South African newly registered line; and consequently, cowpea productivity. **REFERENCES**LYNCH, J.P. 1995. Root architecture and nutrient acquisition. In: H Bassiri-Rad (ed.), Nutrient acquisition by plants: P an ecological perspective. Ecological studies 181: 147-184.

Keywords: Cowpea genotypes; P fertilisation; moisture stress; root traits; grain yield

DIAGNOSTIC SOIL HORIZONS AS FUNCTIONAL HYDROLOGICAL UNITS

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INTRODUCTION

Water scarcity in South Africa is an issue of national concern. Soils and more specifically soil horizons play an important role in catchment hydrology. It forms an integral part in the understanding of temporal and spatial distribution in catchments. Understanding horizon hydrology needs conceptualisation and systematic quantification. This must be in accordance with the South African soil classification system (SCWG, 1991). Conceptualization and quantification of diagnostic horizons can have prescribed hydrological functions, which can help to improve hydrological modelling.

MATERIALS AND METHODS

Selected representative hydrological and pedological data are applied. Discussion of morphology and properties will be aided by diagnostic horizon characteristics, tacit knowledge, land type data and unpublished field data.

Using tacit knowledge, hydropedology was put in context of concepts concerning hydrological functionality of diagnostic horizons: flow rate, flow direction, storage and source horizons.

Quantified results are subjected to statistical analysis.

RESULTS AND DISCUSSION

Diagnostic soil horizons are classified as hydrological functional units. Red and yellow-brown apedal B horizons transport water vertically downwards, E and soft plinthic B horizons store and transport water laterally, and in G horizons water moves vertically upward. The hydrological properties of these horizons vary accordingly. The use of soil horizons as morphological indicators as transfer functions for field identification of hydrological units are of value. This emphasises the value of using real soils, compared to conceptualised soil “forms”, in hydrological models.

CONCLUSIONS

Soil surveys can play a role in hydrological predictions in ungauged catchments to design and parameterise hydrological models useful for Catchment Management Agencies of South Africa.

ACKNOWLEDGEMENTS

Water Research Commission, University of the Free State

Keywords: Hydropedology, Catchment management, Hydrological modelling, Pedotransfer functions

HOW TO WRITE AND SUBMIT A SCIENTIFIC PAPER THAT GETS REVIEWED AND ACCEPTED QUICKLY

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INTRODUCTION

One of the many goals of scientific research is to publish the results that are obtained, in a reputable, peer reviewed journal. The peer review process is deemed essential to maintain standards of quality and provide credibility for the research results being published. Successfully publishing in good journals can be directly linked to a researcher's perceived success and many employers and sponsoring institutions require publication to facilitate or ensure continued funding of specific research projects. The process of writing-up and submitting a manuscript to a journal can however be quite daunting. This paper aims to provide authors with insight into publishing high quality scientific work in reputable, peer reviewed journals.

MATERIALS AND METHODS

The author draws on seven years' experience as Editor-in-Chief of South African Journal of Plant and Soil. The "time to process" manuscripts submitted to the Journal in 2012 and 2013 using the online submission and review platform ScholarOne is summarised and reported. Common mistakes and practices that lead to unnecessary delays are highlighted. Faults that attract unnecessary reviewer critique, as well as things that frustrate and annoy reviewers and editors are discussed.

RESULTS AND DISCUSSION

Typically, editors of scientific journals are not paid employees of the journal they edit, in most cases they act as editors in addition to holding a full-time position elsewhere. The same holds true for reviewers. Suggestions are given for avoiding common mistakes made in the submission of manuscripts and the correct process for responding to peer review comments is discussed.

CONCLUSIONS

Careful planning and attention to detail during both the preparation and submission of a manuscript to a peer reviewed scientific journal can make the process less frustrating and/or distressing for the authors of manuscripts.

REFERENCES

Bakker A, 2013. How to write a coherent research paper. Available at http://www.researchgate.net/publication/255754353_How_to_write_a_coherent_research_paper2013-08-13 [accessed 18 November 2013]Brenninkmeijer L, Eitner F, Floege J, 2012. How to write and publish a scientific paper. Port Journal Nephrol Hypert 26(4): 239-244.

Johnson TM, 2008. Tips on how to write a paper. Journal of the American Academy of Dermatology 59(6), 1064-1069.

Kallestinova ED, 2011. How to write your first research paper. Yale Journal of Biology and Medicine 84: 181-190.

ACKNOWLEDGEMENTS

Keywords: correspondence, instructions to authors, peer review

A PERSPECTIVE OF THE PRINCIPLES OF SOIL CLASSIFICATION

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INTRODUCTION

The initial principles for the current soil classification systems were published in *Soils of the Tugela Basin* (van der Eyk et al. 1969) recognising a 'classifiable soil body' and setting apart 'soil' from the geological sphere. *Soils of the Tugela Basin* describes the *'sphere of pedological interest'* as the material at or near the soil surface, darkened by organic matter that supports an active biologic community, and merges often imperceptibly, with hard rock. The Binomial Soil Classification System (MacVicar et al. 1977) and the current Taxonomic Classification System (SCWG 1991) have well capitalized on these principles in their framework and practical application. However, detailed interpretation assessments now require adaptations to the original principles and the concept attached to the *'sphere of pedological interest'.*

RESULTS AND DISCUSSION

Debate centres around at least three important principles concerning the Soil Classification System namely: (i) an 'expanded sphere of pedological interest', (ii) soil profile depth criteria, and (iii) structural adaptions to formal classification categories. This paper provides perspective on the first principle. Adaptations to the concept of certain horizon definitions will be required. Deeper soil materials with properties meeting concepts of existing horizon definitions should now be recognised as that defined horizon. All major soil horizons to mechanically impenetrable rock require recognition within the classification system. This implies that the classification recognises:

- all soil materials in real soils as defined horizons indicative of pedological processes,
- all soil horizons only to those depths necessary to permit the interpretation requirements,
- and assigns qualitative location information to the formal classification nomenclature.

CONCLUSION

This will improve accuracy in interpreting soil properties, bring freedom in identifying soils, and open the way for documentation of new soils.

REFERENCES

Van der Eyk JJ, MacVicar CN, de Villiers JM. 1969. *Soils of the Tugela Basin*. Pietermaritzburg: Natal Town and Regional Planning Commission.

MacVicar CN, De Villiers JM, Loxton RF, Verster E, Lambrechts JJN, Merryweather FR, Le Roux J, Van Rooyen TH, Harmse HJ Von M. 1977. *Soil Classification: A Binomial System for South Africa*. Pretoria: Department of Agricultural Technical Services.

SCWG (Soil Classification Working Group). 1991. *Soil Classification: A Taxonomic System for South Africa*. Pretoria: Department of Agricultural Development.

Keywords: Expanded sphere of pedological interest, Soil classification

MODELLING CROP WATER USE FOR SUSTAINABLE GROUNDWATER ABSTRACTION ON AN AQUIFER UNDER STRESS

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INTRODUCTION

South Africa is classified as an arid country with 98% of the water in South Africa allocated to existing lawful users, leaving only 2% for future growth (Molewa, 2013). Groundwater abstraction becomes increasingly important and has increased from approximately 684 million m^3 in 1950 to 1 770 million m^3 in 2004, with irrigation comprising more than 64% of the groundwater use in South Africa. Optimal groundwater use requires both the physical understanding of the aquifer system and the knowledge of the projected abstraction and uses over time. Crop growth models such as the Soil Water Balance (SWB) model can be used to predict the water balance and crop growth from weather, soil and crop data (Annandale et al. 1999) and therefore also abstraction for irrigation purposes.

MATERIALS AND METHODS

Field trials were carried out at a commercial farming enterprise on the Steenkoppies Aquifer in Tarlton, Gauteng, over a two year period. Parameters for the SWB model for cabbage (*Brassica oleracea)*, broccoli (*Brassica oleracea*), carrots (*Daucus carota*) and beetroot (*Beta vulgaris*) were determined and climatic data were obtained from a nearby Agromet managed automatic weather station at Deodar (26°08' S and 27°35' E and 1700 m altitude).

RESULTS AND DISCUSSION

Water productivity for the different vegetable crops ranged between 1.4 - 25.1 kg m^{-3}. A good correlation between predicted and actual measurements for both dry matter production and harvestable dry matter production was found. SWB predicted soil water deficit extremely well for both summer seasons. For the winter season the initial soil water deficit was well predicted, but as the season progressed the prediction was higher than the actual soil water deficit measured.

CONCLUSIONS

Model parameters simulating crop growth and water use were determined and the SWB model was successfully calibrated. A database of the crop-specific growth parameters has been generated, with separate model parameters between winter and summer vegetable seasons. SWB can be used to estimate the amount of groundwater to be abstracted for irrigation of vegetables on the Steenkoppies Aquifer.

REFERENCES

Annandale JG, Benade N, Jovanovic NZ, Steyn JM, Du Sautoy N. 1999. Facilitating irrigation scheduling by means of the Soil Water Balance model. Water Research Commission, Pretoria.

Molewa E. 2013. Media briefing by Minister of Water and Environmental Affairs, Ms Edna Molewa, on water policy and fracking in the Karoo. http://www.pmg.org.za

Keywords: Groundwater, SWB-model, vegetables, crop growth parameters

CONTROLLED TRAFFIC WITHIN THE SOUTH AFRICAN SUGAR INDUSTRY

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INTRODUCTION

About 95% of all sugarcane in South Africa is harvested manually but vehicles are commonly used to extract the harvested crop either to a loading zone or directly to the mill. It is often only the 0.9m row spacing that can accommodate the 1.8 m wheel spacing of most vehicles used infield. However, immediately after a field is harvested it is difficult to see the rows of sugarcane stools if a fair amount of crop residue (about 5 ton ha^{-1}) covers the surface. The difficulty of clearly seeing the cane rows, together with the need to get the harvested stalks out of the field as quickly as possible, often results in vehicles driving over the stools. This causes compaction in unwanted places (i.e. near or on the cane rows) and as well as stool damage, which permanently reduces the yield potential of the affected fields. The objectives of this paper are to discuss yield losses due to stool damage, the complexity pertaining to row spacing in the sugar industry and proposed controlled traffic systems under consideration within the South African sugar industry.

MATERIALS AND METHODS

Information for this paper was collected from field trials conducted by the South African Sugarcane Research Institute (SASRI), reported in the international literature and through discussions with sugarcane farmers practicing controlled traffic. To achieve the latter, a group of SASRI scientists and extension specialists visited farmers in dryland and irrigated areas that had experience with controlled traffic. These farmers were interviewed and their experiences documented.

RESULTS AND DISCUSSION

Yield losses due to stool damage ranged from 7% to 43%, depending on the soil type, soil water content at the time of harvest and axle load. Yield loss accumulated with every harvest leading to shorter ratoon cycles and more frequent replanting than would be required if stool damage and compaction on the cane row were avoided. Although controlled traffic is practiced by only a few farmers in South Africa, it is not a new concept within the industry. On one farm it has been practiced for the last 28 years. However, most systems in place today were adopted less than 10 years ago and cover less than 5% of the sugar industry. In general the format of these recent systems are two cane rows close together followed by a wider inter-row spacing (so called tram rows) to allow space for the wheels of infield equipment.

CONCLUSION

A single recommendation pertaining to row spacing is not feasible because of the variation in wheel spacing of the equipment used on farms in South Africa. Consequently, the general principal adopted within the industry is to adapt the row spacings on farms to the vehicles used by the particular farmers. With the current practice of a 10% annual replant, the conversion of a farm to a controlled traffic system could take a minimum of 10 years. In the higher altitude areas of the industry where row spacing is typically 0.9 m, the principal of controlled traffic could be easily adopted. The conversion would simply be to match all wheel tracks with inter-rows and to ensure that traffic is constrained to inter-row travel.

Keywords: controlled traffic, row spacing, sugarcane, stool damage

HOW WET IS A WETLAND: AN EXAMPLE FROM FLORISBAD, SOUTH AFRICA

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INTRODUCTION

Wetlands are important ecological areas and serve as hydrological regulators, especially in the more arid parts of the world, such as South Africa. Wetland delineation in South Africa is done through the recognition of three wetland zones and an upland zone. The duration of water saturation is, however, only specified qualitatively. The duration of water saturation in wetland soils is further normally measured as hydroperiod in piezometers or wells, yet the majority of long-term soil water studies are made as gravimetric or volumetric soil water content measurements. The aim of this study was therefore to relate the duration and degree of water saturation to the various wetland zones in the Florisbad wetland, occurring in central South Africa to enable the quantitative distinction between these zones.

MATERIAL AND METHODS

The four zones (permanently wet, seasonally wet, and temporary wet zones and an upland permanently dry zone), with three replications, were delineated at the Florisbad Quaternary Research Station in central South Africa, based on vegetation and the soil water contents, redox potential, and pH were measured weekly for one year.

RESULTS AND DISCUSSION

Degree of water saturation varied greatly in the topsoils (0-500 mm) of the four zones (from 0.12 to 1.52 m^3 m^{-3}), but was fairly similar (between 0.99 and 1.19 m^3 m^{-3}) in the subsoil (450-900 mm) of the three wetland zones. This similarity in the subsoils of the wetland zones was not reflected by the redox potential. The average redox potential varied between -118 mV in the temporary wet and -249 mV in the seasonally wet zones while being slightly more oxidised at -212 mV in the permanently wet zone.

CONCLUSIONS

Data presented clearly distinguish between the wetland zones and can therefore be used with confidence to distinguish these zones, based on long-term volumetric soil water measurements or modelling. It is, however, expected that these norms might vary due to differences in primarily climate, soil chemistry, and bulk density.

Keywords: delineation, redox, saturation, wetland

CAN AVOCADO NURSERY TREES BE COMMERCIALLY PRODUCED WITHOUT A NURSE SEED?

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INTRODUCTION

Avocado rootstocks in South Africa are largely vegetatively propagated to produce genetically identical plants, thereby increasing production by maintaining superior characteristics and reducing variation between trees in an orchard, leading to more efficient orchard management. Avocado is regarded as a difficult-to-root species, resulting in the current commercial method of propagating clonal rootstocks using a nurse seed, etiolation and double grafting. The requirement for the nurse seed increases the cost, labour, and time required to produce a nursery tree. If stem cuttings taken directly from mature avocado trees could be rooted at a high percentage, the nurse seed could be eliminated. Previously, stem cuttings made from low-vigour rootstocks did not show high rooting success, but new vigorous rootstocks may have potential. Furthermore, etiolated avocado material is known to root easily and phenolic compounds might provide a physiological reason for the increase in rooting of etiolated material. The aim of this study was to test whether stem cuttings made from new generation rootstocks might have higher rooting success than older generation rootstocks and to measure total soluble phenols in green and etiolated avocado material.

MATERIALS AND METHODS

A factorial design was used for the stem cutting experiment. Factor one was three different rootstocks: 'Duke 7' (international standard and previously experimented with); and R0.09 and R0.06 (new vigorous Westfalia Fruit rootstocks). Factor two was two levels of indole-3-butyric acid (IBA): 0.3% (w/w) and 0.8% (w/w). Total soluble phenols (TP) were measured in two types of avocado tissue: etiolated avocado material and avocado material maintained in the light.

RESULTS AND DISCUSSION

There was no significant difference in rooting percentage between the three different rootstocks and rooting success did not exceed 20% for any of the rootstocks. There was also no significant difference between the two IBA treatments. Total soluble phenol concentration did not differ significantly in green and etiolated material.

CONCLUSIONS

New vigorous rootstocks did not show higher rooting success than the low vigour rootstock 'Duke 7'. Stem cuttings made directly from mature avocado trees rooted with low success and this method is not commercially viable. Phenolic compounds cannot provide a physiological reason for the increase in rooting ability of etiolated avocado material. Investigations continue.

Keywords: avocado, difficult-to-root, vegetative propagation

VIRTUAL EXPERIMENTS TO QUANTIFY HYDROLOGICAL RESPONSE OF SOUTH AFRICAN HILLSLOPES

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INTRODUCTION

Subsurface lateral flow (SLF) in hillslopes is a dominant streamflow generation process in a variety of catchments especially in semi-arid areas. However, direct measurements of SLF are tedious and confounded by disturbances to the natural flow regime. Virtual experiments have been proposed to improve conceptualisation of hillslope hydrological processes. In this study we aim to quantify SLF responses under a range of soil and environmental conditions in order to obtain typical responses for hillslopes with specific properties.

METHODOLOGY

A set (68) of Hydrus-2D simulations were conducted on 25 m hillslopes with varying gradients (*ß*), soil depths (SD), saturated hydraulic conductivity of conducting layer (K_{sc}), ratios in K_s between conducting and impeding horizons (*R*) and rainfall volumes. The influence of rainfall was normalised by obtained SLF unit hydrographs (UH) for the simulations. These UH's were further described by an Advection Dispersion Function (ADF) where D_p is the dispersion coefficient and t is the response time:
g(t) = ((4π*Dp*t)/T)^((-1)/2)t^(-1)*exp*[-1(1-t/T)^(T/4*Dp*t))]
Two linear multiple regression equations using *ß,* SD, K_s and *R* were developed to predict D_p and τ in order to derive SLF UH's for user defined hillslopes. The resultant regression equations were used to solve the ADF and thereby determine the UH for a hillslope in a research catchment (Weatherley) where the SLF is measured directly. Through convolution of the ADF prediction of SLF was possible for a range of rainstorms. Simulated SLF were compared with measured SLF to evaluate the accuracy of the predictions.

RESULTS

D_p and *T* values can be predicted with the following linear multiple regression equations:
$Dp = 0.41(ß) + 0.06(SD) - 0.15(K_{sc}) + 0.07(R) + 10.09$ ($R^2 = 0.86$)
$T = 0.0045(ß) - 0.0004(SD) + 0.0002(K_{sc}) + 0.0014(R) + 0.1136$ ($R^2 = 0.81$)
These were used to obtain a UH for a hillslope in the Weatherley catchment and through convolution compared with measured SLF. The model simulated SLF responses of the hillslope accurately.

CONCLUSION

Virtual experiments with Hydrus-2D served as a vehicle to obtain D_p and τ values to determine the SLF UH's for under a range of soil and environmental conditions.

Keywords: Advection dispersion function, Hillslope Hydrology, Hydrus-2D, Unit Hydrographs

USE OF RNA-SEQ TO ESTABLISH A GENETIC RESOURCE TO STUDY SOYBEAN NODULE DEVELOPMENT AND SENESCENCE

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INTRODUCTION

Symbiotic nitrogen fixation in soybean enables atmospheric nitrogen to be assimilated, driving the plant's development and ultimately, yield. This symbiotic interaction is short-lived and sensitive to environmental stresses leading to senescence and reduction of nitrogenase activity. The involvement of cysteine proteases in nodule senescence has previously been reported, but their involvement during nodule development is not known. Furthermore, the involvement of their inhibitors, the cystatins, during any of these processes is also unknown. The aim of the study is to determine if the functional life-span of soybean nodules can be extended, by silencing key metabolic enzyme genes involved in nodule senescence.

MATERIALS AND METHODS

Identification of cysteine proteases and cystatins in soybean were done by homology searches using several online resources. Plant material (4, 8 and 14 weeks) was produced by growing a commercial cultivar from seed and inoculated with a commercially available *Rhizobium* inoculum. Plants were grown to appropriate age and RNA was harvested from the nodules using commercially available kits. The transcriptome sequencing was outsourced to Case Western Medical Institute (Cleveland, OH). The data processing, normalisation and datamining were done using the Galaxy platform available through the Department of Bioinformatics. Transcript quantification and RNA-Seq validation was done using qPCR for selected transcripts.

RESULTS AND DISCUSSION

The transcriptome analysis of the time points investigated allowed comparison of gene expression from nodule development to nodule senescence, allowing a holistic perspective to be obtained. Papain-like cysteine proteases were implicated during nodule development and maturity and are thought to contribute protein maturation and tissue differentiation. High expression levels of papain-like cysteine proteases were seen, but increase in proteolytic activity was only seen at the latter stages of senescence, which is speculated to be due to papain-like cysteine proteases requiring posttranslational modification by the legumain-like cysteine proteases. A subset of the cystatins identified in soybean showed higher expression during nodule development and the remaining cystatins had preferential expression during senescence. Still the functions of these proteins are unknown, but are currently being investigated.

CONCLUSIONS

Characterising the 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 and prolonging the period of active nitrogen fixation by delaying nodule senescence.

ACKNOWLEDGEMENTS

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Keywords: Cystatin(s), Cysteine protease(s), Nodule(s), RNA-Seq, Soybean, Senescence

SOIL SURVEY IN A DIGITAL AGE: APPLICATIONS FOR INDUSTRY

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INTRODUCTION

During the past two decades the advances in information technology and remote sensing have opened a whole range of possibilities on how soil surveys can be improved. Internationally these methods are collectively known as digital soil mapping (DSM). However, for DSM to be conducted with success, local research is needed to fine tune the methodology for the unique situation regarding data availability and soil-landscape interaction. Such research in South Africa has reached a point where the soil survey industry can benefit from the new technology.

MATERIAL AND METHODS

Several case studies, conducted as commercial soil surveys in Southern Africa using DSM methodology, have provided the platform to determine how the soil survey industry can benefit from DSM. These case studies were done for a range of uses and area sizes, with variable data available.

RESULTS AND DISCUSSION

Calculations show that there is an exponential increase in time saved with DSM methods and the area of the survey. The conventional grid system used in South Africa requires plenty of field work, and therefore is cumbersome and expensive. By extracting more information from each point observation, the need for observations can be decreased, thereby reducing the monetary and time cost of a soil survey. DSM can do this by quantifying the expert knowledge which a soil surveyor inadvertently collects while doing the field work for a survey. The expert knowledge is quantified as soil landscape rules and applied to the whole area by an inference system. This has placed the emphasis not on the amount of observations, but on the placement of the observations. Dependent on the aim of the soil survey, different sampling schemes can be used to determine where soil observations should take place.

DSM produced soil maps come standard with an accuracy assessment. For soil class maps, this takes the form of an accuracy matrix. From this matrix problem areas can be easily identified, and if necessary be improved on with additional field work. Such improvements apply to the tacit knowledge rules by which the map is created, which is also the form in which the map is stored. This takes up a lot less space.

Within certain boundaries, the quantified tacit knowledge can be extrapolated to unsurveyed areas, thereby greatly increasing the area which can be mapped during one survey.

CONCLUSIONS

DSM techniques can greatly improve the current soil survey techniques, and should be looked into by the soil survey community.

ACKNOWLEDGEMENTS

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Keywords: Digital soil mapping, expert knowledge, extrapolation, accuracy matrix

EXAMPLES OF THE ROLE THAT ARBUSCULAR MYCORRHIZAL FUNGI PLAY IN SUSTAINABLE AGRICULTURE

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INTRODUCTION

In the Western Cape, ill-informed agricultural practises have depleted the soil nutritional status and microbial life. With the focus on agriculture, a shift to re-establish the microbial balance in the soil has arisen. Arbuscular Mycorrhizal fungi (AMF) showed potential for use as bio-fertilizers to reduce chemical inputs, but the effect of these microbes on plant growth must still be investigated. The aim of this paper is to provide information on the potential role of AMF in sustainable agriculture.

MATERIALS AND METHODS

Two examples will be discussed. The first is on the impact that AMF plays after using various alternative fumigants, as determined in a replanted peach orchard. Six treatments (untreated, Cropguard, Protect, Biocult Mycorrhizae, Cropguard+Biocult Mycorrhizae and Protect+Biocult Mycorrhizae) were applied to young peach trees planted on re-established soil (Robertson, Western Cape). The growth in stem diameter was compared over a period of two growing seasons.

A second trial was conducted to investigate the effect of AMF on the growth of maize with various levels of super phosphate fertilizer. The experiments were conducted under controlled glasshouse conditions in Stellenbosch, Western Cape. Maize plants were planted in fumigated coarse sand and fertilizer applications except for phosphorous (P) were done to meet the recommended nutritional requirements for optimal growth. The two AMF treatments were, No Mycorrhizae and Mycorrhizae, while Phosphorous was applied at control conditions P_1=0 kg ha^{-1}, P_2=10 kg ha^{-1}, P_3=20 kg ha^{-1}, P_4=30 kg ha^{-1}, P_5=40 kg ha^{-1}. Each treatment had 24 replicates. Dry Mass and Yield was compared between treatments at different Phosphorous levels.

RESULTS AND DICUSSION

The peaches stem diameter significantly increased with Mycorrhizae treatments. The dry mass and yield of Maize significantly increased with the Mycorrhizae treatment.

CONCLUSIONS

Mycorrhizae improved crop performance in both trials, anticipating a reduction in chemical inputs.

ACKNOWLEDGEMENTS

Nulandis, Paarl & Joseph Pharudi.

Keywords: Arbuscular Mycorrhizal (AM) fungi, fumigants, phosphate levels

INCIDENCE OF ROOT DISCOLOURATION AND ASSOCIATED FUNGI, CAUSING SEEDLING BLIGHT, IN THE MAIZE PRODUCTION AREAS OF SOUTH AFRICA

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INTRODUCTION

Maize seedling blight has become a major problem in some parts of the country. Seedling blight affects maize plant stand, vigour and ultimately yield. In most cases farmers may have to replant fields due to poor emergence of seedlings which results in financial loss. Different fungi are involved in the seedling blight complex, this can result in a succession over time. Each fungus varies in significance depending on the environmental conditions affecting the soil and seedlings at a given time. The aim of this survey was to sample maize seedlings throughout the maize producing areas of South Africa, to determine which fungi are present in the roots of seedlings no older than three weeks. The roots were visually inspected and the discoloured roots of the maize seedlings were investigated to determine if the seedlings with most discolouration have higher prevalence of certain fungi species in their roots.

MATERIALS AND METHODS

A survey was conducted throughout the South African maize production area during the 2012/13 planting season to determine the occurrence and incidence of maize seedling blight. Ten seedlings were sampled at random per selected maize field, 10 meters in the turf field. Discolouration of roots was rated and percentage discolouration determined. Roots were cut into 1 mm pieces and sterilized with sodium hypochlorite (7%) for one minute. The roots were placed on selective growth media (Pythium agar and 2% Potato Dextrose Agar - PDA). Fungi growing from the root pieces on the media were reisolated and plated out onto three different agars, namely water agar, carrot agar and 2%PDA, for identification.

RESULTS AND DISCUSSION

Of the fungi isolated, 69 different fungal spp. were identified, of these the more common were: *Aspergillus* spp*., Clonostachus* spp*., Fusarium* spp*., Penicillium spp., Trichoderma* spp and *Verticillium* spp*.* From the 83 samples obtained, 61 had 0 < 10% discolouration while 22 had 10 < 90% discolouration, with only 6 of the 22 samples having greater than 70% discolouration.

CONCLUSION

The significance of seedling blight in maize in South Africa is generally low, however, under environmental conditions favourable in certain production areas this disease complex can result in significant losses. From the different fungal species identified, not all were pathogenic to seedlings. The samples that had higher root discolouration percentages (more than 70%) were more prone to be associated with the seedling blight complex.

Keywords: Seedling blight, root discolouration, associated fungi

IRRIGATION STRATEGIES FOR FORELLE PEAR TREES IN THE WESTERN CAPE

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INTRODUCTION

Water conservation and demand management are key factors to secure limited water resources for economic growth and development objectives in South Africa (Pegram and Eaglin, 2011). The cost of water, its allocation and trading are means to improve water use practices and water use efficiency in irrigated agriculture. At the operational level, producers could realise substantial water savings through well-managed irrigation or by applying deficit irrigation (Fereres and Soriano, 2007). Therefore, the possibility of obtaining optimum fruit yield and quality by means of deficit irrigation was investigated for pears to supply guidelines for optimal irrigation management.

MATERIALS AND METHODS

Forelle pear (*Pyrus communis* L.) trees on BP3 rootstock were subjected to 15 irrigation treatments in the "Warm Bokkeveld" production area. Treatments consisted of combinations of micro-sprinkler irrigation at 50%, 70% or 90% plant available water (PAW) depletion or no irrigation during four phenological phases *viz.* (1) vegetative growth and cell division, (2) cell enlargement, (3) fruit ripening and (4) post-harvest. Tree response was evaluated in the 2008/09, 2009/10 and 2010/11 seasons.

RESULTS AND DISCUSSION

Low rainfall plus reduced irrigation marginally reduced vegetative growth. Trees irrigated at 90% PAW depletion during phases 2 or 3, or throughout the season, as well as trees that received no irrigation during phase 3, showed earlier leaf fall, out of season bud break and bloom than trees consistently irrigated at 50% PAW depletion. Limiting irrigation during ripening or throughout the foregoing season, decreased the flower index and flowers per bunch in the following season. Water deficits in phases 2 and 3, or throughout the season, reduced yield *via* its effects on fruit growth, final fruit size and fruit numbers.

CONCLUSIONS

Limited irrigation during the vegetative growth and fruit cell division phase, or post-harvest, did not decrease yield substantially and seems to have potential to save irrigation water.

REFERENCES

Fereres E, Soriano M. 2007. Deficit irrigation for reducing agricultural water use. *J Exp Botany* 58:147-159.

Pegram G, Eaglin FC. 2011. Corporate water risk in South Africa, implications for growth and development. Report KV 265/10, Water Research Commission, Pretoria.

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Keywords: deficit, fruit, growth, micro-sprinkler, quality, yield

PHENOTYPIC CHARACTERIZATION AND 16S RDNA-RFLP ANALYSIS OF RHIZOBIAL STRAINS NODULATING COMMON BEAN (*Phaseolus vulgaris* L.) IN LIMPOPO PROVINCE

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INTRODUCTION

Common bean is one of the most important food grain legumes in the world due largely to its high protein content, dietary benefits and disease-preventing traits. As a crop, common bean benefits from free symbiotic N formed as a product of its mutualistic relationship with soil bacteria called rhizobia. However, the grain yield of this food legume is generally very low due mainly to poor soil fertility and the quality of soil rhizobia. So far, however, little is known about the native rhizobia nodulating common bean in South Africa. The objective of this study was to isolate and characterize indigenous rhizobia nodulating common bean in soils of the Limpopo Province.

MATERIAL AND METHODS

Root nodules of common bean were collected from farmers' fields and experimental plots in different locations of the Limpopo Province. Following surface sterilization, the root nodules were crushed, streaked on yeast mannitol agar (YMA). Single colony isolates were identified, and re-streaked for colony description or phenotypic characterization. Rhizobial genomic DNA was extracted by CTAB method (Ausubel et al. 1994), and the 16S rDNA region of genomic DNA amplified using PCR. The PCR-amplified product was digested using different restriction endonuclease enzymes.

RESULTS AND DISCUSSION

Visual appearance of colonies formed by the bacterial isolates took 3 to 5 days to occur on YMA plates. The size of colonies varied between >1 to 4.5 mm, and were generally round in shape. They however differed in elevation, with 62.2% being flat, 35.5% domed, and 2.2% conical. About 73.3% of the colonies were gummy, while the rest were dry. Furthermore, 88.9% of the isolates were milky white, 8.9% white, and 2.2% were watery opaque. The PCR amplification of 16S rDNA of rhizobial genome showed a single band of 1500 bp on agarose gel. Analysis of the 16S rDNA restriction fragment length polymorphism (RFLP) showed considerable variation among the rhizobial isolates.

CONCLUSION

The isolation of bacteria from root nodules collected from sites in Limpopo Province revealed large rhizobial biodiversity in soil populations. Authentication and cross-infectivity tests of these isolates are likely to produce bacteria that have great potential for use in inoculant production.

REFERENCE

Ausubel FM, Brent R, Kingston RE, Moore DD, Smit JA, Seldman C and Struhl (ed.) Current protocols in molecular biology, section 2.4 John Willey and Sons, New York, N.Y, 1994.

ACKNOWLEDGWEMENTS

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Keywords: Root nodules, PCR, genomic DNA, DNA amplification, single colonies

PROJECTING THE LOCAL IMPACT OF CLIMATE CHANGE ON FOOD CROPS IN SOUTHERN AFRICA

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INTRODUCTION

Climate change impact assessments on agriculture in southern Africa are mostly carried out at large spatial scales. As such, conclusions about the impact of climate change on crop production are broad brushed to represent large swathes of differing agro-ecological conditions and agricultural practices, posing a risk of missing out on local impacts that reflect the peculiar bio-physical conditions under which dryland farmers in the region operate (Zinyengere et al. 2013). Finer scale studies are therefore necessary.

MATERIALS AND METHODS

This study investigated how climate change may affect yields of various major food crops in specific locations in southern Africa; maize and sorghum (Mohale's Hoek – Lesotho and Big Bend – Swaziland), maize and groundnuts (Lilongwe – Malawi). Climate projections from 9 GCMs were downscaled to study locations for a baseline period (1961-2000) and future period (2046-2065). Agronomic management strategies specific to each location were also simulated *i.e.* combinations of planting dates and fertiliser amounts. An assessment of simulated yield changes for confidence, uncertainties and their relative sources was performed.

RESULTS AND DISCUSSION

Results show that climate change will have significant effects on crops in the region, with consequences that vary across locations and crops. In Big Bend - Swaziland, maize and sorghum yields are projected to decline by an average of 20 and 16 % respectively. Yields of maize and groundnuts are also projected to decline on average in Lilongwe - Malawi by 5 and 33 % respectively. Maize and sorghum yields in Mohale's Hoek – Lesotho are projected to increase on average by 8 and 51 % respectively. There is low uncertainty about the direction of projected change but high uncertainty about the magnitude of change, especially for sorghum in Mohale's Hoek - Lesotho and maize and sorghum in Big Bend – Swaziland, emanating mostly from GCMs and agronomic strategies simulated. Agronomic practices were found to have potential to exacerbate negative effects or take advantage of the benefits of climate change in some locations.

CONCLUSION

The study shows that the impacts of climate change on crops in the region will be significant but location and crop specific. As such broad brush conclusions about the impacts of climate change over large areas may not be prudent. The study recommends location and crop specific impact assessments, especially for identifying potential adaptation strategies in the region.

REFERENCES

Zinyengere N., Crespo O., Hachigonta S., 2013. Crop response to climate change in southern Africa: A comprehensive review. Global Planet. Change. 111, 118–126.

Keywords: climate change, food crops, agronomic practices, GCMs, southern Africa

EFFECT OF SEAWEED EXTRACT ON PLANT GROWTH AND SYMBIOTIC PERFORMANCE OF SELECTED GRAIN LEGUMES IN NELSPRUIT, MPUMALANGA

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INTRODUCTION

Kelpak is a liquid extract from the seaweed *Ecklonia maxima* found in coastal waters and contains macro and micro nutrient elements, amino acids, vitamins and organic compounds (Crouch and van Staden 1993). Liquid extracts derived from seaweeds, have been used on a variety of crops to improve their growth, development and yield (Crouch and van Staden 1993). Despite these benefits, nothing has been reported on the role of Kelpak on plant growth and symbiotic performance of nutritionally-important N_2 fixing grain legumes under local conditions. This study therefore assessed the effect that Kelpak application has on plant growth and symbiotic performance of inoculated and un-inoculated legumes.

MATERIALS AND METHODS

A factorial experiment using cowpea, Bambara groundnut, groundnut, common bean, and soybean was laid out at the Nelspruit Research Station with four replicates and four treatments namely; (i) Kelpak plus inoculation, (ii) inoculation alone, (iii) Kelpak alone and, (iv) no Kelpak and no inoculation. Soil analysis was done prior to planting. The plants were rain-fed. At physiological maturity five plants per plot were sampled, separated into shoots, roots and nodules. The plant parts were then oven-dried, weighed, ground and shoots analysed for $^{15}N/^{14}N$ isotope using mass spectrometry. Grain yield was also recorded. The data collected was analysed using STATISTICA software Program version 7.1.

RESULTS AND DISCUSSION

In general, the application of Kelpak increased nodulation and dry matter of nodules, roots, shoots of all inoculated and un-inoculated test grain legumes. Moreover, % N, N content, N-fixed, soil N uptake and grain yield were also highest with Kelpak applications. Application of the seaweed extract plus *Rhizobium* and seaweed extract alone increased shoot biomass accumulation in soybean (57.0 g plant^{-1} and 54.7 g plant^{-1}, respectively) and groundnut (50.6 g plant^{-1}and 50.1 g plant^{-1}, respectively) while, common bean accumulated the least. In addition, seaweed extract plus *Rhizobium* and seaweed extract alone increased N-fixed in soybean (297 kg ha^{-1} and 252 kg ha^{-1}, respectively) and groundnut (145 kg ha^{-1} and 119 kg ha^{-1}, respectively) while, Bambara groundnut, cowpea and common bean fixed the least.

CONCLUSIONS

From these results, application of seaweed extract (Kelpak) improved plant growth and symbiotic performance of inoculated and un-inoculated test grain legumes at Nelspruit.

REFERENCES

Crouch IJ, Van Staden J. 1993. Effect of seaweed concentrate from *Ecklonia maxima* (Osbeck) Papenfuss on *Meloidogyne incognita* infestation on tomato. Journal of Applied Phycology 5: 37-43.

Keywords: Application, inoculation, kelpak, plant growth, symbiotic performance