

Abstracts: Oral Presentations

EFFECT OF *Amaranthus cruentus* RESIDUES ON TOMATO (*Lycopersicon esculentum* L.) SEED GERMINATION AND SEEDLING GROWTH

J Allemann

University of the Free State, P.O. Box 339, Bloemfontein, 9300

E-mail: Allemannj@ufs.ac.za

INTRODUCTION

Allelopathic effects have been demonstrated in a number of plant species, including both crops and weeds. These plants secrete chemicals that can either inhibit or stimulate germination, growth and yield of other plants grown together with, or succeeding, the allelopathic species. The detrimental effects of several amaranth species, ranging from growth inhibition to total inhibition of germination, have been reported in a number of crop species. Residues of a number of amaranth species have also been reported to be phytotoxic to a number of plant species, probably due to the allelochemicals being released during decomposition of plant residues. *Amaranthus cruentus* exudates have been shown to inhibit tomato (Cv Rodade and Floradade) seedling growth. Pilot trials indicated that residues of this species also affected the growth of tomato seedlings, but results differed from those of earlier work. The objective of this trial was, therefore, to test if cultivar differences in sensitivity to amaranth residues occurred.

MATERIALS AND METHODS

The allelopathic potential of plant residues from three varieties of *Amaranthus cruentus* (Anna, Arasha and Imbaya) was evaluated in a pot trial conducted in a glasshouse on the main campus of the University of the Free State in Bloemfontein, South Africa. Six seeds of four tomato cultivars were planted into soil in which three concentrations (0, 5 and 10 mg kg⁻¹) of amaranth residue had been incorporated. The trial was laid out using a completely randomised block experimental design with 10 replicates. Pots were irrigated as required and received a full nutrient solution once weekly. Harvesting took place five weeks after planting and the number of plants, plant height and plant mass determined. All data were converted to percentage of the control treatments prior to statistical analysis.

RESULTS AND DISCUSSION

Both amaranth variety and the residue concentrations had a significant effect on the dry mass of the tomato seedlings, with those grown in Imbaya residues being significantly heavier than those in Anna residues. Seedlings cultivated in the presence of the residues were heavier than the control plants. Plant height was affected significantly by the interaction between amaranth variety and the residue concentration, with seedlings in 10 mg kg⁻¹ Imbaya residues being significantly shorter than those in the same concentration of Arusha residue. In both cases a stimulatory effect was noted in plants grown in residue treated soils. However, an inhibitory effect due to the amaranth residue was noted in the percentage germination attained in two of the four cultivars tested. In both of these cultivars germination was significantly inhibited at the 5 mg kg⁻¹ residue level.

CONCLUSIONS

Cultivar differences in sensitivity to amaranth residues occur with respect to seed germination, although seedling growth appears to be stimulated. Imbaya residues appeared to have less of a stimulatory effect than those of the other two varieties.

Keywords: Allelopathy, Amaranth, cultivars, germination, seedling growth, tomato

EVALUATION OF SILICON UPTAKE IN CITRUS AND ANALYTICAL METHOD VALIDATION

NM Asanzi¹, NJ Taylor¹ and JT Vahrmeijer²

¹Department of Plant and Soil Production, University of Pretoria, Pretoria 0002, South Africa;

²Citrus Research International, Nelspruit 1200, South Africa

E-mail: mnafabuanga@yahoo.fr

INTRODUCTION

The importance of silicon as a beneficial element for improving yield and quality of many crops, including citrus, is well-known (Epstein, 1999). Analytical methods for Si determination in plants have been developed mostly for Si-accumulators such as rice, maize, wheat, sugarcane and cucumber. However, information is limited on the analysis and uptake of silicon in citrus. Therefore, experiments were conducted to validate an analytical method for silicon and to assess the uptake of silicon in citrus.

MATERIALS AND METHODS

A microwave-assisted acid-base hydrolysis method was adapted from Haysom & Ostatek-Boczynski (2006). The Si concentration was determined with an induced couple plasma optical emission spectrometry (ICP-OES) and the results were compared with the results obtained from the standard colorimetric method. The Si uptake experiment was conducted in a glasshouse at the experimental farm of the University of Pretoria from September 2011 to January 2012. Two year-old citrus trees, 'Delta' Valencia oranges (*Citrus sinensis*) and 'Nules' Clementine (*Citrus reticulata*) both grafted onto Carrizo citrange rootstocks were used in this study. Potassium silicate was applied to the roots (0, 75 and 150 mg kg⁻¹ of soil) and as a foliar spray until runoff (0, 100 and 500 mg L⁻¹). The experiment was conducted over two seasons.

RESULTS AND DISCUSSION

A correlation of 98% was found between the results of the ICP-OES and the results from the standard colorimetric method. Results from the uptake study showed that silicon absorption increased significantly ($P=0.05$) with application rate and silicon content in the leaves was significantly higher ($P=0.05$) when applied to the roots, than when applied to the leaves. Silicon uptake was also significantly higher during summer than winter. There were no significant differences ($P=0.05$) in the silicon content of the two citrus varieties.

CONCLUSIONS

Silicon analysis using ICP-OES correlates with colorimetric analysis. Silicon uptake is influenced by the season and concentrations. Root applied silicon resulted in a higher uptake than foliar applied silicon.

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Keywords: Citrus, colorimetric, ICP-OES, silicon, uptake

EVAPORATION ESTIMATION OVER SUGARCANE

ESN Babikir¹ and MJ Savage¹

¹University of KwaZulu-Natal, P/Bag X01, 3209 Scottsville

E-mail: babikir@ukzn.ac.za

INTRODUCTION

In sugarcane producing areas, there is continuous pressure on available water resources as a result of the erratic rainfall occurrence, expansion of sugarcane areas and competition with other crops. These aspects have a significant impact on sugarcane production. Therefore, accurate and reliable evaporation data are important for irrigation scheduling and the optimum use of the available water resources so as to obtain maximum sugarcane yields. A simple method for estimating evaporation involves measuring sensible heat (H) from which latent energy (LE) can be calculated as a residual, using the shortened energy balance from measurements of net irradiance (R_n) and soil heat flux (G_{soil}). The surface renewal (SR) method allows $H = H_{SR}$ to be estimated using high frequency air temperature data. The aim of this study is to calibrate and validate SR with eddy covariance (EC) estimates of $H = H_{EC}$ which are used for estimating evaporation for dryland sugarcane.

MATERIAL AND METHODS

A field experiment was conducted at the Baynesfield Estate, KwaZulu-Natal for a year. Unshielded and naturally-ventilated fine-wire thermocouples at 0.20, 0.50, 0.75 and 1.50 m above sugarcane were used to measure 10-Hz air temperature using time lags of 0.4 and 0.8 s from which H_{SR} was estimated. A three-dimensional sonic anemometer was used for obtaining H_{EC} . SR estimates of H_{SR} was calibrated and validated against H_{EC} estimates. Later, a residual LE and hence evaporation was estimated using R_n , G_{soil} and H measurements as: $LE = R_n - G_{soil} - H$ where H corresponds H_{SR} or H_{EC} .

RESULTS AND DISCUSSION

SR calibration factor (α) values increased with a decrease in measurement height and with increase in air temperature time lag. The H_{SR} estimates showed reasonable correspondence with H_{EC} estimates, with improved results obtained at a height of 0.50 m using $\alpha = 0.91$ for a time lag of 0.8 s. Daily and seasonal total evaporation is reported on. The average daily evaporation was 1.76 mm.

CONCLUSIONS

Evaporation can be estimated using SR if α is known and the other components of the energy balance are measured accurately. Higher daily evaporation values were observed in summer.

ACKNOWLEDGEMENTS

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Keywords: Air temperature, energy balance, structure function

MAIZE EMERGENCE AT FOUR PLANT DENSITIES AND UNDER DIFFERENT TILLAGE PRACTICES AND ROW SPACING

TC Baloyi

Agricultural Research Council-Grain Crops Institute, P/ Bag X1251, Potchefstroom 2520

E-mail: baloyitc@arc.agric.za

INTRODUCTION

Conservation tillage practices is steadily gaining a global interest as an alternative to reverse trends of soil fertility degradation associated with intensive conventional tillage and crop monoculture practices. However, soil compaction especially under reduced tillage is a subject of concern. Soil compaction leads to an increase in soil strength and bulk density that impede growth of plant roots (Hartge, 1988). In South Africa, many farmers do not conform to recommended plant densities. Therefore, a delay in crop emergence and reduced plant establishment under reduced tillage are likely to be a prime challenge to such producers. This study was therefore conducted to assess maize emergence under conventional and minimal soil disturbance tillage systems and different row spacing.

MATERIALS AND METHODS

On-farm rainfed trials were conducted at Boskop, Poortjie and Ventersdorp during the 2011/12 cropping season at four maize densities (10, 20, 30 and 40 000 plants ha⁻¹) using minimal soil disturbance and a conventional tillage system at either 0.9 or 1.5 m row spacing. A randomised complete block design was used in a split-split plot arrangement with three replications. Tillage systems were assigned to the main plots, row widths to the sub-plots and maize densities to the sub-sub plots. Each plot comprised of four 10 m long rows of maize (cv. PAN 6Q-445B). Maize emergence was counted from the first to the last day of emergence in 7 m of the two middle rows in order to determine the percentage of emerged seedlings (PE), mean emergence dates (MED) and emergence rate index (ERI).

RESULTS AND DISCUSSION

MED and ERI differed significantly ($P < 0.001$) for row spacing, while density had a significant ($P < 0.01$) influence on all maize emergence components. However, no significant differences resulted with tillage practices. The interaction effect of row width x plant density was significant on MED and ERI, while the locality x row width x density interaction was significant only for MED. MED was significantly lower in either row spacing for the lowest plant density (10 000 plants ha⁻¹) compared to the highest density (40 000 plants ha⁻¹). The ERI for 30 000 plants ha⁻¹ in narrower rows (0.9 m) increased significantly relative to 20 000 plants ha⁻¹. However, in wider rows (1.5 m), the ERI for 40 000 plants ha⁻¹ significantly decreased than for 10 and 30 000 plants ha⁻¹, respectively.

CONCLUSIONS

Maize emergence was not dependent on tillage practices, nor was the percentage of emerged plants dependent on row spacing. Maize planted at the lowest plant density (10 000 plants ha⁻¹) in either rows spacing has a lower MED than at the highest plant density (40 000 plants ha⁻¹). Plant density of 30 000 plants ha⁻¹ in narrower rows promoted higher ERI.

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Keywords: Maize emergence, plant density, row widths, tillage systems

DETERMINATION OF THE STORABILITY AND VIABILITY OF SOUTH AFRICAN BARLEY CULTIVARS

A Barnard¹ and SG Ybema²

¹ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700; ²NWK Lichtenburg, PO Box 107, Lichtenburg 2740

E-mail: barnarda@arc.agric.za

INTRODUCTION

Since malting barley, the primary ingredient in the processing of beer, has to be delivered to the consumer in a germinative state, production and storage thereof requires much greater care and management than for other small grain crops. The most important quality attribute of malting barley is its ability to germinate. During prolonged storage, barley grain will slowly lose its vitality, causing a slower germination and even grain death, which will be of less value for the maltster. No work has previously been done in South Africa on the storability of barley.

MATERIALS AND METHODS

Ninety samples of barley grain, comprising the cultivars Puma and SSG 585, from various regions in the Northern Cape were analysed. Rapid visco analyses (RVA) were conducted on all the samples at Time 0. The germination energy (GE) was also determined at Time 0. The samples were divided into sub-samples and stored at 3 different climate regimes for GE determination at 3, 6, 12, 18, 24, 30 and 36 months. One hundred healthy seeds per replicate were germinated in the dark at 18°C–21°C. After 24h, 48h and 72h the germinated kernels were counted and removed, thus avoiding excessive moisture uptake by those kernels that germinated early. The cumulative percentage of kernels that germinated each day was recorded and the final results expressed as an average of the values.

RESULTS AND DISCUSSION

A comparison between samples with low and high RVA values indicated significant differences in the final germination (%). Samples stored for 36 months showed a significant decrease in the germination, especially when stored at low (10°C) or high temperatures (22°C–25°C). These values decreased from an initial 92% to 30% and 40% respectively at low and high temperatures. Samples stored at temperatures between 12°C–15°C were able to maintain their final germinative potential for much longer (90% after 30 months of storage). The GE (%) of Puma was consistently higher than that of SSG 585 over all environments stored and tested.

CONCLUSIONS

RVA is a suitable technique to detect pre-germination in barley. The samples used in this study could be safely stored for up to 30 months in storage conditions where the temperatures were kept between 12°C–15°C and the humidity was kept below 20%. Temperatures lower than 12°C with an increased humidity and higher temperatures (22°C–25°C) with humidity higher than 60%, were not suitable for the safe storage of barley.

ACKNOWLEDGEMENTS

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Keywords: Barley, germination, storage, viability

CALIBRATION AND VALIDATION OF AQUACROP FOR PEARL MILLET

ZA Bello¹ and S Walker¹

¹*Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein, South Africa*

E-mail: belloz@ufs.ac.za

INTRODUCTION

AquaCrop was developed, in the context of water scarcity, to help project managers, consultants, irrigation engineers, agronomists, and the farm managers with the formulation of guidelines to increase the crop water productivity for both rainfed and irrigated production systems (Raes *et al.*, 2009). The objectives of this study were to calibrate and validate the AquaCrop model for pearl millet, under irrigated and rainfed conditions.

MATERIALS AND METHODS

An experiment was carried out on the lysimeter facility of the Department of Soil, Crop and Climate Sciences of the University of the Free State, Bloemfontein during the 2010/2011 season while the field experiments were carried out over two seasons, 2008/2009 and 2009/2010 under the line source sprinkler irrigation system. The plots were laid out as a split plot design. Two lines of pearl millet were cultivated under five levels of water application from fully irrigated to rainfed replicated four times. The lysimeter datasets were used for parameterization and calibration of the model. Data from the 2008/2009 and 2009/2010 field experiments were used for calibration and validation of the model. Parameters evaluated for performance of the model were canopy cover (CC), biomass, soil water content (SWC) and cumulative evapotranspiration (ET). Goodness of fit for the calibration and validation of the model was carried out with coefficient of determination (R^2), root mean square error (RMSE) and index of agreement (d).

RESULTS AND DISCUSSION

Response of the two lines of pearl millet to environment was well calibrated and gave a good simulated for CC, biomass and cumulative ET under irrigation. Calibration of the model for soil water content was challenging which might be due to the fact that information from literature was used for the rooting depth parameter. Validation of AquaCrop for pearl millet was satisfactory considering all simulations and the statistical evaluation of the selected parameters under observation during the process. Simulated CC, biomass and cumulative ET versus observed produced respectively d index of agreement of 0.949, 0.953 and 0.975 for improved line and 0.91, 0.904 and 0.987 for local variety. The SWC was moderately simulated for the two lines of pearl millet but needs more improvement.

CONCLUSIONS

The AquaCrop model was able to simulate crop growth represented by canopy cover and biomass, as well as cumulative ET accurately for pearl millet under irrigation and rainfed conditions. Irrespective of physiological nature of the crop, AquaCrop was able to give good results of water productivity of the two lines of pearl millet.

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Keywords: AquaCrop, biomass, calibration, pearl millet, canopy cover, validation

BIOENERGY PRODUCTION - STATUS AND PROSPECTS FOR THE FUTURE

G Berndes

Department of Energy and Environment, Chalmers University of Technology, Göteborg, Sweden

E-mail: goran.berndes@chalmers.se

Bioenergy and water are inextricably linked. In a world where several countries already face water stress – and where over 70% of global freshwater use takes place in the agricultural sector – bioenergy development might present considerable challenges, from the perspective of water quantity as well as water quality. At the same time, by leveraging the introduction of efficient water management techniques and providing energy for water pumping and cleaning, and by providing a wider range of land-use options to optimize the use of land and water, bioenergy development provides opportunities to improve water productivity, maintain and improve water quality, and increase access to water.

The presentation will provide an overview of the expanding bioenergy sector with indicative quantifications to illustrate how bioenergy demand might influence land and water use around the world. Examples will also be given of how proper integration of bioenergy systems into forestry and agriculture can even reduce some of the impacts of present land use, such as eutrophication and soil erosion. The aim of the presentation is to provide perspectives on bioenergy and water linkages and to contribute to the dialogue on bioenergy development and the establishment of governance systems to promote sustainable bioenergy supply.

Keywords: Bioenergy

CLONAL PROPAGATION AS A SELECTION CRITERION OF POTENTIAL NEW AVOCADO ROOTSTOCKS

Z Bijzet¹, PJ Robbertse² and FC Wehner³

¹ARC-ITSC, Private Bag X11208, Nelspruit 1200, South Africa; ²Department of Plant Production and Soil Science, University of Pretoria 0002, South Africa ; ³Department of Microbiology and Plant Pathology, University of Pretoria, Pretoria 0002, South Africa

E-mail: zeldab@arc.agric.za

INTRODUCTION

Rootstock material of local and foreign origin is maintained in a gene source block at the ARC-ITSC in Nelspruit (Bijzet *et al.* (1993)). This plant material is utilised in a breeding programme and the resulting seedlings undergo an initial screening with respect to resistance / tolerance to *Phytophthora cinnamomi* to eliminate inferior genotypes. Selections, comprising single surviving seedlings from the initial screening, are multiplied and incorporated in a statistical screening of clonal material. The objective is to determine their performance relative to the clonal Duke 7, which is regarded as a standard or control rootstock in South Africa as it is tolerant to *P. cinnamomi* and is the dominant rootstock in the industry. Selections with a performance better than Duke 7 are promoted to field evaluation and are incorporated in horticultural trials to determine their production potential. Only selections passing both these field tests are released as new rootstocks. Fourteen selections remaining after the initial screening were included in this trial. Clonal multiplication is an important nursery practice and should be included, in addition to *P. cinnamomi* tolerance, as selection criterion for avocado rootstocks.

MATERIALS AND METHODS

The main methods of propagating avocado clonally were described by Frolich & Platt (1972), Ernst (1978) and Moll & Wood (1980). The method of Moll & Wood (1980) was preferred to multiply selected seedlings, since limited material was available for grafting and a large number of plants are required for additional screening tests as well as for horticultural evaluations that might follow at a later stage. Easy and effective clonal multiplication of avocado rootstocks was evaluated by quantifying various parameters such as grafting to first cut, cuttings per nurse seed, percentage of cuttings rooted and number of days to rooting.

RESULTS AND DISCUSSION

The percentage of cuttings that can be successfully rooted is the most important selection criterion with regard to clonal ability and 12 of the 14 selections performed better than 'Duke 7' in this regard. As to the other criteria listed, the majority of the selections performed better than the standard cultivar 'Duke 7' except for the criterion "time from cut to root". Except for Selection K, a local escape tree, which was the best overall performer, the performance of the selections and Duke 7 varied from criterion to criterion.

CONCLUSIONS

The cloning ability of the different selections varied considerably even though they shared the same parent. One of the mechanisms with regard to tolerance in 'Duke 7' is its considerable root growth potential. It would thus be expected that the percentage cuttings that rooted as well as the number of days from cut to root should give an indication of the potential of the selections with regard to one of the mechanisms for tolerance. This was confirmed, as selection K excelled in the screening trial and also excelled in this trial with regard to all the multiplication criteria tested.

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Keywords: Avocado, clonal, multiplication, *Phytophthora cinnamomi*, rootstock, screening

INCREASING WATER PRODUCTIVITY TOWARDS FOOD SECURITY THROUGH RAINWATER HARVESTING AND CONSERVATION

JJ Botha¹, JJ Anderson¹, LF Joseph¹, PP van Staden¹, K Smith¹, DJ Beukes¹ and M Hensley²

¹ARC-Institute for Soil, Climate and Water, P/ Bag X01, Glen, 9360; ²Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300

E-mail: BothaC@arc.agric.za

INTRODUCTION

Subsistence farmers occupy large areas in the semi-arid region of southern Africa. Crop yields and rainwater productivity (RWP) are low because these areas are marginal for crop production due to: (a) low and erratic rainfall; (b) high evaporative demand; and (c) dominantly duplex and clay soils. To improve smallholder productivity, crop production and RWP need to be increased through the application of appropriate rainwater harvesting and conservation (RWH&C) techniques. Rural households have access to arable land (not utilized) and homestead gardens (low production). The objective of this study was to increase crop yield and RWP by making use of appropriate manual RWH&C techniques in homestead gardens and mechanical RWH&C techniques in croplands.

MATERIALS AND METHODS

Crop production was demonstrated in homestead gardens and croplands in South Africa, Botswana and Zimbabwe. In-field rainwater harvesting (*IRWH*) was compared to conventional tillage/farmer's practice (*CON*) in homestead gardens in Thaba Nchu (Free State), Alice (Eastern Cape), Lambani (Limpopo), Palapye (Botswana) and Insiza (Zimbabwe). On-farm cropland demonstrations were laid out at Thaba Nchu (Free State), Krwakra (Eastern Cape), Lambani (Limpopo) and Insiza (Zimbabwe). On-station cropland experiments were conducted at Glen (Free State), Fort Cox (Eastern Cape) and Towoomba (Limpopo) over four seasons (2008/09 - 2011/12). On-farm and on-station treatments included *CON*, *IRWH* (2-m & 2.4-m runoff areas), Daling plough, mechanized basins and minimum/no-till with four replications in a randomized block design. Maize was used as the test crop. Grain yield and RWP were measured and calculated by making use of standard procedures (Botha, 2006).

RESULTS AND DISCUSSION

Seed yields varied between 0 and 5400 kg ha⁻¹. RWP varied between 0 and 5 kg ha⁻¹ mm⁻¹. On-station and on-farm results indicated that: a) in homestead gardens, *IRWH* (manual) resulted in significantly higher yields and RWP values than *CON*; b) RWH&C techniques on the croplands resulted in higher yields and RWP values compared to *CON* due to the total stoppage of ex-field runoff.

CONCLUSIONS

Crop yields and RWP were increased by using RWH&C techniques compared to *CON*. Application of suitable RWH&C techniques in homestead gardens and croplands can lead to household food security in rural communities in semi-arid areas.

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Keywords: Conservation tillage; maize; rainwater harvesting; rainwater productivity

THE EFFECT OF LONG-TERM TILLAGE PRACTICES ON SELECTED SOIL PROPERTIES IN THE SWARTLAND WHEAT PRODUCTION AREA OF THE WESTERN CAPE

PB Botha¹ and WP de Clercq²

¹*Yara Africa, Postnet Suite 1077, Private Bag X10, Fourways North 2086;* ²*University of Stellenbosch, Private Bag X1, Matieland 7602*

E-mail: pbbotha@sun.ac.za

INTRODUCTION

The effect of long-term tillage on basic soil properties with respect to sustainability was investigated in this dissertation. Over the last three decades soil conservation has become an important prerequisite for sustainable agriculture. The primary aim of this study was to evaluate the effect of different tillage practices on some basic soil properties after 37 years of continuous application.

MATERIALS AND METHODS

The research was conducted on the Langgewens experimental farm, 18 km north of Malmesbury in the Western Cape. The soil form is a Glenrosa in with gravelly sandy-loam texture. The experiment started in 1975 with four main tillage treatments; conventional-, tine-, minimum- and no-tillage. The total organic carbon and water stable aggregate percentage were analyzed for the 0-100 mm and 100-200 mm soil depths for each site. Seasonal dry bulk density (0-100 mm) variation was determined by a Troxler surface gamma-neutron meter for in situ measurement. Saturated hydraulic conductivity was analyzed for only conventional and no-tillage treatments for the in-situ 0-300 mm soil depth.

RESULTS AND DISCUSSION

Total carbon content was in general very low and in the 0-100 mm soil depth it decreased in the order of: no- (0.92%), minimum- (0.86%), tine- (0.83%) and conventional tillage (0.51%). Aggregate stability was significantly the lowest under conventional (47.82%) and tine tillage (45.02%) compared to minimum (61.43%) and no-tillage (78.40%) at 0-100 mm depth. The same trend was observed for the 100-200 mm depth. Significant correlation between total carbon content and aggregate stability for the 0-100 mm confirmed that an increase in total carbon in the soil would lead to an increase in aggregate stability. Seasonal bulk density variation was the lowest in no-tillage, which supports the manifestations of stable soil structure. More intensive tillage treatments such as conventional and tine tillage initially showed lower bulk densities, but only for the first month. Thereafter it increased to significantly higher values as the season progressed. This was mainly as a result of hardsetting of the soil which is driven by natural processes, rainfall and the sandy loam texture that is particularly prone to compaction. Hydraulic conductivity studied for conventional and no-tillage showed significant differences. No-tillage (40.99 mm.h⁻¹) showed a noticeably higher conductivity, which remained constant compared to conventional tillage (19.98 mm.h⁻¹) that decreased over time.

CONCLUSIONS

In the long term no-tillage thus stimulated structure formation of a Glenrosa soil form that significantly improved soil properties studied. These properties may influence processes such as water infiltration, water storage, run-off and drainage positively, due to soil property interaction. No-tillage, in terms of sustainability, quantified by the soil properties studied, thus proved to be superior compared to conventional and tine tillage but to a lesser extent if compared to minimum tillage.

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Water Research Commission

Keywords: Long-term effects, Soil properties, Tillage

EFFECT OF ETHYL METHYL SULFONATE (EMS) ON MORPHOLOGICAL CHARACTERISTICS AND SEED QUALITY DEVELOPMENT OF VERNONIA

AB Boyanee¹, AO Odindo¹ and HA Shimelis¹

¹Faculty of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg, 3209, South Africa

E-mail: andybwandola@yahoo.fr

INTRODUCTION

Vernonia (*Centrophus pauciflorus*) is a potential new oilseed crop for industrial use. However, there are several factors which may limit its use; these include poor seed retention, seed dormancy and seed shattering which can result in enormous seed losses. Ethylmethanesulfonate (EMS) has been used to induce mutations that can cause variability and allow for selection of uniform lines with less shattering hence improved seed yield. This study compared two vernonia lines treated with EMS and controls with respect to head number, average head mass/plant and average number of seeds per head and seed germination.

MATERIALS AND METHODS

Two accessions of vernonia lines (Vge-L1 and Vge-L4) treated with EMS were planted in a randomized complete block design in four replicates. The experimental units consisted of 16 (3 m x 6 m) plots. The treated lines and controls were randomly allocated to each block with 0.75 m between-row and 0.4m between plant spacing. Data collected included: number of seeds per head, 100-seed mass (g), number of heads per plant and average seed mass (g) per head. Seed quality was assessed by the determination of germination expressed in percentage.

RESULTS AND DISCUSSIONS

Vge-L4 seeds treated with EMS produced plants with significantly ($P < 0.05$) more heads (89) than control plants (76). Heads harvested from treated Vge-L4 lines differed significantly ($P < 0.05$) from untreated controls with respect to average seed mass (g) per plant (0.89 and 0.76 g plant⁻¹ for treated Vge-L4 and untreated control, respectively). Highly significant differences ($P < 0.001$) were observed with respect to the number of seeds per head between treated Vge-L4 (122) and control (106) and treated Vge-L1 (112) and control (94). Germination (%) was generally low but differed significantly ($P < 0.01$) between the two lines (60 and 58% for treated and untreated Vge-L1, respectively) and (40 and 32% for treated and untreated Vge-L4 respectively).

CONCLUSIONS

The application of EMS increased head numbers and average seed mass per head and number of seeds per head; this could be significant for the potential use of vernonia as a new industrial crop.

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Keywords: *Centropus pauciflorus*, ethylmethane sulfonate, seed quality, vernonia

COULD IMAZAPYR PLAY A ROLE IN MINIMUM TILLAGE OF SUGARCANE FIELDS INFESTED WITH RUNNING GRASSES?

P Campbell

South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300

E-mail: peta.campbell@sugar.org.za

INTRODUCTION

Running grasses like *Cynodon dactylon* (L.) Pers. (Cynodon), *Digitaria abyssinica* (A. Rich.) Stapf (Digitaria) and *Cynodon nlemfuensis* Vanderyst (Stargrass), compete vigorously with newly planted sugarcane and regeneration of the following ratoon crops. Their aggressive habit can even kill the crop, especially in conditions adverse to growth of sugarcane (Campbell 2008, Sutherland 2010). Current recommendations for minimum tillage require control of weeds and volunteer sugarcane with glyphosate prior to replanting sugarcane. When these fields are infested with running grasses, repeated applications of glyphosate are required, thereby increasing the risk of herbicide resistance. Application of a more residual product, imazapyr, which has a different mode of action to glyphosate, might be a valuable alternative option for minimum tillage in fields infested with running grasses. The aim of this paper is to compare imazapyr and glyphosate efficacy for control of running grasses and volunteer sugarcane.

MATERIALS AND METHODS

A series of field trials were conducted in different bioclimatic regions to compare imazapyr with glyphosate and an unsprayed control.

RESULTS AND DISCUSSION

Imazapyr application at 1250 g a.i. ha⁻¹ provided prolonged control of all three running grass species for approximately 24 weeks compared with only 12 weeks for 3600 g a.e. ha⁻¹ glyphosate. In addition, imazapyr at this application rate also killed volunteer sugarcane, with no significant differences between imazapyr and glyphosate. Here, both products severely stunted stalk height and tiller population in the treated sugarcane stools. From these and phytotoxicity trial results (reported elsewhere), imazapyr (240 g a.i. L⁻¹) has now been registered as Arsenal GEN 2® at an application rate of 1250 g a.i. h⁻¹ for control of the three running grasses and cane stool eradication in fields due for replanting.

CONCLUSIONS

It is concluded that imazapyr can be used in a minimum tillage system when the running grasses Cynodon, Digitaria and Stargrass are prevalent in fields due for replanting. Application of imazapyr for control of running grasses will break the cycle of repeated glyphosate applications, and hence help mitigate the potential risk of herbicide resistance.

ACKNOWLEDGEMENTS

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Keywords: *Cynodon dactylon*, weed control, *Digitaria*, imazapyr, glyphosate, sugarcane

PHOSPHORUS MINERALIZATION PATTERN OF POULTRY MANURE AND SEWAGE SLUDGE-BASED PHOSPHO-COMPOSTS

R Chauke¹, FR Kutu¹ and IK Mariga¹

¹University of Limpopo, School of Agricultural and Environmental Science, P/Bag X1106, Sovenga 0727, South Africa

E-mail: nhlohlotel@gmail.com

INTRODUCTION

Most South Africa soils are generally described as fragile and infertile (Mill and Fey, 2003) and often highly deficient in phosphorus (P). The problem is exacerbated by the sub-optimal to no fertilizer use mostly by resource-poor farmers due to high P fertilizer price leading to huge yield losses. The development of cheaper alternative P-nutrient sources to help overcome soil P problems on smallholder farmlands is therefore very crucial.

MATERIALS AND METHODS

Phospho-composts of different mix ratios (5:5, 7:3, 8:2 and 9:1) were produced through windrow thermophilic composting from poultry manure (PM) and sewage sludge (SS) using ground phosphate rock (GPR). Composted PM and SS without ground phosphate addition were included as control. Cured phospho-composts were chemically characterized and used for P mineralization study through laboratory incubation. Each phospho-compost was ground and thoroughly mixed with 1.2 kg surface soil (2 mm sieved) without recent history of P amendment at the rate of 100 kg P ha⁻¹. Thereafter, the amended soils in 15 cm diameter plastic pots including un-amended control were incubated in an Electro Thermal incubator (ETI-9082) at controlled temperatures of 15-25°C. Soil moisture content was maintained below field capacity during incubation. Soil sampling for Bray1 P determination was done at 7, 14, 21, 28, 35 and 42 days after incubation (DAI).

RESULTS AND DISCUSSION

Bray1 P concentration measured in compost amended soils at 14, 21 and 42 DAI differed significantly ($P < 0.05$), and ranged between 5.47 and 11.14 mg kg⁻¹ and between 5.28 and 11.78 mg kg⁻¹ in PM and SS-based phospho-composts, respectively. The 8:2 mix ratio of both PM and SS-based Phospho-composts gave the highest amount of soil extractable P and cumulative P mineralized over the 42 days incubation period. However, the maximum P mineralization was obtained during the first 21 days of incubation.

CONCLUSION

The different phospho-composts showed great potential for amelioration of P-deficiency problems of crops while thermophilic co-composting improved the solubility of P from GPR. There are on-going studies to quantify P bioavailability from the different Phospho-composts to a variety of high-P demanding crops.

Keywords: Ground Phosphate rock, poultry manure, sewage sludge, phospho-compost and P mineralization

PHENOTYPIC AND GENOTYPIC CORRELATIONS AMONG AGRONOMIC AND QUALITY TRAITS OF MAIZE UNDER OPTIMUM AND LOW SOIL NITROGEN CONDITIONS IN SOUTH AFRICA

G Chigeza¹, E Ndou¹, LL Molefe¹, L Moremoholo¹ and K Mashingaidze¹

¹Agricultural Research Council (ARC), P/Bag X1251, Potchefstroom 2520

E-mail: chigezag@arc.agric.za

INTRODUCTION

Increased crop production for food and fibre as well as recent advances in bio-fuel production from plant biomass requires extensive use of nitrogen (N) fertilisers which in most cases is limited under small-holder farming communities. Breeding cultivars with capacity to produce reasonable yield with minimal amounts of fertiliser presents long-term solutions to this challenge (Edmeades *et al.*, 1998). Genetic variability and heritability of grain yield is reduced under stress and use of indirect selection is recommended. For indirect selection to be effective prior knowledge of genetic relationships among traits is a pre-requisite. The objectives of this study were therefore to quantify phenotypic and genotypic correlations among agronomic and quality traits in maize under optimum and low soil N conditions.

MATERIALS AND METHODS

Seventy-two experimental hybrids were evaluated during the 2011/12 cropping season with supplementary irrigation at three sites; Cedara, Taung and Potchefstroom under two nitrogen levels; optimum N (N applied as per soil analysis results) and Low N (trials planted on depleted N blocks). Agronomic traits recorded included grain yield (kg ha⁻¹), number of ears per plant (EPP) and plant height, while quality traits such as protein and starch content were also recorded. The Alpha-lattice design was used at both sites and data were analysed using SAS.

RESULTS AND DISCUSSIONS

High and significant ($p < 0.05$) positive phenotypic correlations between EPP and grain yield, plant height and grain yield were obtained both under optimum and low N conditions. Phenotypic correlations between quality traits such as protein content and grain yield were positive under optimum N but negative under low N conditions. Moderate to low genotypic correlations between grain yield and EPP, grain yield and plant height, grain yield and protein content were obtained under both optimum and low N conditions at the three sites and across sites.

CONCLUSIONS

Both positive and negative phenotypic and genotypic correlations obtained in this study can be used as a guide for indirect selection under low soil N. Results from this study indicate that selection based on EPP will result in increased response to selection for grain yield under both optimum and low N conditions.

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ACKNOWLEDGEMENTS

Authors wish to acknowledge financial support from the Improved Maize for African Soils (IMAS) project.

Keywords: Phenotypic correlation, genotypic correlation, indirect selection, low soil fertility

PRELIMINARY ASSESSMENT OF SEED QUALITY CHARACTERISTICS OF BOTTLE GOURD (*Lagenaria siceraria* (Molina) Standl.) LANDRACES FROM SOUTH AFRICA AND ZIMBABWE

VGP Chimonyo¹ and AT Modi¹

¹University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

E-mail: vgpchimonyo@yahoo.co.uk

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* (Molina) Standl.) seed exists in diverse forms across different varieties (Decker-Walters *et al.*, 2001). There is a dearth of knowledge on the relationship between seed morphology and seed performance, namely, germination and early establishment of seedlings. The objective of this study was to evaluate the variation in seed morphology of different bottle gourd landraces and its relation to seed quality as defined by germination and vigour.

MATERIALS AND METHODS

Six mature fruits of different bottle gourd landraces were collected from subsistence farmers' fields in Richards Bay (KwaZulu-Natal (KZN), South Africa) and Chimbwanda east (Mashonaland East province, Zimbabwe). Seeds from each fruit were characterized for seed parameters (form, colour, length, width, size, mass and thickness), endosperm parameters (length, width, size, mass and thickness), seed coat thickness and mass, and seed coat lignin content. Standard germination test, root:shoot ratio, seedling fresh and dry mass, germination velocity index (GVI) and electrical conductivity were undertaken to establish seed quality and vigour. All experiments were laid out in a randomised design with three replications. Data were subjected to analysis of variance (ANOVA) using GenStat® (Version 14, VSN International, UK). Descriptive statistics were generated (minimum and maximum values, means and standard deviations) to explain variations within traits while, correlations were done to establish relationships among them.

RESULTS AND DISCUSSION

Significant variations were observed across all the measured traits with large differences ($P < 0.001$) being noted for seed and endosperm size, endosperm dry mass, germination percentage, seed coat thickness and EC. Although all traits were significantly different, most were not good indicators of seed quality. Calabash, a large (213.36 mm^2) seeded variety from KZN had poor germination (31.67%) but high seedling dry mass (0.71 g). Small seeded varieties like Cx, also from KZN, had better germination (83.33%), though seedling dry mass was low (0.39 g). Seed coat thickness for Zimbabwean varieties was thicker ($521.25 \mu\text{m}$) than South African varieties ($447.5 \mu\text{m}$) and this trait was inversely proportional to root:shoot ratio ($r = 0.8149$; $p < 0.05$).

CONCLUSIONS

Bottle gourd seed morphology could be a useful trait for selection of planting material in the context of seed germination as a trait. Aspects of seed dormancy and seed physiology and their effect on seed quality still need to be established.

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Keywords: Bottle gourd, seed morphology, seed quality

HIGH RESOLUTION DIGITAL SOIL MAPPING FOR CROP PRODUCTION

JC Coetzee¹, GM van Zijl¹ and PAL le Roux¹

¹University of the Free State, PO Box 339, Bloemfontein 9300

E-mail: coetseejc@ufs.ac.za

INTRODUCTION

In order to make crop farming profitable and provide food for the growing world population, resources must be used as effectively as possible. Because soil is one the most important resources, optimal use is of great importance. For optimal use of soil knowledge of its suitability for various crop production practices is crucial. Creating accurate maps plays a significant role in crop production efficiency. Digital Soil Mapping (DSM) methods have been proven to minimize the production time of suitability maps over large areas and at low to medium resolutions. In this study it was aimed to show that DSM methods could be applied to produce soil suitability maps at a large scale. It was applied on dryland cash crops.

MATERIALS AND METHODS

Forty hectare in the Bainsvlei area near Bloemfontein was selected. Observation points were determined by purposive sampling using SoLIM. The co-variants used were yield data, Land Sat imagery, digital elevation models (DEM) and Spot imagery. Sixteen observations were made for validation, eight at random and another eight along a transect. Soil properties were assigned to suitability classes and soil property maps were created. The soil suitability maps were created by writing rules with expert knowledge in SoLIM.

RESULTS AND DISCUSSION

The maps created are promising. Digital Soil Mapping, already applied in medium to small scale/medium to low resolution surveys, can penetrate the large scale/high resolution field. With improving technology, resulting in finer resolution satellite imagery and DEM's, DSM methods could well be the soil surveying method used in the future in precision agriculture. Yield as developed by the yield monitor, made the biggest contribution to the accuracy of the map.

CONCLUSIONS

DSM can create large scale/high resolution soil maps useful for site specific precision agriculture. Research will improve the accuracy with less field observations.

ACKNOWLEDGEMENTS

Research Cluster 4: University of the Free State

Keywords: High resolution, expert knowledge, co-variants, soil properties, terrain analysis

CROP MODELING IN SOUTHERN AFRICA: DISCUSSION ON CURRENT AND FUTURE ACTIVITIES

O Crespo¹, Y Beletse² et al.

¹*University of Cape Town;* ²*Agricultural Research Council (ARC) - Roodeplaat*

E-mail: olivier@csag.uct.ac.za

Crop modeling has become a well-established technology worldwide to assist research and management in crop production. Also, in Southern Africa projects are underway to develop and apply crop models for various purposes. There is a need to share experiences, to explore ways to collaborate and combine resources for future research. The aim of this session is to facilitate such a discussion.

First, the AgMIP (Agricultural Model Intercomparison and Improvement Project, www.agmip.org.za) initiative is a worldwide project linking climate change, crop modeling and economic impacts. It provides a common approach to compare and improve crop models across the world. Since its inception in 2010, two regional proposals have been accepted for the first phase ending in February 2014. The status of one of these projects will be reported briefly. Future activities of AgMIP and opportunities for collaboration and funding will be explored and discussed.

Second, the Southern African Crop Modeling Network (SACMoN) was initiated in 2010. It aims to facilitate communication and knowledge sharing within the southern African crop modeling community. The status of SACMoN will be presented and avenues for further development explored in order to make it a useful community networking tool and for facilitating local and international modeling research collaboration.

There will also be opportunity for discussion of any relevant regional/international crop modeling themes.

Keywords: Crop modeling, collaboration, networking

CONNECTING SEASONAL FORECASTS AND CROP MODELS TO HELP ON-FARM DECISIONS

O Crespo¹, W Tesfahuney² and S Walker²

¹CSAG – University of Cape Town, Rondebosch 7701, South Africa; ²University of the Free State, Bloemfontein 9300, South Africa

E-mail: olivier@csag.uct.ac.za

INTRODUCTION

Agriculture is required to feed the population and is highly sensitive to climatic parameters. Thus it is one of the most vulnerable sectors to climate change, especially over Africa where several studies have shown likely negative impacts. This study aims at testing the use of tailored downscaled climate forecasts and complementary tools for tactical decisions related to crop production.

MATERIALS AND METHODS

The sites used represent semi-arid areas where maize production takes place in the Free State, South Africa. The APSIM crop model (Keating *et al.*, 2003) was used to simulate maize yield for a range of (1) sowing dates in a three month window around the usual sowing date, and (2) fertiliser amounts ranging from 0 to 150kg N ha⁻¹. An optimisation approach identifies the combination of sowing date and fertiliser amount that is likely to achieve the highest yield and water extraction under ten seasonal forecast alternatives (ten different initial conditions).

RESULTS AND DISCUSSION

The optimisation approach returns a sub set of the explored decision space (sowing dates x fertilisation amounts) as optimal with regards to yield and extractable soil water. In a significant number of cases it appeared that the efficient decisions identified were dense and clearly delimited. It suggests that the approach robustly identifies optimal decisions. We compared those optimal decisions for past seasonal forecasts, with the optimal decisions simulated under historical weather data (1990-1999). Though it is not a perfect match it shows a promising capacity to point in the right direction.

CONCLUSIONS

Initial assumptions were made that do not allow a direct application of the approach (e.g. hindcast, historical data). Ultimately the approach could be used as a new agricultural decision tool translating seasonal forecast information into agricultural impacts.

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Keywords: Agricultural decision making, crop modeling, seasonal forecasts,

CANOPY POSITION AND CONSUMER PREFERENCE FOR THE APPEARANCE AND EATING QUALITY OF 'FORELLE' PEARS

A Cronje¹, KI Theron², EM Crouch², M Muller¹ and WJ Steyn³

¹Department of Food Science, Stellenbosch University, Private Bag X1, Matieland 7602;

²Department of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602; ³Fruitgro Science, PO Box 12789, Die Boord 7613, Stellenbosch

E-mail: 15128415@sun.ac.za

INTRODUCTION

Temperature and irradiance differences within a pear tree canopy may affect the appearance and taste of the fruit. The ultimate objective of this study carried out over two seasons (2011/2012) was to determine whether outer and inner canopy 'Forelle' pears differ in quality attributes and how these differences, if any, relate to consumer preference for the appearance and eating quality of the pears. Mealiness, a soft, dry textural disorder, is often associated with 'Forelle' pears. Since previous studies indicated that mealiness decreases with cold storage duration, the second objective was to investigate the effect of cold storage duration (9, 12 and 16 weeks) on the eating quality of inner and outer canopy 'Forelle' pears.

MATERIALS AND METHODS

Inner and outer canopy 'Forelle' pears were harvested at Glen Fruin, Grabouw at commercial firmness and stored under regular atmosphere at -0.5 °C. After each cold storage period, fruit were ripened at 20 °C for seven days before physio-chemical analyses. A trained panel of eight judges assessed the flavour and texture of the pear samples during descriptive sensory analysis. Consumer preference assessments were held after each cold storage period (ca. 120 consumers per event). Consumers scored their degree of liking of the eating quality and appearance of the fruit using a nine-point hedonic scale.

RESULTS AND DISCUSSION

The incidence of mealiness was greater in outer canopy fruit for both seasons. Results indicated that inner canopy pears were preferred in terms of eating quality. The red blush of the outer canopy pears was preferred with regard to appearance. Outer canopy pears were found to be higher in TSS in both seasons, while the inner canopy pears were higher in TA. The percentage of mealy fruit decreased as the storage period lengthened.

CONCLUSIONS

Inner and outer canopy 'Forelle' pears do differ in their physio-chemical and sensory characteristics and these differences have an effect on consumer preference. The incidence of mealiness was significantly greater in blushed outer canopy fruit in both seasons. The percentage of fruit that were classified as mealy decreased with prolonged cold storage periods.

ACKNOWLEDGEMENTS

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Keywords: Canopy position, cold storage periods, consumer preference, descriptive sensory analysis, eating quality, mealiness

TOMATO BREEDING RESEARCH AT TEXAS A&M UNIVERSITY

KM Crosby¹, DI Leskovar² and JL Jifon³

¹Texas A&M University, VFIC, 1500 Research Pkwy Ste 120, College Station, TX 77845 USA; ²Texas AgriLife Research, 1619 Garner Field Rd, Uvalde, TX 78801 USA; ³Texas AgriLife Research, 2415 E. Hwy 83, Weslaco, TX 78596 USA

E-mail: k-crosby@tamu.edu

INTRODUCTION

Tomatoes are the most important fruiting vegetable crop in the world. Quality, yield, and resistance to biotic and abiotic stresses are crucial traits to both producers and plant scientists. Tomatoes are the number one home-garden and small acreage specialty crop in Texas with 800 ha, though the large processing industry has declined considerably. The tomato breeding program at Texas A&M AgriLife Research has a 60 year history of cultivar development for hot climates. We have conducted a program of pedigree and backcross selection to introgress disease and quality related genes into our high yielding, early maturing, heat-tolerant breeding lines.

MATERIALS AND METHODS

We planted 16 elite inbred lines with heat tolerance and large fruit size (250-400 g) in a greenhouse and generated F1 hybrid seed for field evaluations. Some of the lines carried the following resistance genes: *Ty-2*, *Ty-3*, *Ty-4*, *Ty-5*, *Tm-22*, *Ph-1*, *Ph-2*, *I-2*, *I-3*, *Sm*, *Frl*, *Ve*, *Sw-5*, *Mi-1* and *Asc-1*. We generated 26 new F1 hybrids to combine these disease resistance genes, and fruit quality in determinate, beefsteak types. Seedlings were grown in 200 cell Styrofoam speedling trays and transplanted to a commercial field plot at Edinburg, Texas in mid-August. Commercial checks Ty-gress and Ty-coon and some elite breeding lines were also included. Plants were grown on light blue plastic mulch, with subsurface drip irrigation. Maturity, yield, fruit size, disease symptoms and plant size were assessed in late October.

RESULTS AND DISCUSSION

Severe begamovirus pressure in the field trial allowed us to differentiate resistance phenotypes between lines with the various *Ty* genes. The following order of magnitude in resistance was observed: *Ty-2* + *Ty-3* > *Ty-2* + *Ty-4* = *Ty-2* = *Ty-5* > *Ty-3* > *Ty-4*. The *Ty-2* + *Ty-3* hybrids were completely resistant to the Texas begamovirus complex, while the next 3 combinations were sufficiently resistant to produce good fruits. The *Ty-3* and *Ty-4* genes alone did not provide sufficient resistance to produce good yields or quality. Late maturity was evident in some of the hybrids and lines with the *Ty-3* and *Ty-5* genes. Earliness and large fruit size were achieved in several hybrids, but blossom end deformation was severe in some of the most resistant, high yielding hybrids.

CONCLUSIONS

Severe begamovirus pressure in south Texas will preclude production of any tomatoes without high level resistance from combinations of different *Ty* genes.

ACKNOWLEDGEMENTS

We appreciate the financial support of J&D Produce, Edinburg, TX, and Rio Valley Canning, Donna, TX.

Keywords: Begamovirus, resistance, breeding, hybrids, heat-tolerant, yield

HOW TO DEAL WITH A MULTITUDE OF PESTS AND DISEASES ON GRANADILLA

MS Daneel¹ and WP Steyn¹

¹ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200

E-mail: mieke@arc.agric.za

INTRODUCTION

Granadilla (*Passiflora edulis*) is a small crop in South Africa, of which most fruit is exported - with the consequent restrictions on use of chemicals. Several pests and diseases are found on this crop and very few products are registered for use on granadillas. *Phytophthora*, or root rot, is a devastating disease, especially on the cultivar Ester, and needs to be controlled to prevent the plants from dying. The leaf and fruit spot fungi complex consists of *Septoria*, *Alternaria*, *Colletotrichum* and *Cladosporium*. The lesions on the fruit are spots of a brown or greyish tan colour with a dark green water-soaked halo. Leaf infection can cause considerable defoliation. These fungi are favoured by wet and humid conditions and warmer temperatures. Nematodes, with root knot nematode (*Meloidogyne*) as the most important species, can also cause considerable damage to the crop by destroying the root system.

MATERIAL AND METHODS

Several trials were conducted in 5 granadilla production areas (White River, Nelspruit, Groblersdal, Hoedspruit and Hazyview) for nematode, *Phytophthora* and leaf and fruit spot control over a 2-3 year period. Trials consisted of 6 replicates, and treatments depended on the pest or disease to be treated. Trials were organized in a complete randomized block design. Nematode analysis was done using soil and root samples, whereas *Phytophthora* and fruit and leaf spot were evaluated by indexing disease symptoms on the plant. Applications for nematodes and *Phytophthora* were done throughout the year, whereas fruit and leaf spot was mainly tested and treated during the summer period.

RESULTS AND DISCUSSION

Products that seemed to be effective for *Phytophthora* control were Ridimol Gold, Bendazid, Proplant and Celeste. More environment-friendly products that also might be considered are Dagutat, Biostart and DPress from Microbial Solutions.

Nematode control was obtained in some of the trials but was obscured as soon as *Phytophthora* became serious, since the roots would die of root rot.

Folicur, Score, Flint and Bravo gave excellent control for leaf and fruit spot when applied fortnightly. This resulted in plants having a better canopy, fewer damaged fruit and less spots on the leaves.

CONCLUSION

Optimum management strategies are very important in granadilla production. If the soil is well prepared before planting and irrigation scheduling is done according to the needs of the plants, *Phytophthora* problems will be considerably reduced. Nematodes should be monitored annually and controlled accordingly. In sandy soils consideration might be given to treating the soil before planting.

Leaf and fruit spot is a fungal complex that can do serious damage to the fruit and leaf canopy when not treated. Several products are effective and are in the process of being registered. It is important to rotate products to prevent resistance.

Keywords: Root rot, *Phytophthora*, nematodes, granadilla, leaf and fruit spot, control

DEVELOPMENT OF A COMMUNITY-BASED PRODUCTION MODEL FOR SUBTROPICAL FRUITS

ZC de Beer¹ and M Masevhe¹

¹ARC ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200

E-mail: zaag@arc.agric.za

INTRODUCTION

The Vhembe District is located at the North-western tip of South Africa, in the Limpopo Province. On average, 53% of the labour force in the District is unemployed. Participation of black people in the fruit industry is mainly restricted to serving as farm labourers and as street vendors. This state of affairs is a major impediment towards the attainment of the strategic objectives of black economic empowerment in the agricultural sector. Subtropical climatic conditions make Vhembe district the home of tropical and subtropical crops, and there is all year round production of both fruit and vegetables. Due to the high unemployment rate, most people in Vhembe make a living out of the agricultural produce that is produced on communal farms. There is a need to help the emerging farmers in Vhembe to produce high quality products that can be sold on local and international markets, thus converting small scale farmers into commercial farmers.

MATERIALS AND METHODS

Emerging subtropical fruit farmers in the Vhembe district were assisted in establishing a legal entity in the form of an Agricultural co-operative (Vhembe Subtropical Fruit Co-operative LTD). This co-op serves as the farmer's representative and works hand in hand with project managers and other stakeholders e.g. National Department of Agriculture, Forests and Fisheries (DAFF), Limpopo Department of Agriculture (LDoA), ARC-ITSC and Subtrop (Subtropical Fruit Grower's Association). The Co-operative was registered with the Department of Trade and Industry (DTI) in terms of Co-operatives Act, 2005 (Act No: 14 of 2005). A Board of 11 members representing six subtropical fruit crops in the Vhembe district administers the cooperative. Project beneficiaries were selected, using a set of criteria, by a committee consisting of extension officers, the co-op and project managers. A minimum of 1 ha had to be planted per crop and the farmers were responsible for 50% of the costs. Crops included mango, citrus, avocado, banana, litchi and macadamia.

RESULTS AND DISCUSSION

Discussions were held between the ARC-ITSC, LDoA, DAFF and the farmer's representatives to identify the farmers' needs. It was concluded that farmers needed training in horticultural practices for the different subtropical crops and also required planting material to establish new orchards and/or extend existing orchards. It was later agreed that these plants would be subsidized by 50% of their total cost to ensure ownership by the beneficiaries. Selection criteria were developed in order to select the first pilot beneficiaries of the project. Thirty farmers were selected to be the initial beneficiaries of the project, but the number increased to 63 beneficiaries due to the request of local farmers. During the first phase of the project, 51 597 plants were purchased, and the beneficiaries started planting in October 2007. By 2010 126 292 plants were planted, representing 297 ha with a total of 181 beneficiaries. Banana plantations have been harvested from 2008 with yields of 60 ton/ha. Average banana yield in SA is 30 ton/ha. The other fruit crops take several years to begin bearing and are yet to provide a marketable crop.

Keywords: Vhembe district, subtropical fruit industry, rural farming

PHYSICOCHEMICAL AND HEAVY METAL CHARACTERISATION OF SOILS: IMPLICATIONS FOR MONITORING AND REHABILITATION

O Dikinya¹ and M Zhai²

¹Department of Environmental Science, University of Botswana, P/Bag 0704, Gaborone, Botswana; ²Department of Geology, University of Botswana, P/Bag 0704, Gaborone, Botswana

E-mail: dikinyao@mopipi.ub.bw

INTRODUCTION

Rehabilitation and effective land management of undisturbed areas require a reasonable technical understanding of the dynamic soil ecological functions. Moreover, ecological restoration and land reclamation have become important components of sustainable development strategy (Sheoran *et al.*, 2010). The role played by soils in any ecological system as recycling of materials (Brady and Weil, 1996) cannot be overemphasized.

MATERIALS AND METHODS

We carried out the study to establish the pre-mining environmental site conditions before disturbance by the envisaged mining activities in northeast Botswana. To characterize the pre-mining conditions, we measured; (a) the physicochemical properties of soils and (b) heavy metal pollutants in identified sites. Physicochemical properties were measured using standard methods while heavy metal concentrations were analyzed using a Finnigan MAT Element 2 high resolution Inductively Coupled Plasma Mass Spectrometer (ICP – MS).

RESULTS AND DISCUSSION

Most soils are predominately sandy clay loam (>5% clay) suggesting high potential of natural heavy metal adsorption on soils. The low Na content (ESP~4%) and organic matter content (0.3 – 2.3 %OC) cannot significantly sustain long term aggregate stability and fertility of soils. The stream gradient didn't have downstream effect on the loading of heavy metals on soils. Further most heavy metals are proportionately below the normal concentrations to pose significant potential environmental problems.

CONCLUSION

The results reveal soils vulnerability to change by any disturbances. Changes in soil properties can significantly affect the environmental status of the land and therefore there is compelling need to continuously gather and monitor the environmental site data for possible future mitigations and land rehabilitation.

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Keywords: Heavy metals, monitoring, physico-chemical properties, pollution

THE EFFECTS OF NUTRIENT SOLUTION ELECTRICAL CONDUCTIVITY ON THE GROWTH AND QUALITY PARAMETERS OF *Cucurbita pepo*

PN Dladla¹ and I Bertling¹

¹University of KwaZulu-Natal, Private Bag X01, Scottsville Pietermaritzburg 3209

E-mail: 209517595@stu.ukzn.ac.za

INTRODUCTION

The fact that patty pans (*Cucurbita pepo*) are harvested prior to physiological maturity does not support a prolonged shelf-life, due to accelerated metabolic and biochemical processes. These biochemical processes result in enzymatic browning and microbial attack, leading to a reduced shelf-life of the crop. Previous research has shown that increasing electrical conductivity (EC) of the nutrient solution can mitigate the poor shelf-life and quality of patty pans. Therefore, patty pans were grown in a closed hydroponic system. The influence of two concentrations of nutrient solution (2.5 dSm⁻¹ and 2.1 dSm⁻¹) on the fruit quality parameters and sensory properties of patty pans were investigated.

MATERIALS AND METHODS

Hybrid squash (STAR 8081) was planted in a closed hydroponic system and harvested at commercial maturity while the exocarp was still soft. Plants were maintained under a 2.1 or 2.5 dSm⁻¹ EC nutrient solution applied every 2nd or 4th day. Patty pans were assessed for fruit yield, leaf area, colour intensity, mass loss, respiration rate, as well as the exocarp assessed for electrolyte leakage, total phenolics and total carotenoids.

RESULTS AND DISCUSSION

In line with reports on other crops (Awang and Atherton, 1995), the application higher EC nutrient solution to patty pan plants significantly ($P = 0.05$) influenced fruit yield and shelf-life. Fruit yield was higher under the 2.5 dSm⁻¹ than the 2.1 dSm⁻¹ regime ($F=0.034$). The former treatment resulted in fruit with minimal display of microbial spoilage and longer shelf-life. Shelf-life showed improvements after cold storage ($F=0.003$).

CONCLUSION

Future research should focus on a broader EC range, so as to obtain a specific EC for the production of highest quality patty pans.

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Keywords: *Cucurbita pepo*, electrical conductivity, fruit quality, hydroponic system, patty pans

THE EVALUATION OF DIFFERENT GIBBERELLINS, IN COMBINATION WITH 6-BENZYLADENINE, AMINOETHOXYVINYLGLYCINE, PROHEXADIONE-CALCIUM AND GIRDLING ON FRUIT SET AND YIELD OF 'FORELLE' PEARS

C Dreyer¹ and KI Theron¹

¹*Dept of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602*

E-mail: carlien@tad.co.za

INTRODUCTION

Maintaining constant high yields in 'Forelle' orchards in South Africa is challenging. This may be due to vigorous growth and consequently low fruit set, which can also lead to biennial bearing (Lafer, 2008). Exogenous gibberellins (GAs) are often applied to increase fruit set, but the outcome is not always positive because of smaller fruit size and a reduction in return bloom. An increase in initial fruit set can be observed when GAs are applied, but often this is partially lost again during June drop (northern hemisphere) (Vercammen & Gomand, 2008). In addition, set can be improved by reducing vegetative growth by applying plant growth regulators (PGRs) or by girdling. Various protocols to improve fruit set are used by South African producers without knowing whether these indeed improve set.

MATERIALS AND METHODS

Different combinations of plant growth regulators including gibberellic acid(GA₃), gibberellins 4+7 (GA₄₊₇), GA₄₊₇combined with 6-benzyladenine (6-BA), or aminoethoxyvinylglycine (AVG) or prohexadione-calcium (P-Ca) in combination with trunk girdling were applied to mature 'Forelle'trees in the Elgin region to determine the best fruit set strategy. Treatments were applied during the bloom period. Fruit set, yield, fruit size at harvest, one-year-old shoot growth and return bloom was determined over two consecutive seasons in a randomised complete block design.

RESULTS AND DISCUSSION

All applied growth regulators improved fruit set relative to an untreated control over two consecutive seasons. Both GA₃ and P-Ca containing treatments reduced return bloom and AVG resulted in smaller fruit size relative to the other treatments. Girdling was not effective in reducing vegetative shoot growth or increasing set.

CONCLUSIONS

GA₄₊₇ appears to be a promising treatment to increase fruit set, while maintaining good fruit size and optimal yields on 'Forelle'

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ACKNOWLEDGMENTS

Restanwold and Oak Valley Estate for their orchards and SASPPA for funding.

Keywords: aminoethoxyvinylglycine, 6-benzyladenine, fruit set, gibberellic acid, gibberellins 4+7, prohexadione-calcium

DEVELOPMENT OF A SMALL SCALE AGRICULTURAL PRODUCTION MODEL IN THE EASTERN CAPE

RJ du Preez¹, K de Jager¹, PC Jones², P Oliphant² and MG Bongo²

¹ARC-Institute for Tropical and Subtropical Crops, P/Bag X11208, Nelspruit; ²Is'Baya Development Trust, P O Box 5252, Cape Town, 8000

E-mail: rosedup@arc.agric.za

INTRODUCTION

The aim of this model is to enable small scale farmers in rural villages to access markets and create sustainable commercial production. Lead farmers in a village are organized into primary marketing and supply co-operatives so as to enable them to achieve the following:

- o make the transition from subsistence farming to commercial production;
- o have access to timely & quality technical services; and
- o be able to convert these inputs into improved livelihoods.

The long term outcome of the programme will be a functional rural village with a vibrant economy. The key to eradicating current poverty in rural areas is to focus on the creation of dynamic rural communities founded on prosperous farming.

MATERIALS AND METHODS

Fruit trees are planted as part of an integrated farm system where vegetable and maize production is also carried out. An integrated production system has been developed successfully using locally produced manure, compost and mulch and no synthetic chemical sprays. Ongoing technical training is undertaken on all aspects necessary to ensure that farmers are capacitated to produce high value crops as an economic enterprise. Technical training is carried out in the villages throughout the year. Training on business development and marketing are also covered.

RESULTS AND DISCUSSION

Production in 30 participating villages has increased as trees come into full production, and the organization of the lead farmers in these villages to form a primary agricultural supply and marketing village co-operative has been completed. The village farmer co-operative provides uniformity in quality by inspection during production, at harvest and upon delivery. Uniform preparation of a commodity for a buyer will also be achieved, as can minimization of the numbers of farmers with whom a commodity purchaser must do business.

CONCLUSION

As the co-operatives become fully functional the economic well-being of the villages will increase. Greater self-reliance will occur with national government inputs and more local and private sector investment. The model can then be implemented in other rural areas of South Africa.

ACKNOWLEDGEMENTS

Thina Sinako and ARC for funding. All participating communities

Keywords: Rural development, fruit trees, integrated farming, co-operatives, marketing

PHYSIOLOGICAL RESPONSE OF TWO CONTRASTING SUGARCANE GENOTYPES TO DROUGHT STRESS

AB Eksteen¹ and A Singels¹

¹SASRI, 170 Flanders Drive, Mount Edgecombe, Durban 4300

E-mail: alana.eksteen@sugar.org.za

INTRODUCTION

High biomass-yielding sugarcane cultivars (energy-cane) may be good candidates for bio-energy production in marginal areas. However, a better understanding is required of how much water would be used and of their tolerance to drought. The aim of the study was to measure the response in water use, plant water status and photosynthesis of an energy-cane genotype (G73) and to compare this with a commercially grown conventional sugarcane cultivar (N19).

MATERIALS AND METHODS

The trial was planted in October 2011 under a rainshelter facility at Mount Edgecombe, South Africa. The rainshelter facility had sandy soil with a field capacity of $0.2 \text{ m}^3 \text{ m}^{-3}$, and four plots were planted with 6 replicate rows each. Two plots received adequate water throughout, while the other two received no irrigation after 10 February 2012. Volumetric soil water content was measured with a neutron water meter and daily sap flow was recorded using the non-intrusive heat-balance method. Leaf water potential (ψ_L) was measured periodically with a pressure chamber, while instantaneous photosynthetic rates and stomatal conductance were measured with a LiCor 6400 from February 2012 until the final harvest in May 2012.

RESULTS AND DISCUSSION

Crop transpiration rate estimated from sap flow observations compared well with transpiration estimates from soil water balance determinations. The average ratio between sap flow derived transpiration and the Penman-Monteith sugarcane reference evaporation was 0.90 and 1.49 for N19 and G73, respectively. Under well-watered conditions, G73 transpired at a much higher rate than N19. G73 maintained similar ψ_L to that of N19 under stressed conditions, despite experiencing lower soil water contents. G73 exhibited higher rates of photosynthesis (A_n) compared with N19 during the first 21 days of water stress, after which both genotypes displayed A_n consistent with stomatal closure.

CONCLUSIONS

N19 displayed reduced transpiration and photosynthetic rates much sooner and at a higher soil water content than G73 during the development of stress events. This resulted in G73 depleting the root zone more rapidly than N19. Early stomatal closure, early leaf shedding and osmotic adjustment are possible mechanisms for drought tolerance (Inman-Bamber & De Jager, 1999). N19 demonstrated greater stomatal sensitivity to water stress than G73 but no significant difference was found for osmotic adjustment between the two genotypes. This information is useful for determining the feasibility of growing energy-cane in marginal areas.

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ACKNOWLEDGEMENTS

The authors gratefully acknowledge the technical support of Sivuyile Ngxaliwe, and the SASRI technical team, and Yuriy Tsupko for the planning of the trial.

Keywords: Drought stress, energy cane, leaf water potential, photosynthesis

REPRODUCTIVE PHENOLOGY AND BUD ABORTION OF CULTIVATED *Disa* HYBRIDS

E Franken¹, EW Hoffman¹ and KI Theron¹

¹Stellenbosch University, P.O. Box X1, Matieland, Stellenbosch 7600

E-mail: 15032930@SUN.AC.ZA

INTRODUCTION

The South African orchid *Disa* with its distinctive range of colours and unique triangular shaped flowers show untapped horticultural potential. However, the current understanding of the mechanisms driving development and flowering are insufficient to assist growers in developing strategies to manipulate flowering time. The aim of this research was thus to determine the time of floral initiation for two *Disa* cultivars and to document floral differentiation until anthesis. This is also a first report on bud abortion and floral abnormalities observed in *Disa* under greenhouse cultivation.

MATERIALS AND METHODS

The study was conducted by means of bi-weekly dissections of 8-10 greenhouse cultivated plants from March-October 2011 of two commercial *Disa* cultivars and observations were made via light- or scanning electron microscopy. Time of floral initiation and stages of floral differentiation were recorded. Vegetative growth parameters throughout the phenology such as plant height, leaf area, number of leaves and leaf- and root dry weight were also recorded.

RESULTS AND DISCUSSION

Dissections revealed that floral initiation differed by approximately one month between hybrids (May and June, respectively). Initiation coincided with a possible low temperature, or short day photoperiodic response. The differentiation of the oldest flower of the inflorescence was divided into ten phases. Duration of floral differentiation for the hybrids used was between 15 and 16 weeks, longer than documented for other orchids (Goh and Arditti, 1985) and geophytes (De Hertogh and Le Nard, 1993). Bud abortion of the two youngest flowers and the apical meristem was observed. Bud abortion, though a common phenomenon within Orchidaceae and geophytes, has not been documented in *Disa*. The cause of abortion in *Disa* is discussed.

CONCLUSION

The timing of floral initiation for two of the commercial hybrids was elucidated and provides a basis for further studies on manipulation of flowering time. This study provided the first report on bud abortion within this genus and it might be an important physiological disorder affecting marketability and profitability of *Disa* hybrids.

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ACKNOWLEDGEMENTS

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Keywords: differentiation, initiation, *Disa uniflora*, geophyte, Orchidaceae

EFFECTS OF POTASSIUM HUMATES AND FULVATE ON THE LEACHING OF N, P, K AND THE CULTURABLE SOIL MICROBIAL COMMUNITY

AJ Gatabazi¹, PC de Jager¹, A van der Merwe¹ and JT Vahrmeijer²

¹Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002, South Africa; ²Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002; Citrus Research International, Nelspruit 1200, South Africa

E-mail: auges2005@yahoo.fr

INTRODUCTION

Potassium humates and fulvates are promising carbon-rich products that can be used to increase crop production and to reduce nitrogen (N), phosphorus (P) and potassium (K) fertilisation (Selimet *et al.*, 2009). Humic acids serve as a catalyst in promoting the activity of microorganisms (Sharif *et al.*, 2002). This study aimed to determine the effects of potassium humates and fulvate on leaching of NPK and the culturable soil microbial community.

MATERIALS AND METHODS

Leaching columns were laid out in CRBD with nine treatments and four replicates. A laboratory scale leaching column study was conducted using a sandy clay loam soil. The sandy clay loam soil used was supplemented with two different fertiliser application rates (220-50-80 NPK and 165-37.5- 60 NPK kg·ha⁻¹) with and without potassium humates or fulvate (200 kg·ha⁻¹). A high and low ash content humates were used. The columns were subjected to wetting and drying. After wetting, leachate was collected from the treatments and analysed for N, P and K concentrations. For microbial analysis, samples were collected (initially, after 2 and 4 weeks), serially diluted and plated onto TSA (Tryptone Soy Agar) and PDA (Potato Dextrose Agar). The plates were incubated at 25°C for 48h for the enumeration of bacteria and 72h for the enumeration of fungi.

RESULTS AND DISCUSSION

The results showed that K-humates and fulvates reduced N leaching ($p < 0.001$). Inconsistent results were found for K and P. After four weeks, bacterial and fungal counts were highest in soil treated with potassium humates and fulvate compared to soils containing no potassium humates and fulvate.

CONCLUSIONS

Potassium humates and fulvate reduce N leaching and increase soil microbial community.

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Keywords: Fulvate, leaching, microbial community, potassium humates

COSTS AND BENEFITS OF GREEN MANURING IN SUGARCANE

CG Gillitt¹, R Rhodes² and SRD Ferrer³

¹South African Cane Growers' Association, PO Box 888, Mount Edgecombe 4300; ²South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300; ³Honorary Research Fellow, School of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg

E-mail: ruth.rhodes@sugar.org.za

INTRODUCTION

'Green manuring' is the practice of growing an alternative (unharvested) crop or plant species between planting cycles of the primary agricultural crop. Agronomic benefits of green manures in sugarcane systems include yield improvements in plant cane, and possibly also the first and second ratoons. Added costs of the practice include increased management requirements and land preparation and input costs, as well as lost sugarcane production attributable to delayed replanting. This study investigated the profitability of green manuring relative to alternative dryland sugarcane production systems in the North Coast region of KwaZulu-Natal. It builds on previous work (Rhodes *et al.* 2012) by accounting for (a) impacts of weed-fallows on weed control costs and (b) yield penalties due to Ratoon Stunting Disease (RSD). Input costs have also been updated.

MATERIALS AND METHODS

Using conventional capital budgeting techniques, modified internal rates of return (a measure of profitability) for green manure fallow, weed-fallow and no-fallow systems were computed. A range of scenarios were studied, based on the date of final harvest (early-, mid- or late-season) of the previous sugarcane crop. For each scenario a schedule of farming activities was established on a monthly basis for an entire cane cycle, i.e. a 10-12 year period from harvest of the previous crop until the final harvest of the replanted crop. A sensitivity analysis of profitability to changes in key assumptions was conducted.

RESULTS AND DISCUSSION

Green manure fallows economically outperformed both weed-fallow and no-fallow options (7.56%, 7.43% and 6.69% return on investment, respectively) in the late-season harvest scenario. For early season harvests, there is usually no option for a straight plough-out replant (i.e. no fallow); but in this scenario, green manure fallows again outperformed the weed fallows (7.52% vs 7.35% return on investment, respectively). For the mid-season harvest scenario, the green manure option (7.13%) was more profitable than that of no-fallow (6.64%), but remained slightly less so than the weed fallow (7.22%) for the mid-season harvest.

CONCLUSIONS

Sugarcane farmers in SA can enjoy agronomic benefits of green manuring without significantly compromising profits. Green manures improve profitability in most of the scenarios contemplated in this paper.

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ACKNOWLEDGEMENTS

Expert advice received from Peta Campbell, Rowan Stranack and Sharon McFarlane is gratefully acknowledged.

Keywords: Economics, fallow, green manure, profitability, sugarcane, weeds

ESTIMATION OF SUNSHINE DURATION FROM SOLAR IRRADIANCE MEASUREMENTS FOR IMPLEMENTATION INTO A WEB-BASED ENVIRONMENTAL MONITORING SYSTEM

BR Grant¹ and MJ Savage¹

¹University of KwaZulu-Natal (UKZN), P/Bag X01, 3209 Scottsville

E-mail: savage@ukzn.ac.za

INTRODUCTION

Sunshine duration data are used as a simple description of the climate of a site and surrounding area which has economic implications on tourism and human health as well as for estimating diffuse irradiance. There is also a long standing tradition of SD measurements at weather stations for inclusion in daily weather data. The need to replace the manual method of SD measurement with an accurate estimation using automatic weather station measurements is apparent. The objectives of the study were to estimate sunshine duration (SD) from routine (automatic weather station) measurements of solar irradiance and to compare such estimates with measured SD from a sunshine recorder.

MATERIAL AND METHODS

Three commonly used algorithms for determining SD from 2-minute solar irradiance measurements were used in this study, at the University of KwaZulu-Natal (UKZN) weather station (Pietermaritzburg, KwaZulu-Natal, South Africa), for the period 01/06/2011 to 31/05/2012. Additional data from Cedara were also used for model testing. The accuracy of the Royal Dutch Meteorological Institute (KNMI) and Campbell Scientific (CS) algorithms were compared to an algorithm used by the World Meteorological Organization (WMO). The near real-time SD data could be viewed or downloaded using the Internet: <http://agromet.ukzn.ac.za:5355/?command=RTMC&screen=Sunshine>

RESULTS AND DISCUSSION

Although the WMO and KNMI methods showed good agreement (coefficient of determination of 0.99), the KNMI SD estimation presented a significant daily root mean square error (RMSE) of 0.89 h. This was attributed to incorrect locality correlation coefficients and not to the previously hypothesized miscalculation of the solar elevation angle. Seasonal correlation coefficients were then produced for the UKZN study site to decrease the daily RMSE to 0.32 h. Monthly correction equations were used to increase the accuracy of the CS algorithm for use at the UKZN weather station. The 'corrected' algorithm has been successfully implemented into the web-based environmental monitoring system and has been tested against the WMO results for June, July and August 2012, generating a RMSE of 0.46 h with a coefficient of determination of 0.99.

CONCLUSIONS

All methods for estimating SD showed good correlation although the KNMI algorithm underestimated SD during winter. The WMO algorithm was determined to be the standard although complex. Therefore the CS algorithm was used for the web-based system.

ACKNOWLEDGEMENTS

The UKZN Teaching and Learning Office and the NRF funded the web-based system. The WRC funded some of the equipment used in this research.

Keywords: Diffuse radiation, near real-time radiation measurements

SYMBIOTIC NITROGEN FIXATION AND CARBON ASSIMILATION IN PROMISCUOUS AND NON-PROMISCUOUS SOYBEAN GENOTYPES INOCULATED WITH *Bradyrhizobium japonicum*

C Gyogluu¹, SK Boahen² and FD Dakora¹

¹Tshwane University of Technology, Private Bag X680, South Africa; ²International Institute of Tropical Agriculture, Mozambique

E-mail: cynthia.gyogluu@gmail.com

INTRODUCTION

Soybean is an economically important legume that has great potential in alleviating protein malnutrition and improving soil fertility on the African continent. The breeding of promiscuous soybean varieties was a step towards encouraging soybean cultivation, especially by small holder farmers, as the need for commercial inoculants is negated. These genotypes have however exhibited poor performance without inoculation at some locations (Pule-Meulenberg *et al.* 2010). This study evaluated the effect of inoculation on the nitrogen fixing and carbon assimilation efficiency in promiscuous and non- promiscuous soybean genotypes.

MATERIALS AND METHODS

Four promiscuous and three commercial soybean varieties were planted at two IITA experimental sites in Mozambique (Ruace and Mutequelesse), in the 2008/2009 planting season. The experiment was laid out in a randomized complete block design with four replications. The soybean genotypes were either inoculated or uninoculated with a peat based *Bradyrhizobium japonicum* inoculant strain WB74. Plant samples were processed for isotopic analysis using mass spectrometry. Data was analyzed using STATISTICA.

RESULTS AND DISCUSSION

A 3-Way Anova analysis of the data revealed that, the soybean genotypes, irrespective of inoculation and location, showed significant ($p=0.05$) differences in their biomass accumulation, N-fixed, % C, C content and $d^{13}C$. Inoculation resulted in greater dependence of the genotypes on symbiotic fixation for their N nutrition, and increased the amount of N-fixed. A greater C concentration and content was obtained in soybean shoots, grain, and on whole-plants at Ruace relative to Mutequelesse. A positive inoculation x environment interaction for grain and whole plants $d^{13}C$ was also found.

CONCLUSIONS

The seven soybean genotypes responded positively to inoculation, resulting in high N_2 fixation. The high N fixed by inoculated plants could have increased Rubisco synthesis, which resulted in higher photosynthetic rates and increased C concentration.

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SA Research Chair in Agrochemurgy and Plant Symbioses, TUT and IITA

Keywords: *B. japonicum*, carbon assimilation N_2 fixation and promiscuous soybean

INDUCTION OF POLYPLOIDY IN *Hibiscus sabdariffa*, AN IMPORTANT MEDICINAL AND NUTRITIONAL PLANT SPECIES

K Hannweg¹ and A Sippel¹

¹ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200

E-mail: karin@arc.agric.za

INTRODUCTION

The genus *Hibiscus* has more than 300 species which are distributed throughout tropical and subtropical regions of the world. Most hibiscus species are used as ornamental plants, but many are believed to have certain medicinal properties; among them is *Hibiscus sabdariffa*. *Hibiscus sabdariffa*, thought to be native to Asia or tropical Africa, is a shrub belonging to the family Malvaceae. The plant is rich in phytochemicals and many parts of the plant, including seeds, leaves, fruits and roots, are used in various foods and beverages as well as having a multitude of health benefits. The results presented form part of a greater plant improvement study for *Hibiscus sabdariffa*.

METHODS AND MATERIALS

One hundred seeds were treated either overnight or for three days in 0.01 g/l, 0.1 g/l, 1.0 g/l and 10.0 g/l colchicine solutions. Treated seeds were allowed to germinate in the mist bed and planted out in 1 litre planting bags in a 1:1 mixture of sand and pine bark when they were large enough to handle. The effect of colchicine concentration and exposure time on seed germination and seedling survival was recorded. Induced polyploids were verified by flow cytometry analysis using a Partec Cyflow Space Ploidy Analyser. Standard methods were used for sample collection, nuclei isolation and staining. Polyploid lines were propagated and horticultural characteristics such as seed size and yield, biomass production together with stomatal size and density were evaluated. Statistical analysis was carried out by ANOVA using Student's t-test.

RESULTS AND DISCUSSION

Exposure time and colchicine concentration had a marked effect on seed germination as well as subsequent seedling survival. Seedling survival dropped markedly 42 days after germination for the 3-day treatment compared with the overnight treatment. Pure tetraploid lines were obtained for both exposure times although at different concentrations. Stomatal distribution was significantly lower for the tetraploids than the diploids and stomatal size was higher in tetraploid lines. Biomass accumulation was lower in the tetraploids than the diploids even though tetraploid leaves were thicker than diploid leaves. Tetraploid plants had larger flowers than their diploid counterparts. Seed yield and seed size was significantly different between diploid and tetraploid lines with the tetraploid lines setting fewer, larger seeds than the diploid lines.

CONCLUSIONS

A method for the induction of polyploidy in *Hibiscus sabdariffa* was developed. Populations of plants are being proliferated for use in further evaluation trials to investigate the effect of polyploidy on the species. Traits under investigation will include photosynthetic capacity, drought tolerance, nematode tolerance, phytochemistry profiles and nutritional value.

Keywords: Roselle, chromosome doubling, nutraceutical, plant improvement

IMPROVING FRUIT QUALITY AND TREE HEALTH OF *Prunus persica* CV. 'SANDVLIET' THROUGH FOLIAR APPLICATIONS OF VARIOUS COMPOUNDS

DT Hendricks¹, E Lötze¹ and L Hoffman¹

¹Department of Horticultural Science, University of Stellenbosch, Private Bag XI, Stellenbosch, 7602 Matieland, South Africa

E-mail: 15137201@sun.ac.za

INTRODUCTION

The fruit production industry is under severe pressure to reduce its dependence on chemicals, while increasing yield and quality. Flavonoids and salicylic acid (SA) have been identified as elicitors of plant resistance, and may benefit fruit quality. SA, especially, is key in the establishment of systemic acquired resistance (SAR). This study was conducted to determine the efficacy of a number of foliar applied formulations to improve tree health and fruit quality, and reduce *Xanthomonas* infection of peaches.

MATERIAL AND METHODS

The trial was carried out over the 2008/09 and 2011/12 seasons in the Worcester area, Western Cape, South Africa on 'Sandvliet' peaches. During the first season 12 treatments was used, with only 5 treatments used during the second season. The Alexin and Xanbac treatments were repeated, as they showed the most positive results. The main treatments contained either salicylic acid (AlexinTM), flavonoids (CropbiolifeTM), dichlorophen (XanbacTM) or potassium (K-MaxTM). The treatments were applied as foliar treatments and sprayed until the point of runoff. The *Xanthomonas* infection on the leaves and fruit was determined, as well as fruit mass, height and diameter. The yield, yield efficiency, shoot length, total soluble solids (TSS), titratable acidity (TA), firmness, back ground colour and shrivelling was also determined.

RESULTS & DISCUSSION

The AlexinTM treatment significantly reduced the *Xanthomonas* infection on both leaves and fruit compared to the control. In the XanbacTM treatment, significantly positive results for the *Xanthomonas* infection of the fruit were only achieved in season two. The CropbiolifeTM and K-MaxTM treatments significantly reduced the *Xanthomonas* infection of the fruit during season two. AlexinTM significantly increased fruit mass in season one and diameter in both seasons. XanbacTM resulted in higher fruit mass in season one and diameter in season two compared to the control. CropbiolifeTM and K-MaxTM both increased fruit diameter. All of the treatments in season two had a negative effect on the shoot lengths compared to the control, as they recorded shorter shoots.

CONCLUSION

The study suggests that salicylic acid (AlexinTM), flavonoids (CropbiolifeTM), dichlorophen (XanbacTM) and potassium (K-MaxTM) can reduce the *Xanthomonas* infection of peaches, and positively affect fruit quality, however results may vary. Thus the long term effect of these compounds still requires attention.

Keywords: Salicylic acid, foliar sprays, flavonoids, systemic acquired resistance

THE USE OF INVASIVE ALIEN SPECIES AS AN ALTERNATIVE SUBSTRATE IN THE CULTIVATION OF *Pleurotus ostreatus*

IN Hlerema¹, BK Eiasu¹ and SH Koch²

¹Department of Agronomy, University of Fort Hare, Private Bag X1314, Alice 5700;

²Agricultural Research Council, Plant Protection Research Institute, Private Bag X134, Pretoria 0001

E-mail: 200910041@ufh.ac.za

INTRODUCTION

Oyster mushroom (*Pleurotus ostreatus*) has the potential to utilize residues of various agricultural and wild plant species and South Africa is facing a rapid increase of alien invasive plant species. The aim of this study was therefore to determine usability of invasive *Acacia* species as alternative substrates for oyster mushroom production.

MATERIALS AND METHODS

Plant material of three *Acacia* species, *A. mearnsii* (black wattle) (BW), *A. dealbata* (silver wattle) (SW), *A. decurrens* (green wattle) (GW), maize bran (MB) and wheat straw (WS) were used in this experiment. The treatments applied were BW, SW, GW, 50%BW+50%MB, 50%SW+50%MB, 50%GW+50%MB, 50%BW+50%WS, 50%SW+50%WS and 50%GW+50%WS. Fifty percent of each substrate combination (Treatment) was soaked in a 3% lime solution and the other fifty percent in tap water for 12 hours to leach out the tannin from the wattle substrate. Thereafter, all substrates were heat treated for two hours in a hot water bath and inoculated with *P. ostreatus* spawn, bagged and incubated at an average temperature and relative humidity of 18°C and 57%, respectively. Substrate temperatures, days to full colonization of substrate, pinning, fruit body formation and yield were recorded.

RESULTS AND DISCUSSIONS

The highest biological efficiencies (BE), 76 and 67%, were recorded for the SW+WS+Lime and BW+WS+Lime treatments, respectively. The treatments that included MB, as well as BW and GW-lime were not suitable for mushroom growth, resulting in zero biological efficiency. The mushroom fruit body protein content ranged from 2.33-4.82% on a fresh weight bases. The lowest mushroom protein content (2.3%) was registered for the wheat straw based treatment, whereas GW + WS-lime had the highest (4.82%). Amongst the wattles (BW, SW and GW) the protein content ranged from 3.64 to 4.26%. Soaking in lime increased the BE and substrate pH. There was a negative correlation ($r = -0.65$) between yield and protein content.

CONCLUSIONS

The results indicate that black wattle and silver wattle have the potential to be used as supplements to grass based substrates in oyster mushroom production for improving protein content.

Keywords: *Acacia*, biological efficiency, black wattle, green wattle, oyster mushroom, silver wattle, tannin

EFFICACY OF GRAMINICIDES REGISTERED ON MAIZE TO CONTROL NAKED CRABGRASS (*Digitaria nuda* Schumach.)

E Hugo¹, AEJ Saayman-Du Toit¹ and CF Reinhardt²

¹ARC-Grain Crops Institute, Private Bag X1251, Potchefstroom 2520; ²Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002

E-mail: HugoE@arc.agric.za

INTRODUCTION

Difficulties to chemically control large crabgrass in maize in South Africa have recently been attributed to the occurrence of naked crabgrass, mistakenly regarded as large crabgrass. The efficacy of herbicides containing acetochlor and s-metolachlor, regularly applied to control large crabgrass, has not been evaluated for the control of naked crabgrass. The aim of this study was to determine the efficacy of herbicide spraying programs most commonly used by producers in maize production to control grass infestations and to determine their efficacy on naked crabgrass.

MATERIALS AND METHODS

A glasshouse trial was done with pre-emergence (Pre-E) herbicides containing acetochlor and s-metolachlor on two soil types to compare control of large crabgrass and naked crabgrass. A follow up field trial was conducted where nine herbicide programs used commonly to control grass infestations in maize production in South Africa were compared for their efficacy to control naked crabgrass. Three programs included only one Pre-E application, another three programs included only one post-emergence (Post-E) application and three programs included Pre-E applications followed by Post-E applications. The trial was conducted on a sandy/clay loam soil (26% clay). Herbicide dosage rates were applied according to the label rate for each active ingredient as registered for use in maize production. The number of naked crabgrass seedlings emerged was counted in treatments at two, three and eight weeks after application and percentage control for each treatment was expressed as a function of the mean number of naked crabgrass seedlings recorded in control treatments. The percentage grass cover (mat-forming or tufts) was visually rated on a 0 to 100% scale where 0% indicated no grass coverage and 100% indicated complete coverage of a treatment block.

RESULTS AND DISCUSSION

Naked crabgrass seedlings started to emerge two weeks after herbicide application and increased to more than 50% when compared to control treatments in the glasshouse trial. In the field, a single application of pre-emergence herbicides (chloroacetamide group) gave poor control of only 60% three weeks after application. Re-infestation of naked crabgrass was >50% within six weeks after application. Naked crabgrass control in herbicide programs consisting of only one post-emergence application of either glyphosate or paraquat was less than 44% due to re-infestation (60%) two weeks after application. Naked crabgrass was most effectively controlled (85 – 100%) in herbicide programs consisting of pre-emergence applications from herbicides in the chloroacetamide group followed by post-emergence applications of herbicides containing callistomones and triketones.

CONCLUSION

Late infestation levels of naked crabgrass can be significant. In areas where this *Digitaria* spp. has been predominantly identified, effective control will only be achieved with Pre-E herbicides followed by Post-E herbicide application three to four weeks after planting to prevent significant yield losses.

Keywords: Acetochlor, glyphosate, mesotrione, residual activity, s-metolachlor

QUANTIFYING WATER USE OF PECANS

NA Ibraimo¹, NJ Taylor¹, JG Annandale¹, JM Steyn¹, S Ghezehei¹ and MB Gush²

¹University of Pretoria, Pretoria 0002; ²CSIR, Stellenbosch 7599

E-mail: nadiaalcinaibraimo@yahoo.com.br

INTRODUCTION

There is currently a gap in knowledge in water use of fruit tree orchards in South Africa, which often results in poor irrigation water management. Consequently, the Water Research Commission of South Africa solicited a research project in 2006 to quantify water use of fruit tree species. Water use of fruit tree orchards varies depending on several factors and making measurements under a wide range of field conditions is time consuming and expensive. Crop water use modelling is therefore an effective way to estimate water use of fruit tree orchards under a wide range of conditions.

MATERIALS AND METHODS

Transpiration of mature pecans was monitored for three consecutive growing seasons (from 2009 to 2012) at Cullinan, South Africa and soil evaporation was estimated for the experimental period using the dual crop coefficient approach of the FAO56 model. These estimates, together with transpiration values, were used to obtain water use from the orchard. A simple equation developed in New Mexico, USA, by Samani et al. (2011), which uses fractional ground cover (fc) to predict crop coefficients and water use of pecans, was tested for seasons with differing fc and weather conditions, by comparing actual to predicted water use.

RESULTS AND DISCUSSION

Seasonal water use of mature pecans at Cullinan varied from 943 to 1035 mm and fc varied from 82-98%. Average crop coefficients throughout the season varied from 0.6 (at the beginning and end of the season) to 1.35 (when the canopy cover was at a maximum). The Samani et al. (2011) equation predicted water use of pecans fairly well on a monthly and seasonal basis, using reference crop coefficients from New Mexico, but failed to perform well for shorter intervals. An adjustment of reference crop coefficients for the climatic conditions in South Africa provided better estimates of water use with the Samani et al. (2011) equation on a weekly and monthly basis.

CONCLUSIONS

The Samani et al. (2011) equation can therefore be used to schedule irrigation of pecans in South Africa, with adjusted reference crop coefficients for the specific climate and measurements of fractional ground cover, with the final goal of achieving maximum orchard productivity and profitability.

ACKNOWLEDGEMENTS

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Keywords: Fractional ground cover, crop coefficients, transpiration

THE DIVERSITY OF PLANT SPECIES USED FOR LEAFY VEGETABLES IN SOUTH AFRICA

WS Jansen van Rensburg¹, HJ Vorster², SP Ntombela¹ and PO Adebola¹

¹Agricultural Research Council, Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria 0001; ²McCain, Valley trial site, R50, Delmas

E-mail: wjvrensburg@arc.agric.za

INTRODUCTION

A wide diversity of plant species are traditionally used as leafy vegetables (potherbs) in South Africa. Some of these species are indigenous but many of them are indigenised species that became over years part of the culinary tradition of the local people. These traditional vegetables are seldom cultivated and most of the species are collected in the wild or in fallow land where they are commonly regarded as weeds. Some of these species have been proven to be very nutritious. Despite these characteristics, these crops have been regarded as backward, and have been neglected by modern science for a long time.

MATERIALS AND METHODS

Baseline information on the use of indigenous and traditional vegetables was gathered using various participatory research tools in seven rural villages in five provinces in South Africa. These villages differed in terms of ethnicity, agro-ecology and climate.

RESULTS AND DISCUSSION

The species utilised and the preferences vary between agro-ecological zones as well as between ethnic groups. The knowledge of different crops was based on different groups within the community. Leafy vegetables tend to be the domain of the woman, while cash crops, fruit grains and cereals tend to be the domain of the men. The knowledge tends to be rudimentary in the youth.

A large variety of species is being utilised as leafy vegetables. The most popular wild harvested species are amaranth (*Amaranthus* spp.), spider flower (*Cleome gynandra*) and jutes mallow (*Corchorus* spp.) amongst others. Cultivated species are local landraces of cowpea (*Vigna unguiculata*) and pumpkin (*Cucurbita* spp.). Many species are used as leafy vegetables in localised areas, for instance lambsquarters (*Chenopodium album*), blackjack (*Bidens pilosa*), balsam pear (*Momordica basilemima*) and many others.

CONCLUSIONS

African vegetables are still used extensively by rural and even urban and peri-urban South African households. It is a major contributory factor towards food security and balanced diets of households. Some of these species, like amaranth, contribute considerably to the daily intake of iron and vitamin A of rural households. However, over the years the use of African vegetables has diminished and in certain parts there is a real danger of losing the knowledge associated with African vegetables.

ACKNOWLEDGEMENTS

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Keywords: Imifino, indigenous vegetables, morogo, traditional vegetables

EFFECTIVE CONTROL OF REED ENCROACHMENT BY MEANS OF AERIAL APPLICATION OF A NON-SELECTIVE HERBICIDE AND REQUIREMENTS FOR SUCCESSFULL DRIFT MANAGEMENT WITHIN A SENSITIVE CROP IRRIGATION SCHEME

GN Jansen van Vuuren

Villa Crop Protection, PO Box 10413, Aston Manor 1630

E-mail: gvvuuren@villacrop.co.za

INTRODUCTION

Dense growth of *Phragmites australis* reeds below Hardap dam, Namibia, is a major reason why the nearby town of Mariental was flooded several times when the dam's sluice gates were opened following torrential rains in the catchment area. This caused serious economic effects in terms of urban development and insurance restrictions. Earlier attempts to control the reeds by means of aerial spraying caused drift damage to the irrigation scheme's crops, and without success in controlling the reeds. A new aerial spraying programme, launched in 2008 has proved extremely successful.

MATERIALS AND METHODS

A 240 g/l a.e. glyphosate IPA formulation is applied with a helicopter at a 7.0 l/ha dosage rate in 50 l/ha total application volume. A 2.0 % drift retardant is added at 250 ml/ha to reduce the volume of driftable fine droplets. A droplet spectrum at a VMD of at least 350 microns is applied.

Constant monitoring of meteorological conditions includes wind speed and direction, ambient temperature at 2 and 10 metres above ground level, and relative humidity. The decision to spray or not, is determined by the combination of wind speed, direction and atmospheric stability as well as the generation of low level smoke to confirm cold air drainage conditions down into and along the river allowing safe application even when conditions would theoretically be regarded as unsafe.

RESULTS

Drift control measures proved very successful with no crops injured after 8 spraying operations since 2008. Control of reeds took a time due to the enormous subsoil rhizome system that has to be killed off, as well as infrequent burning of dead reed material which hampers effective coverage of live green plant material during follow up spraying operations. Since 2010 large areas of reeds were ripped from the river bed following opening of sluice gates allowing for effective flow of water down the river.

CONCLUSION

The dense reeds stands were reduced effectively, however, yearly maintenance spraying is still required. Open areas in the river and wide canals have improved biotic diversity in the river system.

Keywords: Phragmites australis, glyphosate, aerial spraying, drift management

AMAZING MAIZE PART III: SUCCESS IN BREEDING THE POPPING GENE IN HYBRIDS

CP Jele^{1,2} and J Derera²

¹KZNDAE; ²School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg

E-mail: phumelele.jele@kzndae.gov.za

INTRODUCTION

Popcorn (*Zea mays* var *everta*) is a popular snack worldwide, but global production is dominated by the USA. There is no record of large scale production of popcorn in South Africa due to lack of suitable varieties. In South Africa, popcorn breeding efforts were last reported in 1954. Therefore the study aimed at developing new popcorn varieties adapted to South African conditions.

MATERIALS AND METHODS

The 119 experimental hybrids were evaluated under rain-fed conditions at Cedara and Ukulinga Research Farms with two replications for one season, during 2011/2012. The USA commercial hybrid CAP618 was used as a standard. Microwave and hot air machines were used for the popping test. Samples of 25 cm³ each were popped in the laboratory and the experiment was replicated twice. Flake volume was measured using a graduated cylinder. The number of unpopped kernels was determined. The data were analyzed using the SAS statistical package.

RESULTS AND DISCUSSION

There hybrids, method and site main effects were highly significant ($P < 0.01$) for flake volume and number of unpopped kernels which provides opportunity for selection. The method x hybrid interaction effects, and hybrid x site interaction effects were not significant ($P > 0.05$). The flake volume ranged between 630 and 1190 cm³ in the microwave, and between 740 and 1380 cm³ for hot air popping. The commercial hybrid yielded 1125 and 1187 cm³ in the microwave and hot air popping, respectively. At least 16 new developmental popcorn hybrids outperformed the standard hybrid with average flake volumes ranging from 1200 to 1380 cm³. There were fewer unpopped kernels in these hybrids than the standard. The new hybrids also exhibited superior expansion ranging from 24 to 28 times when compared to 23.8 for the standard. There were also significant differences among hybrids for yield, but the site and hybrid x site interaction effects were not significant, indicating some high level of stability.

CONCLUSIONS

Newly developed popcorn hybrids at the UKZN surpassed the standard, indicating success in breeding the popping genes in locally adapted maize. The results have profound implications for breeding progress and the economy. Development of local hybrids can lead to reduction in import of popcorn seed.

Keywords: Popcorn hybrids, flake volume, popping method

GRAFTING TECHNOLOGY TO MANAGE BIOTIC AND ABIOTIC STRESSES

J Jifon¹, D Sivakumar², K Crosby¹, P Soundy², L Leskovar¹

¹Texas A&M AgriLife Research, Vegetable and Fruit Improvement Center, Department of Horticultural Sciences, Texas A&M University; 2415 East Highway 83, Weslaco, TX 78596, USA; ²Tshwane University of Technology, Department of Crop Science, Pretoria 0001, South Africa

E-mail: jjifon@ag.tamu.edu

INTRODUCTION

Drought and soil-borne diseases are among the major biotic and abiotic stresses that collectively limit productivity globally to less than 25% of crop potential (Boyer, 1982). Cost-effective technologies for managing these limitations are an integral part of strategies for addressing food security, especially among low-input Emerging Farmer Systems that often lack the resources for intensive management. Vegetable grafting is becoming popular, not only for managing soil-borne diseases, but also for managing abiotic stresses such as drought, especially during crop establishment stages. Root vigour and the ability of suitable rootstocks to efficiently absorb soil moisture and maintain favourable plant water status are critical in this role for grafting. In the present study, we characterized physiological and allometric relationships of rootstocks and grafted plants in order to identify traits that improve productivity under stress conditions.

MATERIALS AND METHODS

Leaf photosynthesis (Pn) stomatal conductance (gs), transpiration (E), leaf water potentials (LP), root dry matter allocation, and root hydraulic conductance (Lr) characteristics of six-week old seedlings of four hybrid squash varieties: *Cucurbita maxima* cv: 'Strong Tosa', 'RS1330', 'Shintosa Camel', and 'Tetsukabuto'; a *Lageneria siceraria* variety (cv Pelops), and a commercial watermelon scion variety (cv 'Super Seedless 7167') were investigated.

RESULTS AND DISCUSSION

Leaf water potentials were significantly higher among rootstock varieties than in the commercial scion variety, even though the leaf areas were significantly greater in the former. Leaf stomatal conductance (gs), transpiration (E) and photosynthesis (Pn) values followed similar trends as LP. Among the rootstock varieties, 'RS1330' and 'Tetsukabuto' had the highest root dry mass allocation coefficients. Average Lr values of rootstock varieties were significantly greater than that of the commercial variety.

CONCLUSIONS

Differences between the rootstocks and the commercial variety are consistent with predictions of ample water supply by the more vigorous root systems; however, the current data also indicate differences in the capacity for water flux (hydraulic conductance) through root systems of the rootstocks studied. The root vigour traits described herein should be useful in sustaining productivity in highly-weathered, low fertility soils, and in drought stricken regions.

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Keywords: Grafting, rootstock, abiotic, biotic stress, cucurbit, squash, watermelon, yield, quality

EVALUATION OF MAIZE YIELD AND RAINWATER PRODUCTIVITY UNDER IN-FIELD RAINWATER HARVESTING AND CONVENTIONAL TILLAGE ON THE FORT HARE/OAKLEAF ECOTOPE

LF Joseph¹, JJ Botha¹ and JJ Anderson¹

¹ARC-Institute for Soil, Climate and Water, Private Bag X01, Glen 9360

E-mail: josephf@arc.agric.za

INTRODUCTION

The majority of rural households in the Eastern Cape Province of South Africa struggle to meet basic needs especially in terms of household food security. Recent studies indicate that agriculture contributes little to solve this problem especially in the villages around Alice. Crops are usually produced under dryland conditions by using conventional tillage (CT). Research on clayey soils in semi-arid areas of the Free State Province showed that in-field rainwater harvesting technique (IRWH) has the potential to increase maize grain yield by up to 50% compared to CT (Hensley *et al.*, 2000). The main aim of this study was to evaluate the effects of IRWH treatments and CT on maize grain yield and rainwater productivity (RWP) on the Fort Hare/Oakleaf ecotope.

MATERIALS AND METHODS

A fully randomized complete block design field experiment with three treatments, viz. IRWH: with mulch (IRWH_{+M}), IRWH: without mulch (IRWH_{-M}) and CT, and three replications was conducted over four seasons (2004/05 - 2007/08) on the Fort Hare/Oakleaf ecotope at Alice in the Eastern Cape Province. Maize was used as crop indicator. RWP was calculated using an equation described by Botha (2006).

RESULTS AND DISCUSSION

The grain yields ranged between 2066 and 6658 kg ha⁻¹ over the four growing seasons for all the treatments. The mean grain yield under IRWH_{+M} and IRWH_{-M} increased by 16 and 13% compared to CT, respectively. IRWH_{+M} and IRWH_{-M} increased RWP by 20 and 10% respectively, as compared to CT.

CONCLUSIONS

It can be concluded that IRWH treatments out-performed CT in terms of grain yield and RWP. It is therefore recommended that farmers around Alice be encouraged to replace CT with IRWH_{+M} or IRWH_{-M} on similar ecotopes.

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ACKNOWLEDGEMENTS

Water Research Commission for funding the project.

Keywords: Conventional tillage, grain yield, in-field rainwater harvesting, rainwater productivity

RE-CLASSIFICATION OF MEMBERS OF THE PSORALEAE IN THE TRIBE PHASEOLEAE

SA Kanu¹, FD Dakora², SB Chimpango³ and JI Sprent⁴

¹Department of Crop Sciences, Tshwane University of Technology, P/Bag X680, 175 Nelson Mandela Drive, Arcadia, Pretoria 0001, South Africa; ²Department of Chemistry, Tshwane University of Technology, P/Bag X680, 175 Nelson Mandela Drive, Arcadia, Pretoria 0001, South Africa; ³Botany Department, University of Cape Town, Rondebosch 7701, Cape Town; ⁴Division of Applied and Environmental Biology, University of Dundee, Dundee DD1 4HN, Scotland, UK.

E-mail: kanu.popfred@gmail.com

INTRODUCTION

The uniqueness of the tribe Phaseoleae has been reported by several researchers, based on studies with tropical legumes such as common bean, soybean, bambara groundnut, kirsting's bean and cowpea. The described unique shared symbiotic traits among others include a determinate nodulation phenotype and internal nodule anatomy, xylem composition and transportable solutes of fixed N and the presence of calcium oxalate crystals in nodule cortex. In this study, the aim was to examine the symbiotic traits of members of the tribe Psoraleae that occur uniquely as endemics in the Cape Fynbos of South Africa.

MATERIALS AND METHODS

In 2005, identification of *Psoralea* species was conducted in six study sites in the Cape Fynbos. Mature root nodules were harvested from eight *Psoralea* species namely *Psoralea aculeata*, *P. aphylla*, *P. asarina*, *P. laxa*, *P. monophylla*, *P. pinnata*, *P. repens*, and *P. restioides*. Internal nodule anatomy was examined using conventional LM and TEM microscopy. Ureide bioassay was done as described by Dakora *et al.* (1992). Histochemical test for the presence of calcium oxalate (CaC₂O₄) in nodule cortex was done as described by Yasue (1969).

RESULTS AND DISCUSSION

All eight species share unique symbiotic traits with the tribe Phaseoleae. For example, mature root nodules of field plants were found to be spherical and determinate, with sizes ranging from 3 to 6 mm, similar to cowpea and soybean. LM examination of resin embedded nodule sections revealed an internal organization similar to that of bambara groundnut, cowpea and soybean (Phaseoleae) with four main tissue components (outer cortex, middle cortex, inner cortex and central infected tissue). Furthermore, TEM examination showed presence of two types of cells (infected and uninfected interstitial) within the central infected tissue. Additionally, this study showed the presence of calcium oxalate crystals in the outer cortex of *P. pinnata* nodules that stained black upon treatment with a silver nitrate-dithio-oxamide sequence. Interestingly, analysis of tissue extracts from various plant parts showed that ureides (allantoin and allantoic acids) are the major products of N₂ fixation in the eight *Psoralea* species studied.

CONCLUSIONS

Taken together and based on these shared unique symbiotic traits of tropical biogeographic origin, determinate nodulation phenotype, internal nodule anatomy, presence of calcium oxalate in outer cortex and ureide biogenesis, it is proposed that the genus *Psoralea* and its species (50) be re-classified in the tribe Phaseoleae.

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Keywords: calcium oxalate, members, Phaseoleae, Psoralea, symbiotic traits

A WEB-BASED MICROCLIMATIC MEASUREMENT AND EVAPORATIVE COOLING CONTROL SYSTEM IN A FORESTRY NURSERY

ND Kaptein¹ and MJ Savage²

¹*Institute for Commercial Forestry Research (ICFR), P O Box 100281, Scottsville 3209;*

²*University of KwaZulu-Natal (UKZN), P/Bag X01, Scottsville 3209*

E-mail: Nkosinathi.Kaptein@icfr.ukzn.ac.za

INTRODUCTION

Protected environment structures such as greenhouses and shadenetting are an option to address the problem of many weather hazards and improve control of the microclimate. Evaporative cooling may be an option to reduce inside temperatures. In this study, that utilises a web-based data and information system for sharing of measurements and display of the shadenet environmental conditions in near real-time, the effectiveness of automated and environmentally-controlled evaporative cooling is investigated.

MATERIAL AND METHODS

Air temperature, atmospheric vapour pressure, solar irradiance, wind speed and leaf wetness duration, measured using a dielectric leaf wetness sensor, were measured every 2 and 60 min. A datalogger was programmed to control evaporative cooling of *Eucalyptus dunnii* seedlings. The solenoid valve was controlled based on the measured shadenetting microclimate and leaf wetness. The measured near real-time data was displayed using a web-based system. The data could be viewed or downloaded using the Internet

http://agromet.ukzn.ac.za:5355/?command=RTMC&screen=ICFR_nursery

The automated evaporative cooling system was compared to timer-based system within the shadenetting.

RESULTS AND DISCUSSION

The automated evaporative cooling (AEC) system was effective at reducing air temperature inside the shadenet. Water savings was also noticed from the system compared to the timer-based system. The AEC system over- and under-irrigated at high and low air temperatures respectively. AEC plants showed poor growth early in the season during system setup, but plants showed significant improvements later in the season. The study showed that AEC can be used with success in evaporatively cooling the seedlings.

CONCLUSIONS

Water wastage was noticed in the timer based system since it was programmed to sprinkle water at a fixed time of day, regardless of rain or lower air temperatures, for example. The AEC system applied 4 mm of water per day on hot days compared to a timer system that applied a fixed 8 mm of water on a daily basis.

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Keywords: leaf wetness, Microclimate control, nursery microenvironment

CAROB SEED (*Cerantonia siliqua* L.) INTERPOPULATION VARIATION AND GERMINATION CHARACTERISTICS

PA Karsen¹

¹*Institute for Plant Science, Department of Agriculture Western Cape, Private Bag X1, Elsenburg 7607*

E-mail: pippak@elsenburg.com

INTRODUCTION

The aim of this work was to study the germination characteristics (under controlled conditions of light and temperature and using different pre-treatments for promoting germination) and variability of seed from individual *Cerantonia siliqua* trees.

MATERIALS AND METHODS

Seeds collected from individual trees were tested. Seed was germinated at a constant temperature of 25/18°C (day:night) and 16/8 h light/dark photoperiod. Seed was pre-treated by scarification using boiling water at 60°C and 80°C for five and ten minutes; sulphuric acid for five, ten and thirty minutes, or smoked in a water solution for 24 hours to enhance germination. Soaking seed in distilled water served as the control.

RESULTS AND DISCUSSION

The untreated seeds showed a deep dormancy (final germination percentages ranged from 14% to 29%). Chemical (sulphuric acid for 30 minutes) and boiling water (at 80°C for 10 minutes) scarification drastically improved final germination percentages (86%-97%, and 91%, respectively). Since dormancy was significantly lower, the impermeability to water of the seed coat (physical dormancy) seemed to be one of the important causes of the seed dormancy present in this species. Great variability in seed weight, seed water content and germination parameters were found among seeds from different trees. Significant differences between different trees under the same incubation temperature were detected for seed germination when pre-treated with boiling water at 80°C for 10 minutes (final germination percentage ranged from 58 to 100%). However, germination rate (as expressed by mean germination time) was between 6.3-14.8 days among seeds from different trees. A negative trend was obtained between seed mass and final germination percentage: the smallest seeds had the lowest germination percentages. Moreover, seed mass showed a positive significant correlation with seed water content.

CONCLUSION

Hot water and sulphuric acid scarification improve germination of carob seed as the impermeability of the seed coat is markedly reduced. There is a high inter-population variation in the seed resulting in variability in germination. The variability of germination may be due to differences in seed coat thickness of individual trees.

Keywords: Carob, germination

EFFECT OF DIFFERENT RATES OF ENRICHED CATTLE MANURES ON YIELD AND QUALITY OF TEA (*Camellia sinensis*) IN KENYA

VM Kekana¹, IM Tabu¹ and DM Kamau²

¹Department of Crops, Horticulture and Soils, P.O. Box 536, Egerton University, Kenya;

²Department of Chemistry, P.O. Box 820, Tea Research Foundation of Kenya, Kericho

E-mail: moroamochevian@gmail.com

INTRODUCTION

Tea is one of the leading cash crops in Kenya contribute about 4% of the GDP. Nitrogen is one of the most important fertilizer inputs that determine yield and quality of tea. The fertilizer is generally applied in the inorganic form of NPK. The required high rates of inorganic fertilizer (up to 300 kg N/ha/year) are, however, expensive, acidify the soil and pollute water masses. Organic manures are recommended as important sources of nutrients but are limited because of the low nutrient content and slow release that makes the practice unsustainable for this perennial crop. Integrated nutrient management is generally recommended in order to maximize the advantages while minimizing the shortfalls. A study was therefore conducted to determine the effect of enriched manures on yield and quality of tea.

MATERIAL AND METHODS

The experiment was carried out at East of Rift Valley, Kenya (0° 26' S, 37° 15' E). The trial was a 4 by 4 factorial experiment laid out in a Randomized Complete Block Design (RCBD) and replicated three times. A high yielding clone 31/8 was used with four fertilizer types (organic manure (OM), NPKS, OM: NPKS 1:2 and 1:4) applied at four different rates: 0, 75, 150 and 225 kg N/ha. The properties of the cattle manure used in the experiment were analyzed according to Okalebo *et al.* (2002). Tea was plucked at 7-10 day intervals and the weight per plot recorded at every plucking round. The yields were converted to kg made tea per hectare per year (kgmt/ha/y), while quality parameters TF, TR and caffeine were determined from made tea.

RESULTS AND DISCUSSION

The yield varied significantly with fertilizer type and rate. As compared to the control and NPKS, applying N fertilizer in the form of enriched manures showed higher yields. The TF and TR decreased with fertilizer rate, while caffeine increased with fertilizer rate. Enriched manures and NPKS showed higher TF and caffeine content than the use of organic manure alone.

CONCLUSION

Enriched manures have shown beneficial effects by increasing crop yield and better quality of tea. Long term monitoring of this experiment should be continued to verify the consistency of these results. There is need, however, for further research on economic analysis of different sources of manures available that can further enhance the long term productivity of tea.

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Keywords: Caffeine, enriched cattle manures, theaflavin, thearubigin, yield

COMPARISON OF SOIL EROSION UNDER NO-TILL AND CONVENTIONAL TILLAGE SYSTEMS IN THE HIGH RAINFALL MLONDOZI AREA, MPUMALANGA PROVINCE, SOUTH AFRICA

MV Kidson

ARC-ISCW, P/ Bag X 79, Pretoria 0001

E-mail: michael@arc.agric.za

INTRODUCTION

The LandCare Programme, aimed at agricultural practices conducive to soil resilience and water conservation, is largely driven by empowering people to help themselves. One of the key elements of the empowerment process in the Mlondozi Landcare project was in the form of farmer managed trials. Eighteen farmers initially joined the programme and their soils were monitored for six years. The results of the monitoring showed that there was an overall improvement in soil quality including soil cover, pH, fertility and root count. There was an improvement in maize yield from an average of 0.4 to 4.5 t/ha. There was a significant improvement in soil fertility for the elements Ca, Mg, P and K. The root count improved from 30 to 35 roots per 10 x 10 cm area for the topsoil and from 7 to 13 roots per 10 x 10 cm area for the subsoil.

MATERIALS AND METHODS

At the end of the Mlondozi Landcare project undisturbed soil samples were taken from the farmers' fields where maize was cultivated following conservation agriculture (CA) farming and the traditional cultivation (TC) system, using specially constructed metal trays for a laboratory rainfall simulator. The soils were tested in the rainfall simulator with a simulated storm event, removed and allowed to dry before a second simulated storm event. Each storm event lasting 110 minutes (50 rotations). The soils from the two farming systems were compared for runoff, erosion and infiltration.

RESULTS AND DISCUSSION

The TC soils had a significantly higher infiltration rate for the first 16 rotations. After 68 minutes (rotation 34) the CA soils' infiltration rate was higher. For simulated storm 2 the TC soils had a slightly higher infiltration rate up to 32 minutes (16 rotations) whereafter CA soils had a higher infiltration rate. Between 48 and 80 minutes (rotations 24 and 40) the CA soils had a significantly higher infiltration rate. A statistical t-test was applied to the data to test for differences between the two cultivation systems, with a sample size of 72, at 18 sites with 4 replicates. There was a significantly higher soil loss for CA soils for storm 1 compared to the TC soil, and a non-significant difference in runoff for storms 1 and 2. Infiltration was significantly lower for the CA soil for the first storm but not significantly higher for the CA soil for the second storm.

CONCLUSIONS

The initial and final infiltration rates were compared for CA and TC soils for two simulated storms. The TC soils' initial and final infiltration rates were similar, while the CA soils had a higher initial and final infiltration rate for the second storm, due to the soils settling with the first storm. From the results it can be concluded that the CA soils maintained aggregate stability far longer than the TC soils.

Keywords: Conservation agriculture, infiltration, laboratory rainfall simulator, LandCare

WATER AND BIOFUEL RESEARCH IN SOUTH AFRICA

RP Kunz¹ and JPW Jewitt¹

¹University of KwaZulu-Natal, P/Bag X01, Scottsville 3209

E-mail: kunzr@ukzn.ac.za

In December 2007, the former Department of Minerals and Energy (DME) approved the revised national biofuels industrial strategy (DME, 2007). The South African strategy was generally considered to be conservative, tempering the international drive towards large-scale biofuel production with a pragmatic approach towards a short-term goal of 400 million litres of biofuel. The focus was on the production of bioethanol from sugarcane and sugarbeet and biodiesel from sunflower, canola and soybeans. Citing food security concerns, it specifically excludes maize (corn). *Jatropha curcas* also excluded due to its possible alien invasive threat.

However, the Department of Energy (DoE) has recently published regulations regarding the mandatory blending of biofuels (DoE, 2012). The mandatory biodiesel blending was modified to B5, equivalent to at least 465 million litres of biodiesel. Similarly, the mandatory bioethanol blending was modified to a permitted range of E2 up to E10 (i.e. 238 - 1187 million litres of bioethanol). In order to meet the bioethanol demand, South Africa requires the annual production of at least 600,000 tons of grain sorghum.

Impacts on water resources are a major concern in the production of biofuels and in this regard, the following are relevant:

1. In South Africa, the impacts of land use and land use change on the hydrological cycle and their potential impact on water resources are well known. Principle 18 in the preamble to the National Water Act (NWA) of South Africa (DWA, 1998) states:

"Since many land uses have a significant impact upon the water cycle, the regulation of land use shall, where appropriate, be used as an instrument to manage water resources within the broader integrated framework of land use management".

This principle has been given effect in legislation by Section 36(2) of the National Water Act of 1998 through the concept of a "stream flow reduction activity", or SFRA, defined as:

"... any activity (including the cultivation of any particular crop or other vegetation) ... [that] ... is likely to reduce the availability of water in a watercourse to the Reserve^[1], to meet international obligations, or to other water users significantly".

2. The production of biofuel crops under irrigation is not supported i.e. "The production of feedstock under irrigation will only be allowed in exceptional circumstances and a detailed motivation will have to be provided" (DME, 2009). The Department of Water Affairs (DWA) has taken the position that South Africa is a water scarce country which can "ill afford the use of current or potential irrigation water for fuel production rather than growing crops for food". Under the current legislation, the DWA cannot prevent farmers with existing water use licenses, from converting their farming practices from food/fodder crop production to biofuel feedstock production. However, if the DWA does become aware of farmers supplying irrigated feedstock to biofuel processing plants, it intends to impose an appropriate industrial water tariff on the irrigated water used to produce the crop, and not the usual subsidised agricultural tariff.

Thus, in terms of the NWA, it is necessary to assess the potential water use and likely impact of potential biofuel feedstock production in South Africa before permission is granted for its production, in which case a water use license may be required, even for dryland production (Jewitt *et al.*, 2009). Water and productivity of potential biofuel feedstocks remains uncertain. In this paper, we expand on the context for biofuel production in South Africa and present a framework for assessing its sustainability focussed on potential impacts on water and other natural resources.

^[1] Water for basic human needs and environmental flows

Keywords: Biofuels, water use, mandatory blending rates

SHORT TERM EFFECTS AFTER INTRODUCTION OF CONSERVATION AGRICULTURAL PRACTICES ON YIELD AND QUALITY OF WHEAT AND CANOLA IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

J Labuschagne¹, W Langenhoven¹, H van Zyl¹

¹*Directorate for Plant Sciences, Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607*

E-mail: johanl@elsenburg.com

INTRODUCTION

Tillage practice and crop rotation together with stubble retention are regarded as important management strategies that will determine the success of conservation agriculture (CA). The positive effects of CA on crop performance are however not instantaneous but may take several years to develop. The aim of this study was to quantify the effect of tillage practice and crop rotation on wheat and canola productivity during the wheat and canola phases after completion of the first cropping cycle of four years.

MATERIALS AND METHODS

Three crop rotations, continuous wheat (WWWW), wheat/medic/wheat/medic (WMcWMc) and wheat/canola/wheat/lupin (WCWL) were allocated to main plots and replicated four times at the Langgewens (Moorreesburg) Research Farm. Each main plot was subdivided into four sub-plots allocated to four tillage treatments, namely: zero-till – soil left undisturbed, no-till – soil left undisturbed until planting and then planted with a tined, no-till planter, minimum till – soil scarified March/April and then planted with a no-till planter and conventional tillage – soil scarified late March/early April, then ploughed and planted with a no-till planter. Yield and quality data recorded during 2011 will be discussed in this presentation.

RESULTS AND DISCUSSION

No-till resulted in the highest wheat grain yields in all cropping sequences, although not always significantly ($P=0.05$), in all systems tested. The highest microbial activity was recorded in the no-till system. Residue cover on the no-till plots was higher than the 30% set as minimum to qualify as CA. Soil organic carbon and active carbon content tended to be higher for the no- and minimum-till treatments compared to the other treatments tested. Except for wheat after canola (LWCW), treatment combinations did not influence the hectoliter mass of wheat grain produced. Differences ($P=0.05$) in protein content were recorded with a tendency of lower protein content in the WWWW and zero-till treatments. Falling numbers were not influenced by the treatment combinations tested. The highest canola seed yield ($1923.5\text{kg}\cdot\text{ha}^{-1}$) was recorded for the no-till treatment, although not significantly higher than the zero- ($1629.5\text{ kg}\cdot\text{ha}^{-1}$) and conventional-till ($1878.8\text{ kg}\cdot\text{ha}^{-1}$) treatments. Canola protein and oil content were not influenced by the treatment combinations tested.

CONCLUSIONS

Results showed that, although differences in selected soil quality parameters were recorded, the effect of introducing CA will not yield instant positive results. In the relatively low C soils and hot dry summers of the Swartland this study showed limited positive effects in the 5th season after introducing the treatments.

Keywords: canola, grain quality, nitrogen, oil content, wheat

RESPONSE OF EIGHT SWEET POTATO CULTIVARS / BREEDING LINES TO WATER STRESS

RN Laurie¹, SM Laurie¹ and CP du Plooy¹

¹ARC-VOPI, Private Bag X293, Pretoria 0001

E-mail: rlaurie@arc.agric.za

INTRODUCTION

Sweet potato is one of the root crops grown in developing countries to help fight food insecurity and malnutrition (Ewell and Mutuura, 1994). Furthermore, sweet potato is grown for its short cropping season, harvesting schedule that coincides with hunger periods, and is commonly grown in low input agricultural systems (Woolfe, 1991). Sweet potato in general is a drought susceptible crop, therefore it is important to select cultivars to be introduced to drought prone areas and that produce an acceptable yield.

MATERIALS AND METHODS

Sweet potato cuttings were planted in a rainout shelter at the ARC-VOPI in a split block design with 2 water treatments (60% and 30%) and 3 repeats. Canopy cover was measured twice with a Li-Cor LAI-2200 plant canopy analyser. Stomatal conductance was measured twice with a SC-1 porometer. Chlorophyll content was measured twice with a CCM-200 chlorophyll content meter. Relative water content (RWC) was determined according to the method of Chowdhury (2008). Roots were harvested after a 6 month growth period, and total and marketable yield determined.

RESULTS AND DISCUSSION

Root yield (total and marketable) was greatly reduced at 30% water treatment, with Resisto exhibiting the lowest values and 2006-3-4 the highest. Significant differences in conductance values between the 30% and 60% water treatments were obtained, with differences increasing as the stress prolongs. LAI values increased in general over time, as expected, although not always significant, with the variety 2007-17-1 showing significant differences between the 30% and 60% water treatments at both observation times. Chlorophyll content values also dropped, and the difference between the 30% and 60% water treatments was more pronounced during the second measurement compared to the first measurement, relating to the more severe stress affecting the plants and the struggle to recover. Resisto showed the biggest difference in this regard. The stress had marginal effect on the stem length. RWC values indicated a slightly higher leaf water content trend for all cultivars towards the second observation time, which might indicate a recovery in plant metabolism.

CONCLUSIONS

Drought has severe impact on the growth of sweet potato plants as shown in the presented results. Stomatal conductance, LAI, chlorophyll content values and RWC values have shown to be valuable in the selection process of sweet potato varieties and breeding lines to be introduced into breeding programmes.

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Keywords: drought, soil-water regime, sweet potato

BIOFORTIFICATION OF SWEET POTATO: AGRONOMIC PERFORMANCE OF NEW VITAMIN A-ENRICHED VARIETIES

SM Laurie¹, AA van den Berg¹, MM Mtileni¹, TR Ramathavhana¹ and WM Mphela¹

¹ARC-Vegetable and Ornamental Plant Institute (VOPI), Private Bag X293, Pretoria 0001

E-mail: slaurie@arc.agric.za

INTRODUCTION

Vitamin A deficiency is a major public health problem in South Africa, as 64% of 1-9 year olds were found to be deficient during a national survey in 2005 (Labadarios, 2007). Food security is also of major concern, with only 20% of households considered as food secure. Sweet potato is a starchy staple, easy to grow and hardy, thus the ARC has a comprehensive research program on sweet potato towards realizing the agricultural advantages of the crop (Bovell-Benjamin, 2007). The focus of breeding is especially on beta-carotene content (a precursor of vitamin A) combined with other important traits, such as good yield, good storage quality, adaptability, high dry mass and sweet taste (Laurie *et al.*, 2009; Laurie *et al.*, 2012).

MATERIALS AND METHODS

Three new varieties (Bophelo, Purple Sunset and Isondlo), breeding line 2002-8-2 and relevant control varieties were tested for agronomic performance over two seasons in multi-environment trials at four production sites (Roodeplaat, Elsenburg, Empangeni and Potchefstroom). Data collection included root yield, unmarketable root yield classes, dry-matter content, and taste acceptability. A combined analysis of variance was performed and the Additive Main Effects and Multiplicative Interaction (AMMI) model was used to analyse genotype by environment interaction with Agrobase Gen II. The total carotenoids content was determined on samples from one area (by spectrophotometry).

RESULTS AND DISCUSSION

The results showed that the new orange-fleshed variety Bophelo had a significantly higher yield than USA varieties promoted earlier, and yield in the same range as commercial cream-fleshed variety Blesbok. Taste tests with small groups of farmers indicated good taste preference scores for Bophelo. Line 2002-8-2 produced yields in the same range as Bophelo, while Purple Sunset and Isondlo had significantly lower yield. Boiling a 50 g root portion will provide 320 µg RAE, which is enough to supply the recommended dietary allowance (RDA) for vitamin A for 1-3 year olds. Bophelo has been recommended for use in crop-based approaches to address vitamin A deficiency, as well as for semi-commercial production (1-2 ha) in communities in Nelson Mandela Bay to Amathole districts, Tshiombo area in Venda and Kosi Bay area. A total of 57000 cuttings of Bophelo were distributed from the ARC-VOPI in 2011-12.

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Keywords: adaptability, multi-environment trials, taste, total carotenoid, yield

FIELD BOOK: CLASSIFICATION OF SOUTH AFRICAN SOILS IN THE FIELD

PAL Le Roux¹, DP Turner², MJ du Plessis³, J van der Waals⁴ and HB Booyens⁵

¹University of the Free State; ²ARC-ISCW; ³NWK; ⁴Terra Soil Science; ⁵OMNIA

E-mail: lerouxpa@ufs.ac.za

INTRODUCTION

Regular field workshops of the South African Soil Surveyors Organisation (SASSO) revealed a need for improved application of criteria to classify the soils of South Africa. South Africa proudly use a soil classification system based on soil morphology. This is a major advantage. Application of the criteria varies between individuals and case studies.

BACKGROUND

During the first phase of soil survey and classification, lasting until the late 1900, the soil survey industry was dominated by Government activity with documented landmarks dated 1965 (Soil series), 1977 (Red Book) and 1991 (Blue Book). The responsibility for improvement in soil classification shifted from the owner of national resources (Government) to the land user. Soil classification is therefore lately driven by the private sector. SASSO took up the responsibility to improve the application of soil classification and assessment of soil suitability for the private sector. Repeated occurrence of the same classification problems stimulated the Field Book.

PRINCIPLES AND APPLICATIONS

The Field Book embraces practical soil classification providing user-friendly, scientifically up-to-date guidelines on application of the criteria for classification of the soils of South Africa in the field. Soil morphology is the most useful pedotransfer property. Both soil physical and chemical data are only applicable to the sample analysed. By implication values can only be extrapolated when associated with a visual transfer function like morphology. This principle emphasizes the significance of field classification.

User friendliness

The format of Munsell soil colour notations requirements for diagnostic horizons is presented as a graph. Gaps were exposed in the presentation confirming the improved userfriendliness.

Scientifically correct

Naming soils, like classification in all disciplines, raises the question of significance. Classification support for naming soils in phenoform have been developed keeping their relationship with the genoform. Soils are classified to as many horizons as needed to fit the land use requirements. In dry semi-arid climate this distinguish for example hydrologically and agriculturally significantly between Hutton soils on saprolite and Hutton soils on deep chemically weathered clay. These soils are respectively recharge soils with variable cropping potential and interflow soils with very stable crop production potential. Classification conventions were separated from criteria to make soil names scientifically more useful.

Keywords: Soil classification, soil morphology

IMPACT OF DEFICIT IRRIGATION AND PLANTING DENSITY ON GROWTH, QUALITY AND YIELD OF SPINACH AND ONION

DI Leskovar¹, K Crosby², JL Jifon³, P Soundy⁴ and D Sivakumar⁴

¹Texas A&M AgriLife Research, 1619 Garner Field Road, Uvalde, TX 78801, USA ; ²Texas A&M University, VFIC, College Station, TX, 77845, USA; ³Texas A&M AgriLife Research, Weslaco, TX 78596, USA; ⁴Tshwane University of Technology, Pretoria 0001

E-mail: d-leskovar@tamu.edu

INTRODUCTION

Agricultural communities in semiarid regions of the world are being seriously affected by frequent and more severe droughts, limited water resources, and increased regulations restricting water use. There is an urgent need for maximizing crop water use efficiency while conserving water resources. On the other hand, consumer demand for high-quality and nutritious vegetables is rapidly increasing. Several strategies can be used to increase water savings, such as selecting high-efficiency irrigation systems, applying specific growth-stage crop coefficients and evapotranspiration climatic data for irrigation management, stressing crops to a certain profitable level, and growing crops when evapotranspiration demands are reduced.

MATERIALS AND METHODS

Field studies conducted in southwest Texas evaluated growth, yield, quality and quercetin concentration in response to planting density and deficit irrigation (based on % crop evapotranspiration, ET) applied with subsurface drip in short-day onion (*Allium cepa* L.). Similarly, field studies were conducted to determine yield, leaf quality, vitamin C and carotenoid contents in response to planting density and deficit irrigation under Center Pivot and drip irrigation systems of processing spinach (*Spinacia oleracea* L.).

RESULTS AND DISCUSSION

Deficit irrigation at 75% ET_c had a higher volume of larger bulb sizes than 50% ET_c, but similar to 100% ET_c. Neither irrigation rates nor planting density had a significant effect on onion quality (soluble solids content, pungency, or quercetin). These results suggest that growers could adjust planting densities and implement water conserving practices (e.g. 75% ET_c rate) to target high-price bulb sizes without reducing flavor or nutritional components. In spinach, marketable yields increased with higher water inputs (100% ET_c), while deficit irrigation at 50% ET_c significantly reduced marketable yield under Center pivot and low pressure drip systems. Deficit irrigation at 75% ET_c was not detrimental for both yield and quality.

CONCLUSIONS

Regulated deficit irrigation (75% ET_c) is an effective strategy to save water without reducing quality and productivity in onion and spinach.

Keywords: Evapotranspiration, water use efficiency, crop coefficients, drip irrigation

“LESSONS LEARNED” - CONSOLIDATING RESEARCH OUTCOMES IN CONTROL OF RUSSIAN WHEAT APHID, *Diuraphis noxia* IN DRYLAND WHEAT INTO A PLAUSIBLE CONTROL STRATEGY

RC Lindeque¹, VT Tolmay¹ and M Booyse²

¹ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700; ²ARC-Datametry

E-mail: lindequerc@arc.agric.za

INTRODUCTION

Wheat yield losses in the early 1980's necessitated development of an effective Integrated Pest Management (IPM) system embracing all possible aspects of control including chemical control and host plant resistance. Monitoring effectiveness of these two components at the ARC-SGI became a prerequisite and integral measure of success against RWA infestations under various environmental conditions typical to dryland wheat production regions of the summer rainfall region. The objective of this paper is to report on the advancement of chemical control and host plant resistance from 2000, elaborate on the important influence of environment on RWA control and thirdly illustrate adaptations for augmenting future strategies against RWA.

MATERIAL AND METHODS

Beneficial responses from seed dressing, foliar insecticide and host plant resistance on yield and quality were determined in field trials in the eastern Free State. Trials designed as split-split plots with four replications entailed an imidacloprid seed-dressing, foliar-application of chlorpyrifos or demeton-S-methyl + parathion, a combination of both strategies and an untreated check. For 2000 to 2010 a selection of released cultivars with a RWA susceptible check (Betta) were planted in trials. Standard procedures were used for determining grain yield and quality and data analyses. Genotype x Genotype.Environment interaction (GGE) analysis and Additive Main Effects and Multiplicative Interaction (AMMI) were applied for determining effects of environment on chemical control and host plant resistance. Current research initiatives and progress of resistance donors in the dryland breeding programme are highlighted.

RESULTS AND DISCUSSIONS

For the period 2000 to 2010 gains in yield and quality generally occurred more frequently with imidacloprid seed dressing than foliar-applied insecticides. This benefit could however not consistently be quantified into a financial gain partly because of costs of application and product and effect of environment. AMMI analyses show Environment contributing to 82.3% of total variation in results in 2003 and 2004 and 80.5% in 2005 and 2006. The large effect of Environment on expression of host plant resistance implies resistance to RWA as a quantitative trait involving numerous smaller genes. Russian wheat aphid resistance donors originating from CIMMYT are currently under field evaluation and exhibit acceptable levels of resistance with good agronomical qualities.

CONCLUSIONS

Control of RWA in South Africa has had numerous successes since the original outbreak. Ensuring that momentum gained is preserved research focusses need to adapt to facilitate changes in climate, occurrence of new biotypes and future trends in dryland wheat production.

Keywords: *Triticum aestivum*, dryland wheat, Russian wheat aphid, *Diuraphis noxia*, chemical control, host plant resistance

CALIBRATING AND VALIDATING THE FAO-AQUACROP MODEL FOR A SOUTH AFRICAN TARO (*Colocasia esculenta* L. Schott) LANDRACE UNDER VARYING WATER REGIMES

T Mabhaudhi¹, AT Modi¹ and YG Beletse²

¹*School of Agricultural, Earth and Environmental Science, University of KwaZulu-Natal, PO Box X01, Scottsville, Pietermaritzburg 3209;* ²*Agricultural Research Council - Roodeplaat, Vegetable and Ornamental Plant Institute (VOPI), Private Bag X293, Pretoria 0001*

E-mail: tmabhaudhi@gmail.com

INTRODUCTION

Promotion of taro (*Colocasia esculenta* L. Schott), an underutilised crop, as a possible future crop under water-limited conditions hinges on availability of information describing yield responses to water. A well-calibrated and validated crop model may assist to generate such information. The aim of this study was to calibrate and validate the FAO's AquaCrop model (Steduto *et al.*, 2009) for a local taro landrace.

MATERIALS AND METHODS

AquaCrop was calibrated and validated using data from pot, field and rainshelter experiments conducted during 2010/11 and 2011/12 at Pretoria and Pietermaritzburg. Site-specific weather and soil physical parameters together with measured crop parameters from three experiments conducted during 2010/11 were input for model calibration. AquaCrop uses canopy cover (CC) not LAI, therefore values of LAI were converted to CC. Observations from three experiments during 2011/12 were used for model validation. AquaCrop was tested against independent data from experiments conducted in Umbumbulu, during 2007/08 (Mare and Modi, 2009). Model performance was evaluated using the coefficient of determination (R^2) and root mean square error (RMSE).

RESULTS AND DISCUSSION

Times to emergence (460 GDD), maximum CC (1 557 GDD), yield formation (1 512 GDD), senescence (2 115 GDD) and maturity (2 406 GDD) were input in AquaCrop. Model calibration showed a good fit ($R^2 = 0.789$; RMSE = 2.38%) for CC, biomass (RMSE = 1.35 t ha⁻¹) and yield (RMSE = 1.21 t ha⁻¹). Model validation showed good simulation for CC under irrigated conditions ($R^2 = 0.844$; RMSE = 1.85%) but underestimated CC under rainfed conditions ($R^2 = 0.018$; RMSE = 20.17%). The model predicted biomass ($R^2 = 0.898$; RMSE = 5.74 t ha⁻¹) and yield ($R^2 = 0.964$; RMSE = 1.43 t ha⁻¹) well using pooled data from field and rainshelter experiments. The model predicted biomass ($R^2 = 0.996$; RMSE = 1.745 t ha⁻¹) and yield ($R^2 = 0.980$; RMSE = 1.266 t ha⁻¹) well for the independent data.

CONCLUSIONS

Calibration and validation of AquaCrop for a taro landrace was a first and gave very satisfactory simulations for biomass and yield. To fine-tune the model, improvements should consider taro's growth characteristics such as suckers/stolons, distinctive growth stages, pattern of yield formation and sensitivities to frost.

ACKNOWLEDGEMENTS

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Keywords: AquaCrop, Taro landraces, water stress, yield

EFFECT OF PLANT DENSITY AND HARVESTING FREQUENCY ON THE YIELD OF SWISS CHARD CULTIVARS (*Beta vulgaris* L.) IN A SOILLESS CULTIVATION

MM Maboko¹ and CP du Plooy¹

¹Agricultural Research Council (ARC) Roodeplaat - Vegetable and Ornamental Plant Institute (VOPI), Private Bag x 293, Pretoria 0001

E-mail: mmaboko@arc.agric.za

INTRODUCTION

Swiss chard (*Beta vulgaris* L.), often incorrectly referred to as spinach, is a leafy vegetable popular in South Africa for its nutritional properties. Plant spacing or density plays an important role in optimizing yield. Too high or too low plant populations can result in lower yields and quality, with various recommendations in the literature on plant spacing for Swiss chard production for open field and hydroponic production systems. The objective of this study was to determine the effect of cultivar, plant density and leaf harvesting frequencies on yield of Swiss chard grown in a closed hydroponic system (gravel-film hydroponic systems).

MATERIALS AND METHODS

Swiss chard plantlets were transplanted 28 days after seeding into a gravel-film hydroponic system. Thirty treatment combinations were used, namely two Swiss chard cultivars ('Ford Hook Giant' and 'Star 1801'), five plant densities (10, 16, 25, 40 and 50 plants/m²), combined with three leaf harvesting frequencies (after every 7, 14 and 21 days). A randomised complete block design with four replicates was used in this experiment. Each plot size was 2m x 1m. The first harvest with measurements of leaf area, fresh and dry mass, and number of leaves was done 30 days after transplanting.

RESULTS AND DISCUSSION

There was a significant increase in leaf fresh mass, leaf number and leaf area with an increase in plant density, with the exception of plant densities of 16 or 20 plants/m², which performed similarly. The highest leaf fresh mass, leaf number and leaf area were obtained at a plant density of 40 plants/m². Results show that the high plant density of 40 plants/m², combined with a harvesting frequency of 14 days, resulted in the highest leaf dry mass, followed by harvesting frequencies of 7 and 21 days at the same plant density. 'Ford Hook Giant' yielded higher leaf fresh and dry mass at a harvesting frequency of 14 days, compared to 7 and 21 days harvest intervals, which did not differ significantly. The cultivar 'Star 1801' showed no significant differences in leaf fresh and dry mass across all harvesting frequencies, and was outperformed by 'Ford Hook Giant' on all yield parameters measured. Cultivar 'Ford Hook Giant' produced larger and high number of leaves when harvested at 7 and 14 days, compared to when harvested at 21 days, while cultivar 'Star 1801' performed similarly at all harvesting frequencies.

CONCLUSIONS

The highest yield was obtained with cultivar 'Ford Hook Giant' at a plant density of 40 plants/m² when plants were harvested on a biweekly basis. For the other cultivar included in the trial, 'Star 1801', harvesting frequency had no significant effect on yield.

ACKNOWLEDGEMENTS

Ms Salome Lebelo (experiential training student) for assisting in data collection and Liesl Morey from ARC-Biometry for statistical analysis.

Keywords: Gravel-film technique, leaf area, leaf fresh mass, plant spacing, yield

ALTERNATIVE METHODS OF OPTIMIZING YIELD OF TOMATO CULTIVARS IN SOILLESS CULTIVATION

MM Maboko¹, CP du Plooy¹ and S Chiloane¹

¹*Agricultural Research Council (ARC) Roodeplaat - Vegetable and Ornamental Plant Institute (VOPI), Private Bag X293, Pretoria 0001*

E-mail: mmaboko@arc.agric.za

INTRODUCTION

Tomatoes are the second most consumed vegetable in South Africa, after potatoes (Department of Agriculture, Fishery & Forestry, Directorate of Statistics and Economic Analysis, 2011) and are considered an essential component in the human diet for the supply of vitamins (A & C) and minerals (Jones, 2008). Lack of information in selecting good cultivars may lead to lower yields or unacceptable fruit quality, as cultivars differ in characteristics. Plant density plays an important role in optimizing yield, while a shortened growth season will result in less input costs. The objective of this study was to evaluate tomato cultivars and increase yield, while shortening the growing season with high density plantings, combined with early decapitation of growth point in a closed hydroponic system.

MATERIAL AND METHODS

The plantlets were transplanted 35 days after seeding, utilizing a closed (gravel-film technique) hydroponic system. Thirty six treatment combinations were used, namely four plant densities (25x40, 25x25, 20x25 and 10x20 cm inter-and intra-row, respectively), combined with nine tomato cultivars ('FA593', 'Linares', 'Alexis', 'Alfar', 'Miramar', 'Rodade', 'Star9006', 'Star9011' and 'Zeal'). A randomised complete block design was used with three replicates. The growing points of all plants were removed between the second and third inflorescence at 30-35 days after transplanting with two leaves remaining above the second inflorescence. During harvesting, fruit physiological disorders, number of fruits, marketable yield, unmarketable yield and total yield of the tomato fruits were recorded.

RESULTS AND DISCUSSION

There was no significant interaction between cultivars and plant density on tomato yield. Cultivar 'Miramar' gave the highest marketable and total yield, followed by cultivars 'Rodade' and 'Alfar'. Cultivars 'Alexis', 'Star9006' and 'Zeal' produced highest average fruit mass. Fruit cracking was significantly higher for cultivars 'Linares' and 'Star9006', while rain check was high for cultivars 'Alexis' and 'FA593'. 'Rodade' showed high incidence of zippering compared to other cultivars. Plant densities of 20 or 25 plants/m² produced significantly higher marketable and total yield, while plant densities of 10 or 16 plants/m² resulted in highest average fruit mass and high fruit cracking. The incidence of fruit cracking decreased with an increase in plant density.

CONCLUSION

Cultivar 'Miramar', followed by 'Rodade' gave the highest marketable and total yield in a closed hydroponic system. Results demonstrate that tomatoes pruned back to two trusses, combined with high density planting in a closed hydroponic system can achieve high yield with a shortened growth season.

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Keywords: Gravel-film technique, marketable yield, plant spacing, total yield, yield

INVESTIGATING THE LACK OF REDOXIMORPHIC FEATURES IN SOILS OF THE KOSI BAY COASTAL WETLAND

BB Mabuza¹ and CW van Huyssteen¹

¹University of the Free State, PO Box 339, Bloemfontein 9300

E-mail: mabuzabb@ufs.ac.za

INTRODUCTION

The Kosi Bay sandy aquifer forms part of an ecosystem that has been listed as a World Heritage Site by UNESCO, by virtue of its vast sub-surface waters which render it a wetland. These soils, however, do not demonstrate redoximorphic features associated with redox conditions in wetland soils. This study aims to determine the limiting factor to the formation of these features.

MATERIAL AND METHODS

A controlled (5x3) split-plot laboratory experiment was set up with 195 cores packed to a bulk density of 1.4 Mg m^{-3} and subjected to 5 degrees of water saturation ($S_{0.65}$, $S_{0.70}$, $S_{0.75}$, $S_{0.80}$ and $S_{0.85}$) over 6 weeks. Redox potential (Eh) and pH were measured bi-weekly using a Hannah 8913 meter. Exchangeable cations were measured bi-weekly using a Atomic Absorption Spectrometer.

RESULTS AND DISCUSSION

The average Eh recorded was 312, 255, 207 and 104 mV for the $S_{0.65}$, $S_{0.70}$, $S_{0.75}$, $S_{0.80}$ and $S_{0.85}$ degrees of water saturation respectively, indicating that the soils were weakly reducing for the $S_{0.65} - 0.80$ cores to moderately reducing for the $S_{0.85}$ cores. We determined the degree of water saturation at which reduction sets in to be $S_{0.73}$. This was done through extrapolating a linear trendline for the average Eh of the 5 degrees of saturation. Linear trendlines were also extrapolated for Fe^{2+} and Mn^{2+} and the degree of water saturation at which reduction sets in, is $S_{0.78}$.

CONCLUSION

Results obtained indicate that the soils are able to reduce. We speculate that permeability is rapid and that the water does not sit in the solum long enough for reduction to set in. The results point to a need to re-look the current guidelines for the delineation of sandy wetland soils. We would further recommend that a multiparameter study be done on site to monitor redox potential using Pt electrodes, water table fluctuations using piezometers, and groundwater Fe through laboratory analysis.

ACKNOWLEDGMENTS

Inkaba ye Africa for funding the project.

Keywords: redox potential, pH, exchangeable cations, degree of water saturation

EFFECT OF ZINC FERTILIZER ON GROWTH AND YIELD OF MAIZE (*Zea mays*) IN SEMI-ARID MPUMALANGA PROVINCE

SM Magongwa¹, JBO Ogola², JJO Odhiambo³ and C Mathews¹

¹Department of Agriculture, Rural Development and Land Administration, P/Bag X11318, Nelspruit 1200; ²Department of Plant Production; and ³Department of Soil Science, University of Venda, P/Bag X5050, Thohoyandou 0950

E-mail: ochanda@univen.ac.za

INTRODUCTION

Maize is the major grain crop produced by resource-poor smallholder farmers cropping the more marginal lands of the Mpumalanga Province. Maize is highly susceptible to Zn deficiency and Zn has been shown to be one of the main limiting factors in maize crop growth and yield (Potarzycki & Grzebisz, 2009). Soil Zn deficiency is widespread in most South African soils but most growers focus on N, P, and K fertilization. Although Zn is usually incorporated in some mixed fertilizers, the amounts may not be enough if applied in areas with severe Zn deficiency. Moreover, maize is the main source of zinc for most of the poor rural communities, whose diets are largely maize-based. Indeed, Mortvedt *et al.* (1991) have reported that zinc malnutrition, amongst other micronutrients, is extremely high in regions where maize is the staple food. Therefore Zn fertilizer application may not only increase maize grain yields but also Zn concentration in maize grain and hence lead to alleviation of Zn deficiency in human nutrition (Van Biljon *et al.*, 2010). The objective of this study was to assess the effect of Zn fertilizer rates on growth and yield of maize in the Lowveld region of Mpumalanga.

MATERIALS AND METHODS

A field experiment was conducted under rainfed conditions at Nelspruit (25° 26' 25" S, 30° 58' 57" E and 676 m above sea level) in Mpumalanga, South Africa in the 2011/2012 cropping season. The treatments consisted of a factorial arrangement of maize cultivars (ZM521 and CRN3505, open pollinated variety and hybrid, respectively) and Zn fertilizer rates (0-control, 10, 20 & 30 kg Zn ha⁻¹) laid out in a randomized complete block design and replicated 3 times. Each plot consisted of 4 plant rows, 3 m long and 0.9 m apart. NPK was applied at planting at a rate of 40, 60 and 60 kg ha⁻¹, respectively. A further 40 kg N ha⁻¹ was applied when the crop was knee-high. Number of cobs and grain yield were determined at harvest maturity. Analysis of variance was used to assess the treatment effects on the parameters that were measured.

RESULTS AND DISCUSSION

Cultivar and Zn fertilizer rates did not affect ($P < 0.05$) the number of cobs (average of 5.6 cobs m⁻²) and grain yield (average of 245 g m⁻²) at harvest maturity. Though non-significant, application of Zn fertilizer gave greater number of cobs and grain yield compared to the control. The non-significant effect of Zn on number of cobs and grain yield in the current study could be due to insufficient moisture in the soil which probably led to poor Zn uptake by the maize plants (Alloy 2004).

CONCLUSIONS

The application of Zn increased the number of cobs and maize grain yield, though the increase was non-significant. Therefore Zn fertilizer application may be beneficial in some parts of Mpumalanga Province. However, further field trials should be conducted over several seasons before any recommendations can be made to smallholder farmers.

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Keywords: Cob number, cultivar, grain yield, Mpumalanga

OCT: A NOVEL, RAPID AND NON-DESTRUCTIVE TECHNOLOGY TO VISUALISE MICROSTRUCTURES OF MANDARIN RINDS

LS Magwaza¹, UL Opara¹, S Landahl², HD Ford³, PJR Cronje⁴ and LA Terry²

¹Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Stellenbosch University, Stellenbosch 7600, South Africa; ²Plant Science Laboratory, Cranfield University, Bedfordshire MK43 0AL, United Kingdom; ³Department of Engineering Photonics, Cranfield University, Bedford MK43 0AL, UK; ⁴Citrus Research International, Department of Horticultural Science, Stellenbosch University, Stellenbosch 7600, South Africa

E-mail: 16241630@sun.ac.za

INTRODUCTION

Fresh citrus fruit are prone to various types of physiological rind disorders, manifested by a multitude of symptoms during handling and storage. Physiological rind disorders include peteca spot, rind breakdown, non-chilling rind pitting and rind staining, creasing, oleocellosis, and stem-end rind breakdown. The trend in plant sciences is increasing adoption of non-destructive techniques of quality assessment. Optical coherence tomography (OCT) is one such non-invasive analytical technique currently available to researchers and is suitable for examining internal structures of plant tissue. In this study, the feasibility of OCT for imaging histological changes associated with the development of a progressive rind breakdown (RBD) disorder of 'Nules Clementine' mandarin (*Citrus reticulata* Blanco.) was investigated.

MATERIALS AND METHODS

This study was carried out with 12 fruit of different levels of RBD disorder (scored by visual inspection on a subjective scale from 0=no RBD to 3=severe RBD), which were carefully selected from a batch of fruit stored for eight weeks at $8\pm0.5^{\circ}\text{C}$. Each level of the disorder was replicated three times. Images of healthy and RBD-affected intact mandarin fruit were acquired using a Thorlabs OCT system based on a broadband 930 nm source (Watts of the light source) (Thorlabs Ltd., UK), with the maximum imaging depth of 1.6 mm. Each two-dimensional (2D) image comprises 500 pixels laterally (2 mm) and 512 pixels in depth.

RESULTS AND DISCUSSION

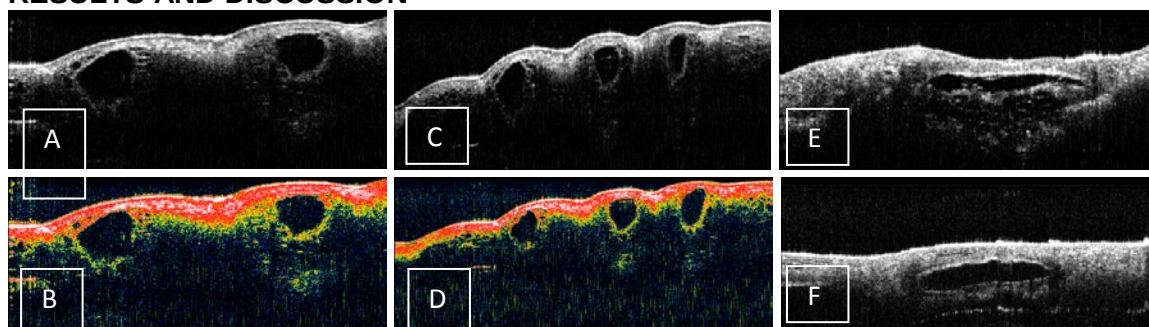


Figure 1: OCT images of 'Nules Clementine' mandarin fruit with or without RBD. The oil glands stayed intact on unaffected fruit (A,B,C,&D) and collapsed on affected fruit (E&F).

CONCLUSIONS

OCT provided high resolution images to a depth of about 0.5 mm. Immediate and non-destructive acquisition of images showing histological and microstructural features of intact rind tissues was demonstrated. Using conventional microscopes, these results would require complex sample preparation and take possibly several hours to acquire similar images.

Keywords: OCT, citrus, oil glands, histological, microstructural characteristics

OPTIMISATION OF HORMONES FOR IN-VITRO PROPAGATION OF INDIGENOUS *Cucumis* SPECIES

MY Maila¹, OM Pelinganga¹, PW Mashela¹ and B Nzanza¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: mmatshelo@webmail.co.za

INTRODUCTION

Wild watermelon (*Cucumis africanus*), indigenous to South Africa, is highly resistant to *Meloidogyne incognita* races 2 and 4, along with *M. javanica*, which are widely distributed in South Africa (Pofu, 2012). *Cucumis africanus* was successfully used as a nematode-resistant rootstock in watermelon (*Citrullus lanatus*) which does not have cultivars which are resistant to *Meloidogyne* species. However, when sexually propagated, germination is poor due to auto-allopathy, with resultant non-uniformity of seedlings (Mashela *et al.*, 2011). The objective of this study was to optimize concentrations of plant hormones for shoot multiplication and rooting of *C. africanus* in the development of *in-vitro* propagation protocols.

MATERIALS AND METHODS

Shoot multiplication and rooting were achieved using full strength Murashige and Skoog (MS) medium supplemented with various levels of hormones (0.0, 0.05, 0.1, 0.25, 0.75) BAP and IBA mgL⁻¹. All cultures were maintained in the growth room at 25 °C under light supplied by cool white inflorescent tubes. Light intensity was 40 $\mu\text{mol m}^{-2} \text{s}^{-1}$ with a photoperiod of 12 h. Shoot multiplication and rooting data were subjected to lines of the best fit and optimized using the relation: $x = -b_1/2b_2$.

RESULTS AND DISCUSSION

Results of the study suggested that for *C. africanus* shoot multiplication and rooting were optimized at 0.694 mg BAP/2.2 g MS medium and 0.334 mg IAA/2.2 g MS, respectively. Propagation of *C. africanus in-vitro* would result in uniform seedlings for the production of nematode-resistant seedling rootstocks for use in watermelons. The two optimized values were validated and were significantly suitable for shoot multiplication and rooting, respectively.

CONCLUSION

In conclusion, the two optimized values for shoot multiplication and rooting are viewed as important empirically-derived statistics in the development of *in-vitro* propagation protocols for *C. africanus* rootstocks in watermelon production.

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Keywords: *Cucumis africanus*, *Citrullus lanatus*, *Meloidogyne* species, auto-allopathy, benzylaminopurine, indole-3-acetic acid

ENHANCEMENT OF SYMBIOTIC RESPONSE AND SEED YIELD WITH *Rhizobium* AND DIFFERENT GENOTYPES OF CHICKPEA (*Cicer arietinum* L.)

MP Makhura¹, C Mathews² and FD Dakora³

¹Dept of Crop Sciences; ²Dept of Agriculture, Rural Development and Land Administration, Private Bag X11318, Nelspruit 1200 ; ³Dept of Chemistry, Tshwane University of Technology, 175 Nelson Mandela Drive, Private Bag X680, Pretoria 0001

E-mail: pride.makhura@gmail.com

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an annual grain legume that is cultivated mainly for human consumption. It has nutritional and agronomic advantages over other legumes and presents high potential as a functional ingredient for the food industry (Aréas, 1992). Chickpea has potential of fixing atmospheric N₂ in association with compatible rhizobium species with benefits to traditional cropping systems. However, little information exists on genotypes based symbiotic performance of chickpea and *Rhizobium* in South African regions. The objectives of this study were to establish relative dependency of chickpea on N₂ fixation for its N nutrition and to quantify the amount of N-fixed by inoculated chickpea genotypes.

MATERIALS AND METHODS

Forty elite chickpea genotypes from India were planted in a randomised complete block design, with four replicates (2.5 X 4 rows) at Mzinti. All genotypes were inoculated with rhizobium at planting. At flowering stage, five plants per plot were dug up to measure plant growth and symbiotic performance. Shoots were separated from roots, oven-dried for 48 hours at 60°C to constant weight, to determine dry matter. They were then ground through 0.45 mm sieve for ¹⁵N isotopic analysis using mass spectrometer. All data were subjected to analysis of variance (ANOVA) at P=0.05.

RESULTS AND DISCUSSION

Genotype ICCV10 accumulated the highest biomass (3.27 g.plant⁻¹) followed by ICCV8108 (3.14 g.plant⁻¹), ICCV6109 (2.28 g.plant⁻¹) and ICCV7103 (2.73 g.plant⁻¹). Isotopic analysis revealed generally low δ¹⁵N values ranging from -1.00 ‰ in genotype ICCV8108 to 1.14 ‰ in ICCV3207. The percent nitrogen derived from atmosphere (%Ndfa) ranged from 27.16 % to 75.28 % in ICCV4105 and ICCV8109 respectively, as a result, amount of N-fixed ranged from 0.61 to 7.10 kg.ha⁻¹ in ICCV7112 and ICCV5103 respectively. Low dry matter and reduced δ¹⁵N in these genotypes resulted in low amounts of N-fixed.

CONCLUSIONS

About 50% of tested genotypes depended more on symbiotic fixation rather than on soil N for their N nutrition. Furthermore, results emphasise the importance to select the suitable chickpea genotypes which will survive under South African weather conditions and has the capacity of highest N₂-fixation.

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Keywords: Chickpea, plant growth, inoculation, %Ndfa, N-fixed

ALLELOPATHIC POTENTIAL OF *Conyza bonariensis* (FLAX-LEAF FLEABANE / KLEINSKRAALHANS)

MW Malatji¹, NJ Taylor¹ and CF Reinhardt¹

¹Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028

E-mail: u04283775@tuks.co.za

INTRODUCTION

Conyza spp are annual, herbaceous weeds belonging to the Asteraceae family. Worldwide, three *Conyza* species are noxious weeds in many crops. *Conyza bonariensis* is a weed of cultivated and non-cultivated lands, gardens, roadsides and waste places. It is highly competitive with crops but little is known about its allelopathic effects. Adding to its problem status is the recent discovery that certain biotypes in South Africa and other parts of the world are resistant to herbicides glyphosate and paraquat. The allelopathic potential of *Conyza bonariensis* occurring in South Africa was therefore assessed.

MATERIALS AND METHODS

Mature plants of *Conyza bonariensis* were collected on the experimental farm of the University of Pretoria. Test species were tomato and lettuce. Extracts of *C. bonariensis* were prepared by extracting *C. bonariensis* leaves/roots in pure water and hexane for 24 h at room temperature. Extract solutions were filtered and diluted with the respective solvents to give a concentration range of 25, 50, 75, and 100% (v/v). The control treatment was distilled water. Crop seeds were first surface sterilized in 1% sodium hypochloride and then placed on sterile Petri dishes. Each plate received 5 ml of the extract. Petri dishes were placed in a growth chamber at 25°C. Germination was measured after seven days as well as root and shoot length of each seedling. Osmotic potential of all extracts was measured using the Herman Roebling digital micro-osmometer. Data were subjected to ANOVA and separation of means was done with the least significant difference test of Tukey at $p = 0.05$

RESULTS AND DISCUSSION

Water and hexane extracts of both leaves and roots of *C. bonariensis* showed inhibitory effects on root and shoot growth of both lettuce and tomato. Leaf extracts generally caused greater inhibition of germination and seedling growth than root extracts. Water extracts appeared to contain different/more inhibitory substances (allelochemicals) than the hexane extracts. These results were found not to have been influenced by osmotic effects.

CONCLUSION

C. bonariensis contains phytotoxic allelochemicals that can inhibit the germination and early seedling development of crop species. Allelochemicals contained in the leaves of the weed appear to be more potent than those in roots. A practical consequence of this characteristic is that incorporation of *C. bonariensis* foliage into the crop seedbed may at least impede germination and early seedling development. This means that the weed should not be allowed to attain significant biomass on crop fields at any stage, irrespective of whether the crop is present or not.

Keywords: Allelopathy, *Conyza bonariensis*, germination

EXAMINATION OF SOIL FACTORS AS EROSION CONTROLLING VARIABLES AND THEIR ROLE IN DELINEATION OF ARABLE LAND FOR SUSTAINABLE CROPPING

A Manyevere¹, P Muchaonyerwa², MC Laker¹ and PNS Mnkeni¹

¹University of Fort Hare, P.Bag X1314, Alice; ²University of Kwazulu-Natal;

E-mail: 200705774@ufh.ac.za

INTRODUCTION

Sustainable use of local soil resources requires correct identification and delineation of arable land, paying particular attention to the land's vulnerability to erosion, for optimization of the use of land resources. Extremely serious soil erosion damage was done in former homelands of South Africa, including the area now known as Nkonkobe, due to incorrect demarcation of arable land as a result of incorrect assessment of the erodibilities of soils. The objective of the study was to determine soil variables controlling soil erosion in different climatic units and use these to delineate land with good potential for cropping in Nkonkobe municipality.

METHODOLOGY

Field observation, aerial photographs and existing soil erosion maps were used to determine the degree of soil erosion using detailed features such as sheet, rill and gully erosion in Nkonkobe Municipality. Erosion severity was coded using the simplified erosion degree scale. Soils were analysed for particle size distribution, chemical properties (exchangeable bases, citrate-dithionite extractable iron) and clay mineralogy using XRD. Numerical values of soil properties and their soil forms were regressed against the erosion severity using step-wise regression.

RESULTS

There were general relationships between different taxonomic soil classes according to the South African soil classification system and different types and degrees of erosion. Step-wise regressions showed that fine sand was the overriding factor on erosion severity in all soil forms.

Erosion intensity was positively correlated with very fine sand ($r = 0.397$), fine silt ($r = 0.356$), Na ($r = 0.310$) and ESP ($r = 0.328$), and negatively correlated with clay content ($r = -0.380$) but there were no significant correlations between erosion intensity with Mg, Ca and Ca: Mg ratio. The clay fraction of soils in humid climates were dominated by kaolinite mineralogy and these soils were more stable than soils in arid and semi-arid climates dominated by clay sized quartz and mica minerals.

CONCLUSIONS

Soil erosion was less intense in humid than arid regions. Soil erodibility was influenced mainly by fine sand content in arid and semi-arid regions and clay mineralogy in humid climates. The findings were used to develop guidelines for the identification and delineation of arable land in Nkonkobe Municipality based on erodibilities of the soils.

Keywords: Soil erosion, delineation, arable land, texture

ACID PHOSPHATASE ACTIVITY AND P NUTRITION IN SOYBEAN (*Glycine max* (L.) Merr.) GENOTYPES UNDER FIELD CONDITIONS IN SOUTH AFRICA

N Mapope¹ and FD Dakora²

¹Department of Crop Sciences; and ²Department of Chemistry, Tshwane University of Technology, P/Bag X680, Pretoria 0001

E-mail: nmapope@gmail.com

INTRODUCTION

Chemical P fertilisers are the most expensive of the major plant nutrients and in the near future, the world could suffer a shortage of P fertilisers as non-renewable P, is getting depleted. This situation therefore, dictates that legume crops such as soybeans with P-acquisition traits be identified and used. The aim of this study was to evaluate P nutrition in soybean varieties grown in farmers' fields, as well as in elite commercial material grown in experimental plots.

MATERIALS AND METHODS

Plants were sampled from a total of 37 farms, 15 in KwaZulu-Natal, 12 in North West and 10 in Mpumalanga. Additionally, 20 varieties were evaluated in the field, under dryland at the Small Grain Institute, Potchefstroom. The experiment was laid in a randomised complete block design, with three replications. Soybeans in the farms and under experiment were inoculated with *Bradyrhizobium japonicum* strain WB74 at or before planting, together with monoammonium phosphate (11% N and 49% P) fertilizer at a rate of 220 kg.ha⁻¹. At R6 stage ten soybean plants in the farms and the experiment were randomly dug up and separated into shoots and roots. Rhizosphere soil (soil attached to the roots) was collected from 10 plants along with bulk soil (soil with no soybean roots influence). Samples were taken to the laboratory where soils for enzyme assay were frozen and the rest air dried for nutrient determination (Makoi *et al.*, 2010). The shoots were oven-dried at 60 °C to constant weight, for P determination (Du Plessis and Burger, 1964). Data were subjected to one-way analysis of variance in Genstat 12th Edition at p=0.05

RESULTS AND DISCUSSION

The data revealed marked differences in rhizosphere acid phosphatase activity, P concentration in rhizosphere soil, P concentration and amounts in shoots between genotypes and farms. Soybean varieties with greater concentration of acid phosphatase activity and P in their rhizospheres included LS678 at Winterton, A5409 at Bergville, LS6164 at Devon, LS6164 at Endcot, PAN535 at Leandra, LS6164 at Nigel, PAN1666 at Potchefstroom, PAN737 at Parys and PAN1453 at Gransvlei. The data also showed that there is a positive correlation between rhizosphere acid phosphatase activity and P concentration.

CONCLUSIONS

This study has shown that legumes such as soybean are able to use mechanisms for enhancing P acquisition in low-P environments and the varietal differences can be exploited for enhanced P nutrition under field conditions.

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Keywords: Correlation, enzyme assay, legume, P-acquisition, rhizosphere soil

THE EFFECT OF GLYPHOSATE HERBICIDE ON THE DYNAMICS OF CERTAIN POPULATIONS OF CULTURABLE SOIL MICROBES

A Marais¹, MI Ferreira¹, M Booyse² and A Botha³

¹Western Cape Department of Agriculture; ²ARC Biometry, Stellenbosch, South Africa;

³Department of Microbiology, University of Stellenbosch, South Africa

E-mail: aneliam@elsenburg.com

INTRODUCTION

The physical and chemical properties of soils have been studied extensively, but the influence of human activities thereon is lacking. Glyphosate is used worldwide to combat weeds, but knowledge about its effect on soil microbes is limited. Even though this commercially available herbicide is usually seen as environmentally safe, there remain concerns about its long-term effect on soil microbes, plants, animals and humans. Soil microbes play an important role in the biogeochemical cycling of nutrients, consequently the maintenance of a healthy soil microbial community is of utmost importance to farmers. Some farmers add sugar or molasses to their herbicides in order to minimise its possible effect on the beneficial microbial populations. The simple sugars within these carbohydrate rich soil amendments supposedly act as alternative substrate for root exudates originating from living weeds which may be absent after herbicide application. In this study, the effect of glyphosate herbicide was tested, with and without added sucrose, on the dynamics of certain populations of soil microbial communities.

MATERIAL AND METHODS

The experiment was a randomised complete block design with 4 treatments and replicated in 6 blocks. A composite soil sample of each plot/experimental unit was taken. The soil was sampled at three stages, namely before treatment, one week after treatment and 20 days after treatment. The number of culturable protozoa (most probable number method) and the potential metabolism of the bacterial community (Biolog Ecoplate™) were determined for each soil sample, whilst filamentous growth – filamentous fungi and actinomycetes – were measured *in situ* using the buried slide method.

RESULTS AND DISCUSSION

Glyphosate caused changes in the metabolic potential of the bacterial soil community. Adding sucrose did not contribute significantly to the effect of the herbicide on the microbes, although protozoa numbers were stimulated by the sugar alone amendment. Protozoa feed on bacteria which could have been stimulated by the sugar. Filamentous growth was slightly higher towards the end of the study period, probably because of the increase in dead plant material which is used as substrate for saprophytic fungi.

CONCLUSION

Whilst glyphosate did bring about a significant change in the potential metabolism of the bacterial community; the effect had seemingly worn off after 20 days, possibly as a result of natural processes.

Keywords: Biolog Ecoplate™, buried slide, glyphosate, MPN, soil microbes, sucrose

YIELD RESPONSE OF CHINESE CABBAGE (*Brassica rapa* L. Subsp. *chinensis*) TO DIFFERENT AGRONOMIC AND MANAGEMENT FACTORS

I Maseko¹, YG Beletse², N Nogemane¹ and CP du Plooy²

¹University of South Africa, P O Box 392, Pretoria 0003; ²Agricultural Research Council - Vegetable and Ornamental Plant Institute (ARC-VOPI), P/Bag X293, Pretoria 0001

E-mail: innocentmsk94@gmail.com

INTRODUCTION

Chinese cabbage (*Brassica rapa* L. subsp. *chinensis*), also known as Muchina, is commonly produced in Limpopo Province. There is limited information available describing production systems, such as optimum planting times, plant density, irrigation and nitrogen levels under South African conditions. The objective of this study was to evaluate yield of Chinese cabbage in response to varying plant densities, nitrogen levels, planting dates and irrigation regimes.

MATERIALS AND METHODS

A field trial was planted at Roodeplaat (25°35' S; 28°21' E; 1164 m.a.s.l.) from June to September, 2012. The factorial (3*3*2*2) experiment was laid out in a split-split plot design, with three replications. The treatments were: three plant densities (133 333, 80 000, 50 000 plants ha⁻¹), three nitrogen fertiliser levels (0, 50 and 100 kg N ha⁻¹), two irrigation regimes (applied either once and three times a week) and two planting dates (1 June and 18 July, 2012). Harvesting commenced at six (6) weeks after transplanting (WATP) and every two weeks thereafter. Leaf number, fresh and dry mass (t ha⁻¹) were recorded at each harvest.

RESULTS AND DISCUSSION

Nitrogen application at 50 and 100 kg N ha⁻¹ significantly ($P > 0.05$) increased leaf number, and fresh and dry mass compared to the control (0 kg N ha⁻¹) for both planting dates. However, no significant differences ($P > 0.05$) were observed between fertiliser treatments. Frequent irrigation (three times weekly) led to a significant ($P > 0.05$) increase in yield due to increased plant growth during the second planting date. However, irrigation had no effect on yield for the first planting date. This was probably due to low temperatures. High plant density (133 333 plants ha⁻¹) resulted in a significantly ($P < 0.05$) higher number of leaves relative to lower plant densities. However, this did not translate to any yield advantage. Lower plant densities produced vigorous crops and that could have compensated for a reduced number of plants. On average, higher harvests were obtained by planting early and there was low aphid infestation compared to late planting.

CONCLUSIONS

From the study, it was established that nitrogen (50 and 100 kg ha⁻¹) and irrigation (three times a week) significantly improved yield. Plant density of 133 333 plants ha⁻¹ significantly affected the number of leaves and reduced yield. The trial was conducted in one season; hence further studies are still necessary to confirm the findings.

ACKNOWLEDGEMENTS

Department of Science and Technology for funding.

Keywords: Chinese cabbage, irrigation, nitrogen, plant density, planting date

ROLE OF ACID PHOSPHATASE ACTIVITY IN SOIL AND ORGAN P NUTRITION OF *Cyclopia* SPECIES IN THE CAPE FYNBOS

ST Maseko¹ and FD Dakora²

¹Department of Crop Science, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa; ²Chemistry Department, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa;

E-mail: mhlekazist@gmail.com

INTRODUCTION

Acid phosphatase (APase) activity is used to indicate P nutrition in crops. APase in rhizosphere soil solubilise particle-bound P, thereby liberating it for uptake by plants. It also translocate organ P to sinks. *Cyclopia* is endemic to the Cape fynbos that occur on ancient sandy and acidic soils with about (2 - 88%) Pi being Fe-bound and (58 - 77%) as Po (Straker, 1996), thus, making Cape fynbos soils the most P impoverished in the world. Production of APase activity and its secretion into the rhizosphere by roots of plants is a mechanism by which plants translocate and solubilise bound P in soils. This study assessed the role of APase activity in solubilisation and translocation of P by organs of *Cyclopia* species.

MATERIALS AND METHODS

Rhizosphere and bulk soil were collected from commercial *Cyclopia* plantations at Koksrivier and Kanetberg, the plants were established without P-fertilization. Five *Cyclopia* plants, each two-year old were sampled along with rhizosphere and bulk soil for enzyme assay and P analysis. P was analysed using an inductively coupled plasma-mass spectrometry and bioassay of APase activity in soil and organs was done using methods by Tabatabai (1994) and Liu et al (2004), respectively.

RESULTS AND DISCUSSION

Rhizosphere soil of *Cyclopia genistoides* and *C. subternata* from Koksrivier and Kanetberg farms, respectively, exhibited significantly greater APase activity compared to bulk soil at both sites. P concentration was also much higher in the rhizosphere of the test legumes relative to bulk soil. Organ APase activity was consistently greater in leaves, followed by stems and lowest in roots of all the *Cyclopia* species, similarly, organ P mirrored the APase activity. The results suggest that *Cyclopia* secrete APase activity to solubilise particle-bound P in its rhizosphere for uptake. Furthermore, these species use the APase activity to translocate P to organs where it is needed most.

CONCLUSIONS

Cyclopia species of the Cape fynbos tolerate low-P in the fynbos partly through the secretion of APases.

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ACKNOWLEDGEMENTS

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Keywords: *Cyclopia*, fynbos, phosphatase, phosphorus, rhizosphere

ALTERNATIVE SUBSTRATES FOR CULTIVATING OYSTER MUSHROOM (*Pleurotus ostreatus*)

MR Masevhe¹, NJ Taylor¹ and P Soundy²

¹Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0001, Republic of South Africa; ²Department of Crop Science, Faculty of Science, Tshwane University of Technology, Private Bag x 680, Pretoria, Republic of South Africa

E-mail: Mashudu@arc.agric.za

INTRODUCTION

Wheat straw has been the main raw material used for cultivating *Pleurotus ostreatus* (Labuschagne *et al.*, 2000), but in South Africa, it is expensive for small-scale farmers to utilize this substrate. Both wild grass and woodchips can be used as alternative due to its availability at all times and because it has little cost. The objective of this study was to investigate the use of alternative, but suitable raw material (substrate) for planting oyster mushrooms.

MATERIAL AND METHODS

The study was carried out at ARC-ITSC, Mbombela, Mpumalanga, South Africa in a custom made huthouse. The experimental design was completely randomized with 3 types of substrates, consisting of wheat straw (control), woodchips and wildgrass, replicated 8 times. The single bale of wheat straw (10kg), woodchips (20kg) and wildgrass (15kg) were sterilized (boiled) in a 225 L drum each. The planted plastic bags weighed 7kg each, to which 1kg of oyster mushroom spawn was added. Growth parameters, such as the rate of colonization and contamination, number of harvests, number of flushes, number of caps and cumulative fresh mass (g), together with temperature and %RH, were evaluated and recorded. Both the growing media and oyster mushroom crop was analysed for mineral composition.

RESULTS AND DISCUSSION

The control differed significantly to that of wildgrass and woodchips in the rate of mycelia colonization from Day 1 to Day 8. The control had a 65% rate of colonization as compared to 50% for woodchips and 45% for wildgrass on Day 1. The control reached the full mycelia colonization (100%) on Day 8, whereas the woodchips and wildgrass remained below 100% mycelia colonization on Day 10. The control significantly suppressed the rate of mycelia contamination (0%) from Week 1 to Week 4, whereas both the woodchips (3.38 to 36.88%) and wildgrass (5 to 12.5%) were contaminated with parasitic fungi. Both the control and wildgrass were harvested 6 times compared to 3 harvests with woodchips. Both the control and wildgrass significantly differed to woodchips in number of flushes, number of caps and cumulative fresh mass.

CONCLUSIONS

The wildgrass can be recommended as alternative to wheat straw because it accelerated the rate of mycelia colonization and suppressed the rate of mycelia contamination. In addition it also improved the number of harvests, number of flushes, number of caps and cumulative fresh mass of oyster mushrooms cultivated on this medium.

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Keywords: Colonization, contamination, substrate, wheat straw, wildgrass, woodchips

EVALUATING FRUIT QUALITY OF POMEGRANATE (*Punica granatum* L.) CV. ACCO IN THE WESTERN CAPE PROVINCE

KL Mashavhathakha¹ and D January¹

¹ARC-Infruitec-Nietvoorbij, P/bag X5026, Stellenbosch 7602

E-mail: mashavhathakhak@arc.agric.za

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important cultivated commercial fruit crop. Interest in the pomegranate has increased recently due to its nutritional and antioxidant activity. Despite various pomegranate cultivars being grown in different provinces in South Africa, not enough effort has been made to assess the performance of these cultivars. Such data will assist in the selection of cultivars for commercial production to meet market demand. The aim of the study was to evaluate and compare the performance of cultivar 'Acco' on three farms in the Western Cape.

MATERIALS AND METHODS

This study was conducted during the pomegranate fruiting season of 2012 on three farms, namely Bonnievale, Porterville and Ladysmith, where fruits of pomegranate cultivar 'Acco' were harvested. The samples were composed of ten randomly selected trees. Ten fruits from each tree were harvested, making a total of 100 fruits per farm. Fruit weights (Fw), fruit length (FL) and fruit width (Fw1) were recorded. After measuring the fruit size, arils were manually separated from the fruits. Total soluble solids (TSS) content was measured. Colour measurements were performed using a chromameter. One-way analysis of variance (ANOVA) was performed.

RESULTS AND DISCUSSION

The average fruit weight ranged from 219.4g - 281.8g. The fruit weight of pomegranate at Bonnievale (281.79g) was significantly higher than on other farms. The fruit length ranged from 68.6 mm - 76.4 mm, with fruit from Bonnievale having greater fruit length than that of the other farms. The fruit width ranged from 75.0 mm - 83.2 mm with Bonnievale fruit again having greater width than fruit from the other farms. TSS was significantly different between farms and ranged from 15.0 - 16.2 °Brix. Porterville (16.2 °Brix) had significantly higher TSS compared to fruit from other farms. In terms of colour, the results ranged from 39.8 - 46.3 indicating that fruit from all three farms have a dark red colour and were consistently similar in colour indices. However Porterville farm had darker red fruit than the other farms. There were no significant differences in the a^* value amongst fruit from the different farms. The Chroma value (C), which represents the purity or the intensity of a colour, ranged from 49.2 - 53.1. Fruits from Porterville showed less intensity than those from other farms ($C > 50$). Significant differences existed in the hue angle (H) which ranged from 24.6 - 29.4.

CONCLUSION

The pomegranates grown on three farms showed significant differences in fruit weight, length and width, which can be useful in selection of superior pomegranates. This also indicates that area is a considerable factor in determining the fruit quality of pomegranate. This study provides information that could be used to better understand the effect of growing region on pomegranate fruit properties in South Africa.

ACKNOWLEDGEMENTS

The authors would like to thank Citrogold Ltd and the ARC for providing funding.

Keywords: Aril, chroma, hue angle, performance

THE STAY- GREEN TRAIT IN RELATION TO PHYSIOLOGICAL RESPONSES TO WATER DEFICIT DURING VEGETATIVE GROWTH IN DUAL- PURPOSE COWPEA LANDRACES

J Mashilo¹ and AO Odindo²

¹Limpopo Department of Agriculture, Towoomba ADC, Bela-Bela 0480 South Africa;

²Discipline of Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Scottsville 3209, Pietermaritzburg, South Africa

E-mail: jacobmashilo@yahoo.com

INTRODUCTION

The stay-green trait in cowpea has been shown to increase productivity during a mid-season drought by allowing retention of green leaf area which allows survival of sufficient vegetative structures for regrowth and resumption of reproductive activity (Gwathmey & Hall, 1992). During post-anthesis drought, the trait is thought to be promoted by increased accumulation of sugars and starch which may help promote maintenance of vegetative structures and regrowth capacity (Gwathmey *et al.*, 1992a). Not many studies have investigated physiological responses that may be associated with the stay-green trait during vegetative drought. It is hypothesized that cowpea cultivars differing in senescence properties may have different physiological responses during vegetative drought stress which may affect regrowth capacity.

MATERIALS AND METHODS

Seeds of two dual-purpose cowpea landraces differing in senescence properties namely: Grey (Stay-green) and Black (Senescent) were grown in 5-litre pots containing a loamy soil under glasshouse conditions. The experiment was a 2x2 factorial arrangement in randomized complete block design with two factors: 2 landraces (Grey, Black) and two water levels (well watered, stressed) replicated 4 times. When plants developed 6 fully expanded trifoliate leaves during vegetative growth, drought was imposed by withholding irrigation for 28 days. The well-watered treatments were irrigated regularly. Sampling was done at 7, 14, 21 and 28 days after starting with stress and leaf water potential, relative water content, proline content and total antioxidant capacity were measured.

RESULTS AND DISCUSSION

Predawn leaf water potential increased more rapidly in the Black landrace as compared to that of Grey landrace during drought. Relative water content of Black landrace declined more rapidly than that of Grey landrace during stress. Total antioxidant capacity increased significantly in the Grey landrace when compared to Black landrace. Proline increased significantly in the Black landrace than Grey landrace during drought. Leaf area was severely reduced in the Black than Grey landrace; however, all plants survived drought stress and resumed growth after drought- relief.

CONCLUSIONS

Results reported in this study maybe helpful to elucidate physiological responses of stay-green cowpea varieties during vegetative drought stress.

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Keywords: Cowpea, vegetative drought-stress, leaf water potential, proline, relative water content, stay-green trait

***Tylenchulus semipenetrans* BIOTYPE IN SOUTH AFRICA: FINAL RESULT AND CONSEQUENCES**

RV Matabane¹, PW Mashela¹ and OM Pelinganga¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: vivyat@webmail.co.za

INTRODUCTION

The citrus industry has been reliant on information which suggested that the citrus nematode biotype in South Africa was the Mediterranean biotype (Cohn, 1976). However, the citrus nematode (*Tylenchulus semipenetrans*) biotype has not been empirically identified in South Africa (Mashela *et al.*, 2012). Biotypes could only be identified using differential host plants. A national project was, therefore, established to validate *T. semipenetrans* biotype in the major citrus-producing district municipalities of South Africa.

MATERIALS AND METHODS

Isolates from 18 municipality districts each constituted a single experiment. Rough lemon (*Citrus jambhiri*), trifoliolate orange (*Poncirus trifoliata*) and olive (*Olea europaea*) serving as differential host plants, were arranged in a randomised complete block design, with 15 replications. Each plant was inoculated with 10 000 J2s, with the experiments harvested after 120 days. Only nematode data were collected and assessed using relative penetration indices (RPI) *i.e.* comparison of the amount of nematodes in the soil with those within the roots.

RESULTS AND DISCUSSION

Isolates from 18 participating districts had negative RPI values on olive, while on *P. trifoliata* and rough lemon, positive RPI values were obtained, except for Amathole, Zululand and West Coast districts where for rough lemon the RPI values were negative. Negative RPI values imply that more nematodes were in the soil than in the roots, while the opposite is true for positive RPI values. Additionally, when nematodes were standardized (meaning that 10 000 J2s were used as inoculums for a feasibility study) those on olive were zero (0), suggesting that the isolates failed to reproduce on this plant. Using *T. semipenetrans* biotype nomenclature, the citrus nematode biotype in South Africa is *Poncirus* instead of the much cited Mediterranean biotype.

CONCLUSION

Since *P. trifoliata* rootstock is a host to the *Poncirus* biotype, this rootstock is not suitable for use in citrus-producing regions of South Africa.

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Keywords: Mediterranean biotype, *Poncirus* biotype, reproductive factor

GROWTH AND YIELD RESPONSES OF FOUR JUTE ACCESSIONS TO VARIABLE FERTILIZER APPLICATION RATES UNDER GREENHOUSE CONDITIONS

LA Matelele¹, FR Kutu¹ and PO Adebola²

¹University of Limpopo, School of Agriculture and Environmental Sciences, P/Bag X1106, Sovenga 0727; ²Agricultural Research Council-Vegetables and Ornamental Plants Institute, P/Bag X293, Pretoria 0001

E-mail: matelelela@gmail.com

INTRODUCTION

Indigenous wild leafy vegetables such as Jute are often consumed as relish by rural people for their nutritional and medicinal benefits. Such consumption is however, often considered as a coping strategy for poverty alleviation and livelihood stress. Increasing and sustaining availability of this important crop is thus a major challenge due to land degradation and climate change. This study aims to develop an appropriate fertilization strategy that will promote increase availability of Jute as a nutrient-rich leafy-vegetable alternative.

METHODOLOGY

A 4 x 6 factorial experiment fitted in a Randomized Complete Block Design with four replications was conducted under greenhouse conditions using surface (0-15 cm) soil sample collected from University of Limpopo experimental Farm, Syferkuil. Treatments consisted of five N-P-K fertilizer rates (0-80-60, 100-0-60, 100-80-0, 100-80-60 and 50-40-30 kg/ha) compounded using Urea (46% N), double super phosphate (10.5% P) and potassium chloride (50% K₂O), respectively; and four Jute accessions (Tanzania, Kenya, Nigeria and Uganda). Unfertilized control treatment was included as a control. Two seedlings of each Jute accession were transplanted into well-labelled 10 kg soil-filled pots each containing fertilizer treatment and watered regularly. Growth and yield data were collected until 24 weeks after transplanting. Data included plant height, number of branches, fresh and dried leaf weight, number and weights (fresh and dried) of capsules. Treatment means were compared using Tukey HSD test at 5% probability level.

RESULTS AND DISCUSSION

Results showed that performance of the different Jute accessions differed significantly ($P < 0.05$) following application of variable NPK rates. Mean fresh and dried leaf weights of 12.3 and 1.85 g/plant, respectively across the various fertilizer application rates for Uganda were the highest. In contrast, mean number of 17.8 branches per plant obtained in Nigeria Jute accessions was the highest while plant height of 74.4 cm for Uganda accessions was the tallest. Kenya Jute accessions produced the highest number of capsules per plant (11.3) while the highest fresh and dried capsules weights of 18.7 and 1.95 g/plant, respectively, were obtained from Kenya accessions.

CONCLUSIONS

Findings underpin the importance of optimum N-P-K application for achieving yield increases in vegetable crop production.

Keywords: Indigenous crops, Jute capsules, NPK application, wild leafy vegetables

THE EFFECT OF SERADEx CONCENTRATION LEVEL, CUTTING TYPE AND TIME OF YEAR ON ROOTING OF *Osteospermum ecklonis*

S Mathe¹ and R van Niekerk¹

¹University of KwaZulu-Natal

E-mail: sakhile0799071541@gmail.com

INTRODUCTION

South Africa has a wealth of indigenous flower crops that have been recently commercially exploited. To meet the anticipated demand for vegetative propagation, optimal rooting procedures for one of these crops, *Osteospermum ecklonis*, were established. Seasonal variations of the ease of rooting cuttings are common and the rooting success often differs with the auxin concentration used to promote better rooting. Therefore, a propagation study was conducted to observe the effect of seasonal variations and the optimal Seradex concentration level on rooting of the native flower crop *Osteospermum ecklonis*.

MATERIALS AND METHODS

Well-developed turgid branches were taken at different seasons of the year, in autumn (22/05/12), winter (27/06/12) and spring (20/09/2012); and tip and basal stem cuttings were prepared at these times. Cuttings were treated with Seradex 1 (1000ppm), 2 (3000ppm) and 3 (8000ppm) respectively. Controls received no seradex. Thereafter cuttings were placed in mistbeds containing Perlite® as a growing medium. Percentage rooting, root length and root number were recorded weekly for a duration of ten weeks.

RESULTS AND DISCUSSION

Terminal cuttings rooted best in autumn and spring when treated with the highest Seradex concentration; however, Seradex 1 was more effective in stimulating rooting in spring cuttings. Therefore spring cuttings rooted better than autumn cuttings. Basal cuttings in all three seasons showed no rooting, while tip cuttings had relatively equal rooting percentage in the all seasons regardless of Seradex concentration level.

Keywords: Seasonal variation, seradex concentration, *Osteospermum* cuttings

IN SITU EVALUATION OF INTERNAL DRAINAGE IN LAYERED SOILS

SSW Mavimbela¹ and LD van Rensburg¹

¹UFS, P.O.Box 339, Bloemfontein 9300, South Africa

E-mail: sabelomavimbela@yahoo.com

INTRODUCTION

Internal drainage is a critical hydrological process in soil water conservation that relies on layered profiles as storage reservoirs. The South African Tukulu and Sepane also referred as the Cutanic Luvisols and Swartland as Cutanic Cambisols in other countries are layered soils earmarked for in-field rainwater harvesting (IRWH) in the Free State Province. The IRWH collects surface runoff from excess rainfall between crop rows and stores it by deep infiltration. Research objectives were therefore, firstly; to describe the pedological and physical properties of the three soil types and secondly, to characterize the internal drainage hydraulic characteristics of the different soil horizon layers.

MATERIAL AND METHODS

In situ drainage and laboratory desorption experiments were used to compare the soils water storage and hydraulic characteristics in relation to their pedological and physical properties. The van Genuchten (1980) model was used to describe horizons soil water characteristic curves and to estimate matric suction for the corresponding 1200 hours drainage curves.

RESULTS AND DISCUSSION

Horizons with clay plus silt of more than 40% were the pedocutanic B- and prismatic C- horizons in the Tukulu and Sepane soils. Abrupt transitions, signs of wetness and a sharp drop in hydraulic conductivity at higher soil water content (SWC) were associated with these horizons. Deep drainage from the Tukulu and Sepane was equivalent to 4% of the 550 mm annual rainfall while in the Swartland it was 9% since it was coarse textured and devoid of structure. The drainage upper limit was estimated to be achieved when drainage flux rate approached 0.001 mm hour⁻¹ equivalent to deep drainage losses amounting 0.1% of annual rainfall.

CONCLUSIONS

It was concluded that the Tukulu and Sepane or Cutanic Luvisols with similar physical properties be considered for in situ rainwater harvesting, and that the 0.1% deep drainage of annual rainfall was a reasonable criterion for evaluating layered soils earmarked for IRWH.

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Keywords: Clay soils, drainage upper limit, hydraulic conductivity, soil water storage

NITROGEN MINERALIZATION FROM SLUDGE IN AN ALKALINE, SALINE COAL GASIFICATION ASH ENVIRONMENT

I Mbakwe¹, PC de Jager¹, JG Annandale¹ and T Matema²

¹*Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002;*

²*Agricultural Research Council- Institute for Soil Climate and Water, Private Bag X79, Pretoria 0001*

E-mail: ikennambakwe@yahoo.co.uk

INTRODUCTION

Rehabilitating coal gasification ash dumps by amendment with sludge has been shown to improve the physical and chemical properties of ash and facilitate the establishment of vegetation. Sludge could supply a range of necessary plant nutrients, chief of which is nitrogen. Nitrogen in sludge, however, is bound up in organic forms which have to be mineralized by microorganisms into plant-usable nitrogen species. At present, it is unclear to what extent mineralization of organic N is attainable in a coal gasification ash medium where a high pH is compounded by high salinity, and what effect ash weathering has on the process. The objectives of this study were to determine the rate and pattern of nitrogen mineralization from sludge in a coal gasification ash medium, to determine the prevalent inorganic nitrogen form in the system, and to assess the effect of ash weathering on N mineralization.

MATERIALS AND METHODS

An incubation experiment was carried out in which fresh ash, weathered ash and soil (loamy sand) were amended with the equivalent of 90 tons ha⁻¹ waste activated sludge from an industrial effluent treatment process, and pH, electrical conductivity and nitrogen mineralization were monitored over 63 days. First order rate constant for N mineralization was calculated using the model proposed by Smith *et al.* (1980).

RESULTS AND DISCUSSION

In fresh ash, 24% of the organic N was mineralized, while 15% was mineralized in both weathered ash and soil. More nitrification occurred in soil while most of the N mineralized in ash was in the form of ammonium. Mineralization rate constants were 0.0064 day⁻¹ for fresh ash, 0.0042 day⁻¹ for weathered ash, and 0.0044 day⁻¹ for soil. The lower mineralization rate in weathered ash is attributed to ammonium adsorption by clay minerals formed during ash weathering.

CONCLUSIONS

The low nitrification observed in sludge-amended ash implies that at least initially, plants grown on these amended dumps will take up nitrogen mostly as ammonium. Moreover, potential for nitrate leaching is low. It is recommended that for rehabilitation purposes, management should aim to balance the nitrogen needs of vegetation with rates of N mineralization calculated under specific prevailing conditions.

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Keywords: Coal gasification ash, N mineralization, rehabilitation, sludge

THE EFFECT OF POST HARVEST FERTILIZER APPLICATION, PLANT SIZE AND PLANT HEALTH ON SUBSEQUENT SUCKER YIELD IN QUEEN PINEAPPLE PLANTINGS

BW Mbatha¹, EC Rabie¹, AM Zobolo² and GE Zharare³

¹ARC-ITSC Hluhluwe Research Station, PO Box 194, Hluhluwe 3960; ²Department of Botany, and ; ³Department of Agriculture Agronomy, University of Zululand, P.Bag X1001, KwaDlangezwa 3886

E-mail: bwmbatha@gmail.com

INTRODUCTION

Queen Pineapple plantings are established from suckers taken from harvested plants. The suckers are left to grow on the mother plant for 6 to 8 months after harvesting the fruit of the plant crop. Suckers are harvested and sorted in different sizes before planting. Improving sucker quality and quantity is one of the first steps towards increasing pineapple yields. Fertilizer (mainly N) can be applied after fruit harvesting to promote sucker development. A study was conducted to determine the effect of sucker size of the mother planting and the health condition of the mother plant on sucker yield, as well as if the effect of the post harvest $[(\text{NH}_4)_2\text{SO}_4]$ application carries over to increase sucker yield in the subsequent plantings.

MATERIAL AND METHODS

Two trials were planted with suckers of four different sizes (sizes 2, 3, 4 and 5) harvested at six (block A) and eight (block B) months from a mother planting that was treated one month after fruit harvest with 3 different dosages of ammonium sulphate (0, 0.5 and 1 ton). The effect of plant size and fertilizer application on plant growth (health) was determined, as well the effect on the subsequent sucker growth. Several factors were identified that influenced plant growth; namely, plants planted too deep, wilting of plants, plants that toppled over (planted too shallow), funnel rot and slow growing and dying back of plants,. The effect of these factors was evaluated on subsequent sucker growth. Eight months after fruit harvest, suckers were harvested and graded by mass and length to determine the effect of plant size and plant health as well as the carry over effect of fertilizer application on number of acceptable suckers.

RESULTS AND DISCUSSION

Only the data of healthy plants, plants planted too deep and wilted plants is presented. In both plantings healthy plants produced a significantly higher ($p < 0.001$) number of acceptable suckers than the wilted plants and those planted too deep whether they were sorted by length or by mass. The size of the suckers that were used to establish the plantings also influenced the number of plantable suckers harvested. Therefore more suckers were harvested from healthy plants in treatments where bigger sucker sizes were used to establish the planting than from smaller plants or plants suffering from factors influencing growth such as being planted too deep or wilted. Post-harvest fertilizer application does not carry over to influence subsequent sucker growth.

CONCLUSION

The health condition and size of the plant are important factors influencing sucker yield. Post harvest $[(\text{NH}_4)_2\text{SO}_4]$ application does not carry over in subsequent growth of suckers.

Keywords: Fertilizer, plant health, plant size, Queen pineapple, sucker yield

WATER STRESS EFFECTS ON YIELD, WATER USE EFFICIENCY AND QUALITY OF WHEAT (*Triticum aestivum* L.)

ZA Mbave¹, JM Steyn¹ and JG Annandale¹

¹University of Pretoria, Department of Plant Production and Soil Science, P/Bag X20, Hatfield 0028

E-mail: aubreymbave@yahoo.com

INTRODUCTION

Grain yield (GY) and quality of wheat depends on the interaction between cultivar and prevailing environmental factors. In South Africa, water stress is one the main environmental factors limiting production of most field crops, including wheat. The objective of the study was to identify the growth stage in which limited water supply will improve water use efficiency (WUE), but have minimal effect on yield and quality of three wheat cultivars.

MATERIALS AND METHODS

Factorial experiments were conducted under a rain shelter at University of Pretoria during the 2010 and 2011 seasons. Main plots were water treatments: well-watered control (NNN), water stress (S) imposed in the stem elongation (SNN); flowering (NSN) and grain-filling (NNS) stages while subplots were three cultivars (Duzi, Steenbras and SST 843). At maturity the number of ears per unit area, kernels per ear, GY and thousand kernel mass were determined. Water use (ET) was calculated according to the soil water balance equation and WUE was calculated as the ratio of GY to ET per season. Grain protein content (GPC) and hectolitre mass (HLM) were determined as quality parameters.

RESULTS AND DISCUSSION

In both seasons NSN gave significantly ($p < 0.05$) the lowest GY compared to other treatments. Lower GY for the NSN treatment was attributed to reduced number of ears per unit area and number of kernels per ear. Yield differences amongst cultivars were not consistent per season. The treatments NNS and SNN got significantly ($p < 0.05$) highest WUE in 2010 and 2011 respectively compared to other treatments. The cultivar Duzi had lowest GPC compared to other cultivars in 2011. The HLM was reduced most by the NNS treatment, whereas both NNS and NSN had significantly ($p < 0.05$) higher GPC compared to other treatments.

CONCLUSIONS

Withholding irrigation during stem elongation stage (SNN) can save water and improve WUE, while maintaining good yield and protein content. The results from this study suggest that, in the absence of rainfall, supplemental irrigation should at least be applied from flag leaf to the end of flowering stage.

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Keywords: Grain yield, quality, water stress and water use efficiency

WATER USE AND PRODUCTIVITY OF SWEET SORGHUM AND SUGARBEET

M Mengistu¹, R Künz¹, C Everson¹, I Doidge², G Jewitt¹, A Clulow¹

¹Center for Water Resources Research, University of KwaZulu-Natal, Pietermaritzburg, South Africa; ²African Centre for Crop Improvement (ACCI), School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa

E-mail: Mengistu@ukzn.ac.za

Sugarbeet and sweet sorghum have been recognized globally as potential biofuel crops mainly for ethanol production. Water use of biofuel feedstock is one of the critical components in the production renewable fuel on a sustainable basis. The aims of this study were therefore to determine the water use and water productivity (crop yield per unit amount of water used) of drip irrigated sugarbeet and sweet sorghum. Field trials were conducted in two successive seasons of 2010/2011 (one) and 2011/2012 (two) at Ukulinga research farm, University of KwaZulu-Natal, Pietermaritzburg, South Africa. Seasonal water uses were estimated using eddy covariance and surface renewal methods. The average seasonal water use of sugar beet (560 mm) was higher than the water use of sweet sorghum (415 mm). The water productivity values for sugar beet were 9.44 and 3.91 kg m⁻³ for season one and two, respectively. The water productivity of sweet sorghum was 6.20 kg m⁻³ for season one and 9.59 kg m⁻³ for season two.

Keywords: Biofuel, water productivity

MICROBIAL ENZYME ACTIVITY IN MULCHED AND UNMULCHED APPLE ORCHARD SOILS

AH Meyer¹, J Wooldridge¹, J Dames² and M Joubert¹

¹ARC Infruitec-Nietvoorbij, P/Bag X5026, Stellenbosch 7599; ²Department of Biochemistry, Microbiology and Biotechnology, Rhodes University, Grahamstown 6139

E-mail: meyera@arc.agric.za

INTRODUCTION

Organic mulches supply organic matter and mineral nutrients (Cherr *et al.*, 2006). Soil enzymes catalyse reactions involved in organic matter breakdown and nutrient cycling: β -glucosidase and urease participating in the carbon (C) and nitrogen (N) cycles, respectively. The activity levels of these enzymes reflect short (Bandick & Dick, 1999) and long-term (Jin *et al.*, 2009) changes taking place in the organic carbon and nitrogen pools. This research aimed to determine the effects of repeated straw mulching on β -glucosidase and urease activities at different soil depths in relation to %C, NO₃-N, NH₄-N and pH, in an apple orchard soil.

MATERIALS AND METHODS

In a fully randomized field trial on Overberg Research Farm, Elgin, 'Cripps Pink'/M7 apple trees received straw mulch, or no mulch, in the tree rows in factorial combination with surface management treatments in the work rows. Each tree row x work row treatment was replicated in four blocks. β -glucosidase and urease activities were determined in soil samples collected at five depth intervals in the tree row, from the side walls of a recently excavated trench, after seven years of treatment applications.

RESULTS AND DISCUSSION

β -glucosidase and urease activities were highest in the top soil, decreasing with increasing depth. Soil urease activities were higher in mulched than in unmulched treatments, decreasing with depth. β -glucosidase activity tended to follow the same depth variation pattern, whilst differences between mulched and unmulched treatments were most apparent at the 15 cm depth. Positive effects of mulching on microbial enzyme activities were associated with positive mulch-induced effects on %C, NO₃-N, and pH.

CONCLUSIONS

Urease and β -glucosidase activities are promoted by mulching with straw.

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ACKNOWLEDGEMENTS

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Keywords: Apple, microbial enzyme activity, mulch, soil surface management

TOWARDS THE OPTIMISATION OF POTASSIUM NUTRITION IN THE SUGARCANE CROP

N Miles

South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300

E-mail: neil.miles@sugar.org.za

INTRODUCTION

Sugarcane is a major crop on the eastern seaboard and lowveld of South Africa. In recent years, declining yields have led to an increased focus on crop management practices. In terms of crop nutrition, interrogation of soil test databases reveals widespread potential limitations, including ubiquitous K deficiency. This paper provides a brief overview of the K nutrition of sugarcane, and lists approaches for optimising K supply to the crop.

RESULTS AND DISCUSSION

Potassium is the nutrient usually taken up in largest amounts by sugarcane. It plays a crucial role in numerous processes in the crop, including photosynthesis, the translocation of sugars, water use efficiency, disease and insect resistance, stalk strength (susceptibility to lodging) and cold tolerance. Removal in the harvest is approximately 2 kg of K per ton of harvested stalks. Where removals are not adequately addressed through fertiliser or amendment applications, deficiencies may rapidly develop, particularly on soils with low non-exchangeable K reserves.

Wide variations in reported threshold topsoil K test values appear in the international literature. The lack of agreement in soil test thresholds is thought to be attributable largely to a failure to accommodate subsoil K reserves in the development of calibrations. Prohibitively low soil exchangeable K levels in many subsoils of the South African industry point to marked exploitation of subsoil K reserves by the crop.

In the South African industry, non-exchangeable soil K reserves vary from 0 to >4 cmol_c/kg, with higher values occurring mainly in soils from the irrigated areas. Clearly, the routine estimation of non-exchangeable K in soil samples submitted by growers for analysis could contribute to vast improvements in K use efficiency. Encouragingly, recent investigations indicate that mid-infrared spectroscopy has considerable potential for the rapid estimation of non-exchangeable K in soil samples.

CONCLUSIONS

Management of the K nutrition of sugarcane presents particular challenges for scientists and growers. Recognition of K contributions from subsoils and non-exchangeable K sources appears to offer considerable potential for improving the efficiency of K use in the crop.

Keywords: Potassium, sugarcane, crop removals, soil tests

CAN PHOSPHORUS ACID AND SILICON INDUCE DISEASE RESISTANCE BY INCREASING CITRUS FLAVEDO FLAVONOIDS?

N Mkhize¹, N Mathaba², I Bertling¹

¹Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, P/ Bag X01, Scottsville 3209, Pietermaritzburg; ²Horticultural Science, School of Agricultural, Earth and Environmental Sciences, UKZN, Private Bag X01, Scottsville 3209, Pietermaritzburg

E-mail: mathaban@gmail.com

INTRODUCTION

Green Mould (*Penicillium digitatum*) and Blue Mould (*P. italicum*) are among the most important post-harvest diseases of citrus fruit (Ortuño et al., 2005). However, there is a reduction in the use of fungicides to control *Penicillium* due to resistance development and pressure from consumers for a reduction in chemical residues on food. Our previous studies have shown silicon and phosphorus acid to trigger systemic resistance to *Penicillium* attack on citrus fruit through increased phenolic concentrations (Mkhize et al., 2012). In addition, Ortuño et al. (2005 and 2010) as well as Kim et al. (2011) found flavedo flavonoid concentrations to decrease after infection and then gradually increase. In *Citrus unshiu* Marc. flavonoids are known bioactive compounds acting against different plant stresses; and assist in the defence against diseases (Kim et al., 2011). Therefore, the aim of this research was to ascertain the changes in the fruit's flavonoid composition after application of these chemicals in order to improve the understanding of the mechanisms involved.

METHOD AND MATERIALS

Valencia and Navel oranges, together with the lemon cultivar 'Eureka' were harvested from Ukulinga Farm and treated, both pre- and post-harvest, with three different concentrations of potassium silicate (3.35, 10.7 and 21.4 mg/l) and one concentration (5 ml/l) of phosphorus acid. As pre-harvest treatments, a drenching treatment was applied around the base of the tree trunk with 5l treatment solutions. Fruit were left on the trees for 21 days after treatment to allow for uptake of the silicon and phosphorous acid to the fruit. On day 22 fruit were harvested, immersed in treatment solutions and then air-dried. After treatment fruit were inoculated with a 1×10^{-4} spore suspension of *Penicillium digitatum*. Disease progress was monitored for 30 days post-harvest.

RESULTS AND DISCUSSION

Treatment with solely phosphorus acid or the low silicon concentration significantly reduced *Penicillium* infection on all citrus types studied compared with the control and phosphorus acid plus silicon combinations. Furthermore, silicon, as well as phosphorus acid, induced an increase in flavedo flavonoid concentrations, the possible reason for the reduced infestation of *Penicillium* in post-harvest storage. According to Ortuño et al. (2011) flavonoids can act as phytoanticipins and phytoalexins, compounds that are part of plant resistance mechanisms against *P. digitatum* during cold storage (Mkhize et al., 2012).

CONCLUSION

Application of silicon or phosphorus acid on citrus fruit, has shown potential to reduce post-harvest infestation of *Penicillium* by inducing an increase in flavedo flavonoid concentration. Flavonoids are secondary metabolites acting as a resistance mechanism against *Penicillium*.

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Keywords: Citrus fruit; silicon; phosphorus acid; flavonoids; *Penicillium*

THE EFFECTS OF APPLYING COMBINATION OF INORGANIC FERTILIZER AND MANURE ON MAIZE YIELD ON AN ACIDIC SOIL OF MFUNDISWENI, FLAGSTAFF, SOUTH AFRICA

Z Mkile¹, S Mhlontlo², MP Maqubela¹ and TT Silwana¹

¹Department of Rural Development and Agrarian Reform, Döhne ADI, P/Bag X15, Stutterheim 4930; ²Department of Rural Development and Agrarian Reform, P/Bag X5262, Mthatha 5099

E-mail: zolani.mkile@agr.ecprov.gov.za

INTRODUCTION

Soil acidification is a single most important cause of declining soil fertility (Barnard & du Preez, 2004) which reduces maize yields in the eastern part of the Eastern Cape. Crop nutrient deficiencies associated with acidic soils are usually caused by reduced quantities of available P, K, Ca and Mg. The objective of this study was to select combinations of organic and inorganic fertilizer that will amend high soil acid saturation and improve maize yield in Mfundisweni soil.

MATERIALS AND METHODS

A dry-land field experiment arranged in a RCBD with three replications was conducted in three seasons from 2007 to 2010 at Mfundisweni in Flagstaff. In each season, maize PAN 6480 was planted in mid-December at a population of 33 333 plants ha⁻¹. The treatments were; L₂NPK₀, L₁NPK, L₂NPK, L₀ ½NPK, L₂ ½ NPK, L₀NPK₀, L₀NPK, L₁NPK₀, L₁½ NPK, M₁₀NPK, M₁₀NPK₀, M₅NPK₀, M₀NPK₀, M₀½NPK, M₅NPK, M₁₀½ NPK, M₅½NPK and M₀NPK. Dolomitic lime- L₂ = 3500 kg ha⁻¹, L₁ = 1700 kg ha⁻¹ and L₀ = No lime; cattle manure- M₁₀ = 10 ton ha⁻¹, M₅ = 5 ton ha⁻¹ and M₀ = No manure; fertilizer 2:3:4 (30) rate: NPK = 500 kg ha⁻¹, ½NPK = 250 kg ha⁻¹ and NPK₀ = No fertilizer; Soil contained 7.2 mg kg⁻¹ P, 40.8 mg kg⁻¹ K, 568 mg kg⁻¹ Ca and 199 mg kg⁻¹ Mg while the soil pH (KCl) and acid saturation were 3.5 and 30.47%. Cattle manure used had nutrient composition of 1.51% N, 0.21% P, and 1.80% K.

RESULTS AND DISCUSSION

In 2007/2008 season, treatments M₁₀NPK, L₂½ NPK and M₅NPK had significantly higher leaf dry matter (LDM) mass which was comparable to treatments M₁₀NPK, M₁₀½ NPK and L₂½ NPK in 2008/2009 season while significant differences with no specific trends were observed in 2009/2010 season. Lowest grain yields (146.7 to 336.7 kg ha⁻¹) were obtained in control plots in all seasons. High maize grain yields between 733 and 2900 kg ha⁻¹ were obtained in combinations with 5 or 10 ton ha⁻¹ manure during 2007/2008 season and a more improved yield (1180 to 4453 kg ha⁻¹) was observed in subsequent seasons. All treatments without kraal manure or lime did not reduce soil acid saturation. Generally, weak negative correlations ($r^2=0.13$; $r^2=0.20$ and $r^2=0.04$) were observed between acid saturation and LDM yields in all seasons. Strong significant negative correlations ($r^2=0.64$, $p=0.05$) and ($r^2=0.36$, $p=0.05$) were observed between acid saturation and maize grain yields in 2009/2010 and 2008/2009 seasons respectively. This can be attributed to uneven distribution of rain during the months of planting in all seasons.

CONCLUSION

Combination of organic and inorganic fertilizers at Mfundisweni, reduced high soil acid saturation and improved maize yields and fertility status of the soil.

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Keywords: Inorganic fertilizer, maize yield, manure, soil acidity

PHYSIOLOGICAL DETERMINATION OF MAIZE SEED PERFORMANCE ON THE BASIS OF SHAPE AND SIZE

AT Modi

Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, P/Bag X01, Scottsville, Pietermaritzburg 3209, South Africa

E-mail: modiat@ukzn.ac.za

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop for human consumption in many parts of the world, with global production exceeding 600 million tonnes (mt) in recent years (Crouch & Ortiz, 2004). The major seed companies in South Africa produce and market maize as a major commodity. Hence it is important to understand the aspects of maize seed quality. Seed quality is determined by viability, germination and vigour, and all these aspects are connected, with vigour being the most important in terms of seed performance to satisfy the needs of a farmer (Finch-Savage and Leubner-Metzger, 2006). While there is a general agreement that smaller seed size compromises seed quality and performance, the question that has not been explored adequately in seed science and technology is whether seed shape affects seed quality and performance. The objective of this study was to determine seed quality of maize on the basis of seed shape.

MATERIALS AND METHODS

Seeds of maize (*Zea mays* L.) cultivar SC701 were purchased from McDonald Seeds, Pietermaritzburg, South Africa. The seed lots were purchased as "Flat" and "Round", respectively, to indicate seed shape. Seeds of each category were further sorted in the laboratory to obtain seeds of equal size ($\pm 0.1\%$) and four categories were produced, namely, "Large Flat", "Small Flat", "Large Round" and "Small Round". Seed viability was determined using tetrazolium chloride test (ISTA, 1996). Rate of seed imbibition was determined in distilled H₂O for 3, 8, 24, 48, 72 and 168 hours. Germination rate and capacity were determined according to international rules for testing seeds (ISTA, 1996). Seed vigour was determined by seedling establishment in a soil medium using seedling trays. Seed carbohydrate concentration (sucrose, glucose and fructose) was determined and correlated with seed electrolyte leakage and seed performance (Modi and White, 2004).

RESULTS AND DISCUSSION

There was no significant difference between flat and round seeds with respect to germination capacity. However, large seeds were significantly ($P < 0.01$) better than small seeds in terms of imbibition capacity, germination and vigour. The small seeds also leaked 12 to 16% more electrolytes during imbibition than the large seeds. Flat seeds leaked significantly more than the round seeds. The results of seed germination were generally replicated during seedling establishment, and there was also a genetic difference between seed shapes.

CONCLUSIONS

Seed size and shape are important determinations of seed quality for maize cultivar SC 701. It is recommended that farmers use relatively larger seeds than small seeds to ascertain the best crop establishment.

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Keywords: Germination, seed shape, seed performance

EFFICACY OF SWEET SORGHUM UNDER DRY LAND PRODUCTION

PP Modiba¹ and ML Mokoena¹

¹Limpopo Department of Agriculture, Towoomba Research Station, P/bag X1615, Bela-Bela 0480

E-mail: phalamodiba@webmail.co.za

INTRODUCTION

Sweet sorghum is a variant of grain sorghum (*Sorghum bicolor* (L) Moench), grown in South Africa for its edible juicy sweet stem instead of grain (Madibela *et al.*, 2002). Given that water availability is poised to become a major constraint to agricultural production in coming years, cultivation of sugarcane may become difficult; hence sweet sorghum would be an alternative crop to be planted. Therefore, there is a compelling need to conserve its plant genetic resources, recognise its economic viability, and promote rural economic development and increase awareness on the value and benefit of its cultivation.

MATERIALS AND METHODS

Fifteen (L1, L2, L3, L4, L5, L6, L7, L8, L9, L10, L11, L12, L13, L14 and L15) sweet sorghum landraces were evaluated for sugar production potential (%Brix), biomass production, stalk height and also the relationship between these productive traits under dry land at Towoomba Research Station during the 2010/ 2011 and 2011/2012 growing season. Average rainfalls were 400mm in 2010/11 and 240mm in 2011/12. The experiment was carried out in a Randomised Complete Block Design (RCBD) replicated 3 times. Each landrace was planted in four rows of 5m long in 13.5 m² plots with spacing of 90 x 9 cm. Fertilizer dosage of 30 N, 20 P and 20 K per ha was applied through banding method during planting. Weeding was done using hands and hoes twice a month.

RESULTS AND DISCUSSION

The results for two growing seasons (2010/2011 and 2011/2012) revealed significant differences in stalk height, sugar content (Brix percentage) and number of internodes. Except for biomass and stalk diameter, these yield measurements differed significantly among the varieties evaluated. However, it was also observed that there was a decrease in growth of stalk height and diameter, between the two seasons but not in terms of %Brix. This suggests that the crop is more susceptible to seasonal climatic variations which were observed to be different in these two seasons. There was also a positive relationship (Correlation co-efficient=0.86) between stalk height and internodes and also between internodes and stalk diameter (0.65). Landrace 15, L7 and L8 produced highest sugar content in both seasons whereas L2 and L3 produced the lowest %Brix.

CONCLUSIONS

Some landraces evaluated in this study could serve as source of sugar and for biofuel production (L15, L7 & L4). It was also evident that, there is a range of genetic diversity in South African sweet sorghum landraces which can be used in future for crop improvement.

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Keywords: Biomass production, landraces, sugar content, sweet sorghum

YIELD EVALUATION OF COMMERCIAL MAIZE HYBRIDS FOR TOLERANCE TO LOW-SOIL NITROGEN

LL Molefe¹, E Ndou¹, L Moremoholo¹, G Chigeza¹ and K Mashingaidze¹

¹Agricultural Research Council-Grain Crops Institute, Private Bag X1251, Potchefstroom 2520

E-mail: molefeL@arc.agric.za

INTRODUCTION

Nitrogen (N) is an important nutrient in maize production; its availability has a substantial effect on plant growth, development and is one of the key nutrient elements essential for high yields. Maize yields of small-holder farmers in sub-Saharan Africa are a fraction of those in the developed world, mainly due to the region's poor soils; drought and farmers limited access to fertilizer and improved maize seed (Derera *et al.*, 2006). High price ratios between fertilizers and grain yield limit application of fertilizers under small-holder farmers thereby limiting maize production. The main objective of this study was therefore to evaluate yield performance of commercial maize hybrids under low and high soil nitrogen (N) conditions.

MATERIALS AND METHODS

Twenty non-Bt commercial hybrids available on market were evaluated under low and high soil nitrogen conditions at two locations namely Taung and Potchefstroom under sprinkler irrigation. Under low soil nitrogen conditions, soil were depleted before planting and nitrogen fertilizer were not used throughout the planting season while on high soil condition nitrogen was applied as per soil analyses requirements. The trial layout was a randomized complete block design with plots consisting out of 2 rows, each 4 m in length and replicated thrice. Data collected included yield per hectare, number of ears per plant, and grain moisture content.

RESULTS AND DISCUSSION

Yield under low N conditions ranged from 0.3 to 6.8 t ha⁻¹ with a mean of 3.8 t ha⁻¹ while under higher N rates the range was 3.04 to 12.7 t ha⁻¹ with a mean of 7.5 t ha⁻¹. The mean number of ears per plant ranged from 0.52 to 1.24 under low N and 0.71 to 1.44 under high N, indicating variability among the baseline commercial hybrids. This result therefore outlines hybrids that perform well under low soil nitrogen.

CONCLUSIONS

This result therefore indicate different performances of commercial hybrids and hence provides opportunity to select ideal hybrids which can be used as standard checks or probe genotypes in a breeding programme aimed at developing new hybrids under both low and high N conditions.

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ACKNOWLEDGEMENTS

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Keywords: Commercial maize hybrids, high-soil nitrogen tolerant, low-soil nitrogen tolerant, yield

A PRELIMINARY ASSESSMENT OF SWEET POTATO GROWTH AND YIELD UNDER WINTER RAINFED CONDITIONS IN A SUBTROPICAL REGION OF KWAZULU-NATAL

NM Motsa¹, AT Modi¹

¹University of KwaZulu-Natal School of Agricultural, Earth and Environmental Sciences, Private Bag X01, Scottsville, Pietermaritzburg 3209

E-mail: mgcibelomotsa@yahoo.co.uk

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is the second most important root crop in the world, after the Irish potato (Laure, 2004). It is nutritious, drought-tolerant, and has been reported to perform well in soils of low fertility (Ewell, 1990). In Southern Africa sweet potato is largely cultivated as a subsistence summer crop under dryland conditions (Ebregt *et al.*, 2007). Hence, agronomic research on the crop remains untapped in sub-Saharan Africa, although limited research indicates that the crop is very sensitive to differences in growth environments (Abidin *et al.*, 2005). Therefore, it is critical to study the adaptation of locally bred varieties to different soils and climatic conditions as a strategy to promote food security. The objective of this study was to assess growth, physiological responses and subsequent yield of locally bred sweet potato lines under rain-fed conditions during winter in KwaZulu-Natal.

MATERIALS AND METHODS

Using local agronomic strategies, three varieties of sweet potato (A40, A45 and 199062.1) were grown in a randomized complete block design replicated three times at KwaMbonambi location, Richards Bay, KwaZulu Natal during the winter season of 2012. Growth data included vine length, leaf number, stomatal conductance (SC) and chlorophyll content index (CCI), measured bi-weekly. At harvest, root yield was determined and their proline content was measured to determine crop response to drought (Szabados & Savoure, 2009).

RESULTS AND DISCUSSIONS

Results of plant growth showed that A40 had significantly ($P < 0.05$) fewer (45%) leaves and longer (24%) vines compared with the other varieties. Variety 199062.1 responded to winter planting by demonstrating greater stomatal regulation of 16 and 18% less than A40 and A45 respectively. This response resulted in significantly ($P < 0.05$) higher (22% and 10.9% from A40 and A45, respectively) chlorophyll content index and significantly ($P < 0.05$) lower (10.5%) proline content in 199062.1 compared with the other two varieties. No significant differences ($P < 0.05$) were recorded in storage root yield across all three varieties.

CONCLUSION

Varieties A45 and 199062.1 seemed to be more adapted to the winter conditions in Richards Bay. Although no significant differences were recorded in overall yield, it can be suggested that variety A45 yielded better than the other two varieties. It is necessary that a follow up summer trial is conducted to confirm and quantify adaptation responses of the three sweet potato lines to environmental effects during growth.

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Keywords: Adaptation, sweet potato lines, winter season

INFLUENCE OF GRASSLAND MANAGEMENT PRACTICES ON RADIATION AND ENERGY BALANCES OF A TALL GRASSLAND

NC Moyo¹ and MJ Savage¹

¹University of KwaZulu-Natal, Private Bag X01, Scottsville 3209

E-mail: nicholas.moyo@gmail.com

INTRODUCTION

The increasing human population and climate change has resulted in an increased demand for already scarce water resources. Accurate estimates of water-use are therefore crucial for water resources management. Grassland management practices impact on grassland radiation and energy balances. Therefore the aim of this study is to determine the influence of these practices on radiation and energy balances of naturally growing grassland.

MATERIALS AND METHODS

A field experiment was conducted above two plots of grassland: mowed (cut-grass site) and undisturbed (tall-grass site) at Ukulinga research farm, Pietermaritzburg, South Africa. The tall-grass site was later burnt in winter. For each site, a four-component net radiometer was used to monitor surface radiation components and a three dimensional ultrasonic anemometer was used for eddy covariance (EC) sensible heat flux (H_{EC}) measurements. The latent energy flux (LE) and hence total evaporation (ET) was computed as a residual of the shortened energy balance using net irradiance (R_n), soil heat flux (G) and H_{EC} measurements as: $LE = R_n - G - H_{EC}$.

RESULTS AND DISCUSSION

There was a noticeable trend of decreasing energy balance components with the approach of winter for all treatment sites. The soil heat flux was the lowest measured component but became greater than LE in winter. The soil temperature recorded at the cut-grass site was consistently greater than the tall-grass site measurements. The mowing of the grass is likely to have led to the observed trend due to less litter on the surface that acted as a thermal insulator. The average soil water content for the cut-grass site was $0.31 \text{ m}^3 \text{ m}^{-3}$ compared to a very low value of $0.12 \text{ m}^3 \text{ m}^{-3}$ for the tall-grass site due to differences in leaf area index. A lower ET (4.36 mm) over a 9-day period was observed at the tall-grass site compared to 5.17 mm for the cut-grass site.

CONCLUSIONS

Grassland management practices affected the soil thermal, soil water content and surface reflection regimes and radiation and energy balances of the grassland site. In future, information on radiation and energy balance fluxes above various surfaces will help for model validations and water resources management.

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Keywords: Eddy covariance, energy balance, grassland management.

IMPROVING SMALLHOLDER MAIZE AND GROUNDNUT PRODUCTION SYSTEMS THROUGH USE OF PHOSPHO-COMPOSTS (DOROWA ROCK PHOSPHATE AND ORGANIC MATTER RESIDUES)

ORS Mtengwa¹, F Tagwira² and ZA Chiteka²

¹University of Venda, Department of Plant Production, Private bag X5050, Thohoyandou 0950; ²Africa University, Faculty of Agriculture and Natural Resources, P.O Box 1320, Mutare, Zimbabwe

E-mail: onai.mtengwa@univen.ac.za

INTRODUCTION

Phosphorus (P) deficiencies are limiting crop production in many agricultural soils worldwide where conventional fertilizers are inaccessible. Continuous cropping in the absence of external nutrient inputs to soils has led to unproductive farmland due to loss of nutrients including P. This has been made worse by the abandonment of traditional methods of land fallow that were important in soil fertility conservation. Maize and groundnuts are the most widely grown crops for food and nutrition therefore their production needs to be improved. Alternative sources of phosphorus replenishment to soil should be able to increase yields and ensure food security. The objective of this study was to increase solubility of P from Dorowa Rock Phosphate (DRP) through composts with organic matter residues to increase maize and groundnut production systems.

MATERIALS AND METHODS

Greenhouse experiments were conducted from 2007 to 2009, five DRPrates were used (0, 40, 80,120,160 kg P₂O₅/ha). The rates were combined with each of the following organic matter residues: -Groundnut (*Arachis hypogaea*), Soyabean (*Glycine max* L), Calliandra (*Calliandra calothyrsus*), dry grain amaranth and fresh grain amaranth (*Amaranthus spp.*) left after threshing, Leucaena (*Leucaena leucocephala*),Sesbania (*Sesbania sesban*)and also without organic residue (uncomposted DRP) as a control (8*5 factorial, 40 treatments with 3 replications) .The combinations of different rates of DRP and residues were composted for 8 weeks before being incorporated into the pots. The test crops were groundnuts (*Arachis hypogaea* L.) and maize (*Zea mays* L.) separately and were planted as sole crops. Maize is the staple food crop while groundnut is the major grain legume crop in the small holder sector of Zimbabwe. Four seeds were planted per pot (10kg soil) and were thinned to two after two weeks. Distilled water was used for watering the pot plants. Results were measured through measurement of available P before and after the experiment and biomass was measured from the test crops.

RESULTS AND DISCUSSION

A significant response of the phospho-composts on P solubility and yield was observed. Increase in DRP resulted in increased P solubility thus availability to the crops. Composting DRP resulted in higher levels of P in both the groundnut and maize trials compared to the treatments where residues were omitted (uncomposted DRP). The response was however differed in maize and groundnuts. The compost of DRPwith *Sesbania sesban*, *Calliandra calothyrsus* and *Amaranthus spp.* generally gave higher levels of P and yield than that when composted and used together with other residues for both test crop. The highest biomass weight in groundnuts was from the 160kgP₂O₅+Fresh grain amaranth combination that produced biomass of 7.6g and the lowest came from the 0 kgP₂O₅+No Residue treatment that produced 3.3g and in maize the highest biomass was achieved through the 160kgP₂O₅+Leucaena leucocephala with 9.05g and the lowest 0 kgP₂O₅+No Residue produced 1.92g.

CONCLUSIONS

Great benefit can be derived from composts made from DRP and organic matter residues.

Keywords: Composting, groundnuts, maize, Rock Phosphate, P dissolution

SOIL PHYSICAL AND BIOLOGICAL PROPERTIES AS INFLUENCED BY THE INCORPORATION OF LEAF LITTER BIOMASS FROM THREE SUB-TROPICAL FRUIT TREES AT NELSPRUIT, MPUMALANGA PROVINCE, SOUTH AFRICA

NR Murovhi¹ and SA Materechera²

¹ARC-ITSC (Institute for Tropical and Sub-tropical Crops), Nelspruit 1200, South Africa;

²North-West University (Mafikeng Campus), Mmabatho 2735, South Africa

E-mail: romeo@arc.agric.za

INTRODUCTION

The majority of smallholder farmers in sub-Saharan Africa rely on organic inputs such as farmyard manure, leaf litter, crop residues and animal manure to replenish soil nutrients. The sub-tropical climate of Mpumalanga Province in South Africa favors the growth of tropical and sub-tropical fruit trees that produces relatively low quality litter that can be used to manage soil fertility. In this study leaf litter from three fruit trees commonly found in the sub-tropical environment of South Africa was used to quantify the physical and biological properties of soil amended with the litter from three fruit tree species commonly found in Mpumalanga Province.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Council's Institute for Tropical and Sub-tropical Crops (ITSC) station located at Nelspruit in Mpumalanga Province of South Africa. A pot experiment was conducted to assess the effects of incorporating leaf litter from avocado (*Persea americana* L.), mango (*Mangifera indica* L.) and litchi (*Litchi chinensis* L.) on soil properties. The treatments were a factorial combination of leaf litter types (*P. americana*, *M. indica* and *L. chinensis*), application rates (0, 1.6, and 3.3 t ha⁻¹) and incubation periods (0, 6 and 12 months) laid in a completely randomized design (CRD) with five replicates.

RESULTS AND DISCUSSION

Soils that were amended with *P. americana* leaf litter had significantly higher ($p < 0.05$) particulate organic matter (1.53%) than *M. indica* (1.35%) and *L. chinensis* (1.35%). The stability of aggregates was significantly higher ($p < 0.05$) on soil amended with *M. indica* and *L. chinensis* than *P. americana* leaf litter. There were positive and significant relationships between soil organic carbon and particulate organic matter ($r = 0.62$, $p < 0.05$), microbial biomass carbon and microbial biomass nitrogen ($r = 0.73$, $p < 0.05$), particulate organic matter and microbial biomass carbon ($r = 0.66$, $p < 0.05$) and particulate organic matter and microbial biomass nitrogen ($r = 0.65$, $p < 0.05$). The results suggest the need to increase the application and incubation time of litter with low quality in order to allow for decomposition of the organic materials to take place. This has practical implication for farmers who manage such leaf litter for improving soil fertility and increasing crop productivity.

CONCLUSIONS

The study has shown that it is important to provide sufficient incubation time for the leaf litter from sub-tropical fruit trees to decompose and supply the much needed organic matter that improves soil properties. It is suggested that farmers should incubate leaf litter from such trees into the soil for at least 365 days before planting a food crop.

ACKNOWLEDGEMENTS

Funding was provided by the Agricultural Research Councils' Institute for Tropical and Sub-tropical Crops (ITSC).

Keywords: Incubation period, leaf litter, litter application, soil quality

AMAZING MAIZE PART II. SUCCESS IN BREEDING A LOW PHYTIC ACID GENE INTO MAIZE

TB Myeni¹, J Derera¹, P Seleokane¹ and M Siwela¹

¹*University of KwaZulu-Natal, P/Bag X01, Scottsville, 3209, Pietermaritzburg*

E-mail: myeni.thulisiwe@gmail.com

INTRODUCTION

In South Africa, malnutrition affects ≈50% of the children due to mineral deficiency. The predominant diet of these children is maize based, and unfortunately this diet is deficient in most of the nutrients because maize contains high levels of phytic acid (>40 mg/g) which binds minerals. Low phytic acid (LPA, ≈30 mg/g) varieties can complement existing strategies that aim to alleviate malnutrition. Consumption of LPA grain by monogastric animals would also reduce eutrophication, because less phosphorus would be released into the environment. Research was undertaken to introgress the *lpa1-1* gene (which is a single recessive mutation in a temperate background) into tropical maize.

MATERIALS AND METHODS

The 80 LPA lines were developed using molecular-marker assisted pedigree selection. Sixty-four LPA and 8 control hybrids were evaluated for yield at Cedara and Makhathini under rain-fed conditions during 2009/10. An augmented 8x9 alpha lattice design was used with control hybrids replicated 9 times. Grain phytate levels were determined in the laboratory using the colorimetric method. The data were analysed using SAS.

RESULTS AND DISCUSSION

There was significant variation among the inbred lines for grain phytate (1.7 to 115 mg g⁻¹). The mutant LPA donor parent exhibited 27 mg/g compared to 67 mg/g for the tropical parent. The other normal endosperm inbred lines also showed higher levels of phytate (49 - 77 mg/g). At least 25 new progeny lines displayed phytate ≈30 mg/g qualifying them as low phytic acid lines. These hybrids exhibited grain yields of 2-5 t ha⁻¹ at Makhathini and 5-10 t ha⁻¹ at Cedara. In general yield results were comparable with the standard control hybrids.

CONCLUSIONS

Our results indicate that significant breeding progress towards development of low phytic acid maize varieties has been realized.

ACKNOWLEDGEMENTS

Funding by the FAO/Global Partnership Initiative for Plant Breeding Capacity, and NRF.

Keywords: Grain phytate, breeding low phytic acid maize, marker-assisted selection

SOIL ORGANIC MATTER, CLAY AND SOIL MINERALOGY EFFECTS ON CRUST STRENGTH, INFILTRATION RATE AND SOIL LOSS IN 14 EASTERN CAPE ECOTOPES

AD Nciizah¹ and IIC Wakindiki¹

¹*Department of Agronomy, University of Fort Hare, Private Bag X1314, Alice 5700*

E-mail: 200905562@ufh.ac.za

INTRODUCTION

Crust formation reduces water infiltration rate, increases runoff and erosion depending on soil properties such as texture, mineralogy and organic matter content. However, little is known about crust formation in soils that are dominated by primary minerals such as those in Eastern Cape Province. The objective of this study was to determine the effects of soil organic matter (SOM) and texture on crust formation and soil loss in less weathered soils.

MATERIALS AND METHODS

Soil samples from 14 ecotopes with varying texture and mineralogy were collected from the surface 0.0 to 0.2 m. Soil samples <2 mm were packed into splash cups slow wetted to field capacity and exposed to 360 mm h⁻¹ simulated rainfall. The sediment from each rainfall event was collected, dried and weighed. Crust strength was measured as penetration resistance (PR) using a hand held penetrometer whilst crust infiltration rate was measured using a mini-disk tension infiltrometer.

RESULTS AND DISCUSSION

Structural sieving crusts were observed in 13 ecotopes. Soil PR and SOM were significantly different across the 14 ecotopes. In contrast, infiltration rate (IR) and splash erosion (SE) did not differ significantly. SOM had weak negative relationships with PR ($r = -0.34$) whilst it had positive relationships with IR ($r = 0.71$) and SE ($r = 0.66$). Clay had strong positive relationships with SE ($r = 0.60$) and IR ($r = 0.78$) and a negative relationship with PR ($r = -0.50$). In contrast quartz had positive relationships with PR ($r = 0.32$) and a negative relationship with IR ($r = -0.40$) and SE ($r = -0.24$) whilst hematite, like clay and SOM had positive relationships with SE ($r = 0.63$) and IR ($r = 0.78$) but had a negative relationship with PR ($r = 0.48$). These results propose that although increasing clay and SOM, which were highly correlated ($r = 0.72$) improve IR in some soils especially those dominated by quartz, there exists a threshold beyond which susceptibility to splash detachment is intensified. Therefore, the effect of SOM in reducing soil loss in the studied soils is minimal at high clay content.

CONCLUSION

In the studied ecotopes, although SOM, hematite and clay increased infiltration, they also increased soil loss by splash erosion whilst reducing crust strength. Consequently, there is need to determine the interactive effects of different SOM and clay contents on soil loss and infiltration. This would enable the establishment of optimum levels of SOM that reduce soil loss for these ecotopes.

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Keywords: Crust strength, splash erosion, quartz

SCREENING OF COWPEA LINES FOR DROUGHT TOLERANCE IN PLASTIC BOXES

HM Ngobeni¹, SM Laurie¹ and RN Laurie¹

¹Agricultural Research Council (ARC) Roodeplaat - Vegetable and Ornamental Plant Institute (VOPI), Private Bag X293, Pretoria 0001

E-mail: NgobeniM@arc.agric.za

INTRODUCTION

Cowpea (*Vigna unguiculata* L) is an important grain legume crop in Africa. Drought is a constraint to crop production in the semi-arid regions, the principal area of cultivation of cowpea. A screening procedure for vegetative drought and heat tolerance in wooden boxes (Singh *et al.*, 1999) was adapted at the ARC-VOPI (Slabbert *et al.*, 2004). This study sought to screen several cowpea land races for heat and drought tolerance.

MATERIALS AND METHODS

Twenty four land races, and two controls (one sensitive and one tolerant) were planted in three replicates in a completely randomized design on 19 September 2011 in a pad-and-fan greenhouse. Seeds were sown directly into the boxes (80 x 150 x 20 cm) and thinned to five seedlings per row spaced 15 cm x 10 cm. The plants were allowed to grow for four weeks after emergence, whereafter water was withheld. Wilting and dying of the plants was monitored and recorded, until 75% of the plants reached permanent wilting stage. Plants were then re-watered and the survival and recovery of the plants was noted.

RESULTS AND DISCUSSION

Significant differences ($P=0.05$) were observed among land races for the variables % wilting, days to wilting and % dead. Vegetable cowpea 1, Ukaluleni, Glenda, Kisumu Mix and Makatini had low % wilting (6-13%). As expected, the sensitive control (TVU 7778) had high % wilting (81%), along with MA1, 2460, 217, Embo Buff, Tatro mix, Meter long bean Piet and M346. Embo Buff and MA1 further had high % dead (33-47%), being very sensitive to drought. The tolerant control IT93K 129-4 was intermediate tolerant: 70% wilt was recorded, while only 7% of plants died. Days to wilting were shortest for Embo Buff (41 days), Tatro mix, 2460, MA1, Meter long bean Piet and TVU 7778, as opposed to Glenda and IT96D 602, which only wilted at 59 days after stress was induced. Significant differences ($P=0.10$) were recorded for % recovery. Ukaluleni (62%) and Glenda (60%) had high % recovery after re-watering. No recovery was observed for Embo Buff, 2460, MA1 and MA2, and low % recovery for sensitive control TVU 7778 (3%).

CONCLUSIONS

Large variation was found in the level of drought tolerance of 24 cowpea land races. Glenda, Makatini and Ukaluleni performed very well in terms of vegetative tolerance to drought. These were more tolerant than the tolerant control and can be used in future experiments as controls. The land races will be evaluated further for agronomic performance in field trials.

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Keywords: Drought and heat tolerance, plastic boxes, *Vigna unguiculata*

WATER USE EFFICIENCY OF TWO CONTRASTING SUGARCANE GENOTYPES IN A WATER DEFICIT ENVIRONMENT

S Ngxaliwe¹, A Eksteen¹, A Singels^{1,2} and NW Pammenter²

¹South African Sugarcane Research Institute, 170 Flanders Drive, Mount Edgecombe;

²School of Life Sciences, University of KwaZulu-Natal, Westville Campus

E-mail: Sivuyile.Ngxaliwe@sugar.org.za

INTRODUCTION

Sugarcane has the potential to be used as a feedstock for electricity co-generation and bio-ethanol production. As the availability of land with sufficient rainfall for sugarcane cultivation is a limiting factor in South Africa, it is likely that cane for bio-energy production would need to be grown in marginal, sub-optimal areas. Hence, it is necessary to know how much biomass can be produced, and how much water will be used in the process. The aim of the current study was to quantify water use efficiency (WUE, defined as dry biomass produced per unit of water used) of two contrasting sugarcane genotypes in response to water stress.

MATERIALS AND METHODS

In October 2011, high sucrose (N19) and high biomass (G73) sugarcane genotypes were planted at a rainshelter facility at Mount Edgecombe. Four plots (two genotypes x two water treatments) received adequate irrigation until February 2012, after which water was withheld from two plots until May 2012, while the remaining two plots continued receiving adequate water. Volumetric soil water content (SWC, n=3 access pipes per plot), leaf area index (LAI) and stalk population were measured (n=20 plants per plot) for the duration of the experiment. Dry mass of aboveground biomass components (n=4 subsamples per plot) was determined at harvest (May 2012), while evapotranspiration was derived from a water balance equation.

RESULTS AND DISCUSSION

Under well-watered conditions N19 produced 15% less dry biomass and used 3.6% less water than G73. Water stress significantly reduced yields for both N19 and G73 by 31% and 57%, respectively. This was associated with a reduction in LAI by 77% and 86%, and the final stalk population by 10% and 55%, for N19 and G73 respectively. In response to water stress, the WUE of N19 improved from 7.03 to 7.99 kg m⁻³ whereas G73 showed a reduction in WUE from 8.03 to 6.04 kg m⁻³. These values compare well with the value of 8 kg m⁻³ used by Keating *et al.*, (1999) for developing a sugarcane module and were consistent with literature.

CONCLUSIONS

Under well-watered conditions, the high biomass genotype (G73) produced a higher biomass yield by using more water than the high sucrose genotype (N19). In response to severe water stress, the G73 genotype produced less dry biomass and the WUE was greatly reduced compared to N19. G73 continued to use water during mild water stress whereas N19 had reduced its transpiration. G73 would not appear to be a suitable high biomass sugarcane genotype to grow in marginal areas with prolonged periods of drought stress. Further research needs to be done subjecting G73 to different water stress levels.

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Keywords: Bio-energy, biomass, sugarcane, water stress, water use efficiency

THE ROOT ENVIRONMENT AS INFLUENCED BY MULCHES AND THE RESULTING EFFECT ON FRUIT YIELD AND SUNBURN OF 'CRIPPS' PINK' APPLES

AF Nicholson¹, NJ Taylor², JG Annandale² and E Lötze¹

¹*Stellenbosch University, Dept Horticultural Science, Private Bag X1, Matieland 7602;*

²*University of Pretoria, Hatfield 0028*

E-mail: ali.f.nicholson@gmail.com

INTRODUCTION

An investigation into the effects of different mulches on the root environment, encompassing physical, chemical and biological factors of the soil, on two different soil types was performed as a field trial, on 'Cripps' Pink' apples.

MATERIAL AND METHODS

The trial was an extension of an existing trial started in 2008/9 and this report comprises the two consecutive seasons, 2010/11 and 2011/12. The experimental sites were a light and heavy soil type, planted with bearing 'Cripps' Pink' apple trees on M793, on Lourensford Estate, Somerset West, Western Cape. Three organic mulches were evaluated: compost, vermi-castings and woodchips, as well as an inorganic mulch, geotextile fabric, and were compared against clean cultivation. A randomized complete block design was used, with four tree plots, repeated six times, with buffer trees between blocks.

RESULTS AND DISCUSSION

The organic treatments resulted in improved physical conditions (lower bulk densities) in the heavier soil, as well as a reduction in temperature fluctuations and a general increase in soil temperatures during the seasons, at both sites. The geotextile fabric treatment resulted in increased soil moisture levels in the top 40 cm, predominantly in the heavier soil. The compost treatment resulted in high soil moisture levels in the top 40 cm only in the lighter soil.

The vermi-castings treatment achieved superior results in terms of ameliorating the nutrient status of the heavier soil. It resulted in significantly higher pH, P (phosphorus), N (nitrogen), K (potassium), Mg (magnesium), Zn (zinc), Mn (Manganese), B (boron), as well as the cation exchange capacity and some exchangeable cations, such as, Na⁺ (sodium ions), K⁺ (potassium ions) and Mg⁺ (magnesium ions). The compost treatment resulted in significantly higher Ca (calcium) and Ca⁺ (calcium ions) in the heavier soil compared to the other treatments. The organic mulches, including the woodchips treatment, consistently resulted in higher mineral levels and therefore performed the best in this regard and did so in the heavier soil. In contrast to the heavier soil, none of the treatments were successful in ameliorating the nutrient status of the lighter soil, with the exception of the increased percentage C as a result of the compost and vermi-castings treatments.

The compost treatment realised consistently higher mycorrhizal colonization at both sites. However it was not always significantly higher than the other treatments. The vermi-castings treatment realised consistently lower plant parasitic nematodes numbers. Higher free-living nematodes were also frequently realised during both seasons and at both sites. The organic mulches therefore proved promising with regard to soil biota.

The organic treatments, with the exception of the vermi-castings treatment, resulted in improved root number and distribution in the heavier soil. The vermi-castings treatment resulted in a superior root environment and an enhanced root system was not needed in order to achieve good fruit yield and quality. In contrast, the geotextile fabric treatment performed better in this regard in the lighter soil. The geotextile fabric treatment also achieved the lowest weed counts, quantified as winter weeds, at both sites. Yield efficiency in the heavier soil, and the incidence of sunburn at both sites, were influenced by mulching. In the heavier soil, the woodchips treatment resulted in the highest yield efficiency and the compost treatment consistently resulted in the highest incidence of sunburn. In the lighter soil the control treatment resulted in the highest incidence of sunburn. The vermi-castings treatment consistently resulted in lower incidences of sunburn.

CONCLUSION

Due to the limited quantification of irrigation in this trial, the consequence of irrigation on different mulches was not evaluated and should be considered for future research.

Keywords: mycorrhizae, vermi-castings, geotextile, woodchips, compost

IMPROVING GLYPHOSATE EFFICACY BY MAKING THE RIGHT ADJUVANT CHOICE

H Nienaber

ARC-Field Crops Division, Private Bag X29, Bethlehem 9700

E-mail: deweth@arc.agric.za

INTRODUCTION

Glyphosate (glycine) is classified as a non-selective, systemic herbicide that is used for broad spectrum weed control. It can effectively control all plant types including grasses, perennials and woody plants. Glyphosate is widely used in crops in South Africa. This makes it very important to utilize this herbicide in the best way possible. However, there is a perception that the addition of an organic acid buffer to glyphosate mixtures can achieve the same level of weed control in comparison to the addition of ammonium sulphate to glyphosate mixtures. This is a very costly perception, as ammonium sulphate has the ability to overcome high salt levels in water and buffers do not exert this ability. A buffer only buffers the pH of spraying solutions. Glyphosate is very sensitive to poor water quality, therefore it is important to eliminate as much salt as possible from spraying water, to optimize glyphosate efficacy. This study was conducted to determine if the addition of an organic acid buffer or ammonium sulphate increases glyphosate efficacy most.

MATERIAL AND METHODS

Two greenhouse trials were conducted at the Agricultural Research Council Small Grain Institute, Bethlehem. Glyphosate (480 g/l a.i.), ammonium sulphate and an organic acid buffer were used in different treatments. The ammonium sulphate and/or buffer were added to the spraying water first, before adding the glyphosate. Three different water types were used for the execution of this experiment (distilled water, hard (CaCl_2) water and brackish (NaHCO_3) water). The test species was cultivated oats, cv. Sederberg. Both experiments were set up as randomized complete block designs. The experiments were evaluated after fourteen days by means of weighing fresh shoot mass and data was analyzed using Genstats 12th ed (12.1.0.3338).

RESULTS AND DISCUSSION

From the results it was evident that antagonism occurred when the organic acid buffer was added to the glyphosate in CaCl_2 water. Adding glyphosate to ammonium sulphate containing water, led to a significant increase in the percentages control recorded. When the organic acid buffer was added to ammonium sulphate containing CaCl_2 water, the percentage control recorded increased significantly. The same trend was observed in distilled and NaHCO_3 water. This can be attributed towards the fact that the ammonium sulphate eliminates high salt levels and improve glyphosate efficacy.

CONCLUSION

Replacing ammonium sulphate in glyphosate mixtures with an organic acid buffer could lead to significantly lower percentages control. If there is a need to use the buffer, rather add it to the ammonium sulphate and the glyphosate, as this will lead to effective weed control.

Keywords: Ammonium sulphate, antagonism, glyphosate, herbicide efficacy, organic acid buffer

GROWTH AND YIELD RESPONSES OF TWO COWPEA CULTIVARS TO DIFFERENT LEVELS OF PHOSPHORUS AND ZINC APPLICATION UNDER DRYLAND CONDITIONS IN LIMPOPO PROVINCE

RA Nkoana¹, FR Kutu¹ and JAN Asiwe²

¹University of Limpopo, P/Bag X1106, Sovenga 0727; ²Agricultural Research Council-Small Grain Institute, P/Bag X29, Bethlehem 9700

E-mail: Raesetjan@gmail.com

INTRODUCTION

Limpopo Province is among areas with high potential for cowpea production in South Africa due to its climatic suitability. However, most soils in this area are characterized by low phosphorus (P) content, a key limiting element in cowpea production. Excessive P application on the other hand may also trigger major nutritional problems particularly zinc (Zn) uptake. This study, therefore, aimed at determining the optimum P and Zn rates required for maximum yields in two cowpea cultivars.

METHODOLOGY

A field study was carried out at University of Limpopo Experimental farm, Syferkuil (23°50'36.86" S and 29°40'54.99" E) during 2011/12-summer planting season under rainfed conditions. The trial was laid out in a split-split plot arrangement fitted into a randomized complete block design and replicated three times. Treatments consisted of two cowpea varieties, IT00K-1217 and Oloyin; five P levels (0, 15, 30, 45 and 60 kg ha⁻¹) applied as double superphosphate (10.5% P) and three Zn levels (0, 10 and 20 kg ha⁻¹) applied as zinc sulphate (36.4% Zn). Agronomic data were collected at crop harvest namely fodder, haulm and grain yields; pod length and number of seeds per pod; while P and Zn contents of seeds were also determined.

RESULTS AND DISCUSSION

Results showed a significant P application effect on grain and fodder yields for both varieties. The highest grain yield of 1586 kg ha⁻¹ was obtained at 60 kg P ha⁻¹ and 20 kg ZnSO₄ ha⁻¹ for Oloyin and 1383 kg ha⁻¹ at 45 kg P ha⁻¹ without zinc application (0 kg ZnSO₄ ha⁻¹) for IT00K-1217. On the other hand, the highest haulm weight of 590 kg ha⁻¹ was obtained at 45 kg P ha⁻¹ without zinc application for IT00K-1217 and 471 kg ha⁻¹ at 30 kg P ha⁻¹ without zinc application for Oloyin. Neither P nor Zn application exerted any positive effect on both pod length and number of seeds per pod though IT00K-1217 gave higher pod length (18 cm) and seed number per pod (14) than Oloyin following application of 60 kg P ha⁻¹ and 10 kg ZnSO₄ ha⁻¹.

CONCLUSIONS

The two cowpea varieties showed differential responses to both P and Zn utilization which underscores the importance of P and Zn nutrition in cowpea production. Phosphorus and Zn determination in grains for both cowpeas will explore the possibility of cowpea grains being used to address micronutrient deficiency particularly zinc, in human diets.

Keywords: Cowpea, grain yield, fodder, phosphorus, zinc, dryland condition

THE SEASONAL EFFECTS ON CHEMICAL COMPOSITION OF *Pelargonium sidoides* (Geraniaceae)

PM Ntshabele¹, S Soundy² and Z Apostolides³

¹Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa; ²Department of Crop Sciences, Tshwane University of Technology, Private Bag X680, Pretoria, 0001, South Africa; ³Department of Biochemistry, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa

E-mail: paul.ntshabele@gmail.com

INTRODUCTION

Pelargonium sidoides is a South African indigenous medicinal plant. The roots of the plant are used as a herbal medicine and for the treatment of upper respiratory tract infections.

MATERIALS AND METHODS

An experiment was conducted on the Hatfield Experimental Farm of the University of Pretoria to establish if different seasons had an influence on root concentration of crude protein, starch, umckalin and leaf and root total polyphenols. The treatments were the control (bird net) and 10%, 40% and 70% black shade nets. Samples were taken during the different seasons, summer, autumn, winter and spring respectively. The total polyphenols were determined with Folin-Ciocalteu phenol reagent (Sigma-Aldrich) according to ISO 14502 – 1 (2005) method. Crude protein was determined according to the Dumas method (AOAC 968.06, 1990). The starch was gelatinised by autoclaving, followed by hydrolysis of the starch to glucose and the determination of glucose according to the AOAC 14.081-14.082 (1980) method. Umckalin was determined according to White et al. (2008). An umckalin standard obtained from AppliChem, Darmstadt, Germany was used to create a standard curve for quantification.

RESULTS AND DISCUSSION

The different seasons significantly influenced the root concentration of crude protein, starch, umckalin, leaf and root total polyphenols. Autumn had the highest leaf and root total polyphenols concentration, whilst lowest of both were found in Winter. The highest root umckalin was obtained in Autumn and the lowest in Summer.

CONCLUSION

The different seasons had an effect on the chemical composition of *P. sidoides*.

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Keywords: Crude protein, starch, total polyphenols, umckalin

AGRONOMIC AND FRESH QUALITY TRAITS OF LETTUCE GROWN UNDER COLOURED SHADE NETS

ML Ntsoane¹, TA Shittu¹, D Sivakumar¹ and P Soundy¹

¹Tshwane University of Technology, Department of Crop Sciences, Pretoria 0001

E-mail: ntsoanelucia@gmail.com

INTRODUCTION

Nets are used to regulate environmental factors affecting crop growth. It may give protection against physical agents such as birds, hail, insects, pathogenic infection and excessive radiation by modifying environmental factors such as temperature, relative humidity and light quality (Shahak, 2008). Very few studies have been conducted on shading effect on leafy vegetables and less has been conducted on lettuce in South Africa. This study was conducted to determine the effect of colored net shading on the growth performance and fresh quality of lettuce (*Lactuca sativa* L.).

MATERIALS AND METHODS

Three lettuce cultivars (Ashbrook, Aquarell and Exbury) were grown under winter conditions (mean temperature 20.0°C and 49% relative humidity). Four colored shade nets (red, pearl, yellow and black) were tested using a randomized complete block design with three replications assigned to each of the coloured shade nets. Photosynthetically active radiation (PAR), air temperature and relative humidity were recorded with data loggers. Pre-harvest incidence of pests and diseases, chlorophyll content, and selected growth parameters were recorded, while freshly harvested lettuce was analyzed for dry matter (DM), ascorbic acid (AA), total titratable acidity (TTA), CIELab color parameters, and sensory acceptability.

RESULTS AND DISCUSSION

Generally, the agronomic traits and fresh quality indices were more influenced by the cultivar differences than shading effect. Yellow shading gave the highest DM content for all the lettuce cultivars. However, 'Exbury' grown without shading had the highest DM, TTA, and ascorbic acid contents. The chlorophyll content of 'Exbury' leaves under pearl and yellow shading increased linearly with age ($R^2 > 0.94$, $p < 0.01$). 'Exbury' was lighter in colour than other cultivars. The least pest and disease incidence was recorded for 'Exbury'.

CONCLUSIONS

The pearl and black shade nets provided the best and poorest protective effects against pests and diseases, respectively. Yellow nets gave the highest yield, but cultivar 'Aquarell' was the most acceptable as per sensory panelists.

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ACKNOWLEDGMENTS

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Keywords: Coloured nets, *Lactuca sativa*, environmental factors

EFFECT OF PLANTING TIME IN YIELD AND SUGAR CONTENT OF SUGAR BEET CULTIVARS GROWN IN CRADOCK, EASTERN CAPE

B Ntwana¹ and SW Tuwana¹

¹Döhne Agricultural Development Institute, Private bag X15, Stutterheim 4930

E-mail: bntwana@gmail.com

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is the second most important sugar producing crop after sugar cane. Planting date plays an active role on growth, yield and quality of sugar (Leilah, *et al.* 2005). This study was aimed at determining the correct planting time on yield and sugar content of sugar beet cultivars.

MATERIALS AND METHODS

The trial was conducted at Cradock situated at 32° 13' 10" S, 25° 41' 14" E and 846m above sea level. A split plot design with planting date (March, May and July) as the main plot and three different cultivars (Anscha, Premiere and EB505) as sub-plots was used. Treatments were laid out in a 10m x 6m area with inter row spacing of 0.5 m and intra row spacing of 0.15m. After eight months of growth beets were harvested and weight and % Brix recorded. Data was 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

Regarding cultivar performance, an average root yield of 1.65 kg/plant was obtained from cultivar Anscha, which was significantly different from other cultivars only during 2010. Yonts *et al* (1999) reported that some varieties are better suited than others. Concerning planting date, May 2009 gave highest yields followed by July and March. Lowest yields in March 2009 were due to high levels of bolting due possibly to temperature fluctuations (Milford *et al*, 2010). The interaction of planting time and cultivar revealed that May is the best planting time for all cultivars and Anscha yielded significantly higher than other cultivars. Sugar content was higher in EB505 during 2009 and Anscha recorded the highest sugar content during 2010.

CONCLUSIONS

Planting date has an effect on yield and sugar content of sugar beet. May is the best month for planting sugar beet and Anscha is the best performing cultivar in Cradock.

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Keywords: Planting time, sugar beet, sugar content, yield

NUTRITIONAL WATER PRODUCTIVITY OF TRADITIONAL LEAFY VEGETABLES (TLV'S): A REVIEW

MK Nyathi¹, YG Beletse¹ and CP du Plooy¹

¹Agricultural Research Council - Vegetable and Ornamental Plant Institute, Private bag X293, Roodeplaat, Pretoria 0001

E-mail: mnyathi@arc.agric.za

INTRODUCTION

South Africa (SA) is a dry country and is also challenged by malnutrition problems, especially Zn, Fe and vitamin A in children and women. Future projections indicate that irrigated agriculture water demand (17 billion m³) will be more compared to current supply (15 billion m³) (CSIR, 2010). To meet the future demand and address malnutrition problem, SA needs to adopt strategies that improve water productivity (WP) and nutritional value of crops. The objective of this study was to set a benchmark for nutritional water productivity (NWP) of selected traditional leafy vegetables (TLVs) (*Amaranthus*, cleome, sweet potato, Chinese cabbage, Black night shade, jute mallow, cowpea and bitter water melon).

MATERIALS AND METHODS

To determine a rough estimate of NWP for TLVs for SA condition, an approach that links WP with human nutrition used by Renault and Wallender (2000) was applied. $NWP = \text{Yield} / (ET_a \times \text{nutritional content of a product})$. Water productivity is the ratio of yield or biomass per unit of water beneficially used by the crop (evapotranspiration (ET_a)). Nutritional contents of TLVs were adapted from literature whilst water productivity values were taken from studies conducted at ARC-VOPI. Both sets of values have their weaknesses or inaccuracies, i.e. calculations are not done with data from the same trials.

RESULTS AND DISCUSSION

NWP for Fe ranged from 10-352 mg m⁻³; Zinc (3.1-616 mg m⁻³) and vitamin A (0.0016-0.33 g-RAE m⁻³). *Amaranthus dubius* and *Amaranthus spinous* indicated highest NWP for Zn and Fe, whilst orange fleshed sweet potato showed the highest NWP for vitamin A. There are several factors affecting NWP of crops. These can be grouped into agronomic practices (planting date, spacing, mulching, organic matter application, fertiliser application rates and intercropping), crop type (C3, C4, high yielding varieties) and environmental conditions (vapour pressure deficit and proportion of diffuse radiation).

CONCLUSIONS

It is concluded that there is little information about NWP of TLVs in SA, especially linking water, soil nutrients and management practices conducted in one location. Research linking water and nutrients is likely to have a significant contribution towards improving water and nutritional water productivity of TLVs in South Africa.

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Keywords: Nutritional water productivity; traditional leafy vegetables; deficit irrigation; water scarcity; South Africa

HEAVY METAL UPTAKE BY DRYLAND AND IRRIGATED MAIZE-OAT ROTATION IN SLUDGE AMENDED SOILS

ZM Ogbazghi¹, EH Tesfamariam¹, JG Annandale¹ and PC de Jager¹

¹*University of Pretoria, Department of Plant production and Soil Science, PO Box X21, Hatfield 0028, Pretoria*

E-mail: u11350921@tuks.co.za

INTRODUCTION

Heavy metals in the environment are a source of some concern because of their potential reactivity, toxicity, and mobility in the soil. Consequently most of the existing sludge guidelines limit sludge land application, according to their heavy metal content (particularly the four main sludge-borne metals; Pb, Cd, Cu and Zn). Nevertheless, no medium to long term local field scale studies were conducted to assess the effect of class A1a sludge application on heavy metal uptake by staple crops such as maize. The objective of the study was to test the hypothesis that the use of class A1a sludge in agricultural lands will not cause health threats through heavy metal uptake by plants or due to an increase in the mobile fraction of heavy metals.

MATERIALS AND METHODS

Field experiments were conducted at the East Rand Water Care Works (ERWAT), Johannesburg, Gauteng, South Africa. The mean annual rainfall of the study site ranged between 405 mm in 2006/07 and 710 mm in 2007/08, mainly during the months of October to March. The soil of the experimental site is a clay loam, Hutton soil form having an average clay content of 38%, and pH (H₂O) of 5.73. Field plots were amended annually with 0, 4, 8 and 16 t ha⁻¹ anaerobically digested A1a sludge and planted to dryland maize and irrigated maize-oat rotation since 2004/05. Plant and soil samples were collected after 7 years of treatment application for heavy metal uptake by plants and accumulation in the soil profile.

RESULTS AND DISCUSSION

In general, the addition of municipal sewage sludge had relatively little effect on Cd, Pb, Ni, and Zn uptake by plants and the level of concentration in the plants was far below the toxicity level of both crops. The concentration of Cd, Pb, Ni, and Zn in maize seed was lower than the concentration in the other parts of the test crops both under dryland and irrigated conditions. The saturated paste extractable Zn in the top 0.3 m layer of the soil profile increased as the sludge application rate increased both under dryland and irrigated systems. The saturated paste extractable fraction of Cd, Zn, and Pb, however, remained below detection limit. It was also interesting to note that the saturated paste extractable Zn was higher under dryland compared with similar irrigated treatments.

CONCLUSIONS

Seven years of continuous Class A1a municipal sludge application to dryland maize and irrigated maize-oat rotation increased the mobile fraction of Zn but had little effect on the mobile fraction of Cd, Ni, and Pb. The effect of sludge application on heavy metal accumulation was more pronounced on the other body parts of maize than in the seed.

Keywords: Heavy metals, maize, oats, sewage sludge

WATER USE EFFICIENCY AND DROUGHT TOLERANCE OF SUGARCANE FOR BIO-ENERGY PRODUCTION

FC Olivier¹, A Singels¹, A Eksteen¹ and S Ngxaliwe¹

¹South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300

E-mail: francois.olivier@sugar.org.za

INTRODUCTION

Sugarcane is a strong candidate crop for the production of bio-energy because it produces high biomass yields, including fermentable sugars and fibre for bio-fuel and electricity production. There are indications that high biomass genotypes use water more efficiently than existing sucrose genotypes (Alexander, 1985). If true, these genotypes can be used for bio-energy production in marginal areas (with low rainfall or poor soils). The objective was to gather quantitative information on crop productivity, water use efficiency (WUE, defined as aboveground dry biomass produced per unit evapotranspiration) and drought sensitivity (defined as biomass yield loss per unit of evapotranspiration deficit) of different sugarcane genotypes and benchmarked against other potential bio-energy crops.

MATERIALS AND METHODS

A one hectare field trial was established in Komatipoort as a completely randomised block design with four replications. Genotypes tested were two sucrose type sugarcane cultivars (N19, N31), two biomass type sugarcane hybrids (04G0073, IK76-63) and three alternative crops, namely Napier grass, forage sorghum (Big Kahuna) and sugar beet (Python). Water treatments consisted of a well-watered and a water deficit treatment (50% of crop water requirement as determined by neutron water meter records). Destructive samples (1 x 2m row length per plot) were taken at four, eight and 12 months of age to determine dry mass of leaves and stems, stem sugars and stem fibre.

RESULTS AND DISCUSSION

Under well-watered conditions the highest dry biomass yield at harvest was achieved by N19 (76 t ha⁻¹), followed by N31 (68 t ha⁻¹), Napier grass (63 t ha⁻¹), IK76-63 (62 t ha⁻¹) and 04G0073 (57 t ha⁻¹). Sorghum and sugar beet yielded 24 and 46 t ha⁻¹ at 4 and 6 months respectively. The high biomass type sugarcane 04G0073 showed the lowest sensitivity to drought, followed by N31 and N19. Napier grass was the most sensitive to drought. Highest WUE was achieved by sugar beet followed by sorghum and N19 (8.0, 6.2 and 5.8 kg m⁻³ respectively) and lowest by 04G0073 (3.7 kg m⁻³). Highest theoretical ethanol yield was achieved by N19 (31 700 l ha⁻¹), followed by N31, 04G0073, IK76-63, Napier grass, sugar beet and sorghum (9000 l ha⁻¹).

CONCLUSIONS

The sorghum-sugar beet combination was the most productive and water use efficient option. Sucrose type sugarcane was more drought tolerant than the alternative crops, and it is therefore believed that conventional sugarcane cultivars can compete with biomass crops for ethanol production due to ease of cultivation and processing versatility. Outcomes will assist the sugar industry in future planning for bio-energy production.

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Keywords: Bio-energy crops, drought tolerance, sugar beet, sugarcane, sweet sorghum, water use efficiency

BIOREMEDIATION OF CRUDE OIL CONTAMINATED SOIL: EFFECT ON SOIL PROPERTIES, PLANT HEIGHT AND CYANIDE CONTENTS OF CASSAVA (*Manihot esculenta* Crantz)

SR Osu¹ and MJ Abia¹

¹Akwa Ibom State College of Education, Afaha Nsit, P. M. B. 1019, Etinan, Nigeria

E-mail: maryjabia2012@gmail.com

INTRODUCTION

One of the environmental changes posed by crude oil contamination in soil is the alteration in physical and chemical nature of soil which subsequently affects the growth of crops (Tanee and Albert, 2010). There is therefore, need to remediate such contaminated soil to improve crop productivity. However, the potential of sawdust as fertilizing material has not been adequately investigated in crude oil contaminated soil. As such, the present study is initiated in order to critically access better scientific measures that will result in the reclamation of crude oil affected soil of the humid tropics.

MATERIALS AND METHODS

Pot experiments were conducted twice in 2009/2010, to determine the effect of crude oil contamination on some soil properties, plant height and cyanide content of cassava (*Manihot esculenta* Crantz). The soil samples were air-dried and analysed according to the method of AOAC (1990). Determination of Percentage (%) Crude oil Concentration was carried out along side with laboratory analysis of contaminated and amended soils. 16kg of garden soil were used for this experiment. Completely randomized design (CRD) was used and replicated four times. Two levels of crude oil contaminations used in this experiment were (3%) and (6%) with four months old sawdust as amendment materials. Both 3% and 6% contaminated soils receive equal measure of sawdust (4kg per 16kg soil) as amendment materials. In the control, there was no crude oil contamination and no sawdust amendment. Laboratory determination of soil pH, total hydrocarbon (THC) total organic carbon (TOC), soil total nitrogen (%), soil conductivity and cyanide content of cassava was done according to the method of Godson *et al.*, (2002) and results expressed. The data collected were subjected to one-way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Results showed that pH was slightly affected by crude oil contamination; total hydrocarbon content (THC) significantly ($p=0.05$) increased with increase in the contamination level of crude oil. Total nitrogen (%) level of the soil decreased with increase in crude oil contamination. Electrical Conductivity (EC) did not follow a definite trend based on treatment concentration. Cassava plant height was reduced with increase in crude oil contamination. Cyanide content increased proportionally with crude oil contamination. Sawdust amendment significantly ($p=0.05$) increased the total organic carbon (TOC) and significantly reduced the total hydrocarbon content, there was no evidence of total nitrogen (%) level increment from sawdust remediation. Plant height was significantly ($p=0.05$) increased with sawdust amendment and there was no evidence of cyanide content reduction as a result of sawdust amendment.

CONCLUSION

Soil amendments are important in reclaiming soils contaminated with crude oil. This study strived to determine the effect of crude oil contamination on soil properties, plant height and cyanide content of cassava. Crude oil contamination reduced cassava plant height and increased cyanide content. Sawdust helped to some extent to remedy the crude oil contaminated soil. However, using it solely does not provide a sure remedy to crude oil contaminated soil. Consequently, more researches should be carried out to discover, from the wide range of organic materials in our environment, those ones that would be more suitable in providing a better remedy to crude oil contaminated soils.

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TUBER YIELD OF CASSAVA (*Manihot esculenta* Crantz) GROWN IN CRUDE OIL CONTAMINATED SOIL ENRICHED WITH AMENDMENTS

SR Osu¹, ES Akpan²

¹Department of Biology, School of Science, College of Education, Afaha Nsit, P. M. B. 1019, Etinan, Nigeria; ²Department of Physics, School of Science, College of Education, Afaha Nsit, P. M. B. 1019, Etinan, Nigeria

E-mail: enobongxst@yahoo.com

INTRODUCTION

In the Niger Delta region of Nigeria oil spillage has been a regular occurrence with resultant environmental degradation. Soil affected with crude oil is suggested to be a major constraint responsible for low yield of crops in the region (Onuh *et al.* 2008). In this study, it was pertinent to utilize Oil Palm Bunch Ash (OPBA) as liming agent to normalize soil acidity and Dried Poultry Droppings (DPD) as organic fertilizer to upgrade crude oil affected soil for increased crop productivity. The choice of cassava for the study is necessitated by the fact that it is the most common crop cultivated in the region and the current high demand for cassava for industrial uses (Jacobson, 1995).

MATERIALS AND METHODS

Two field experiments were conducted in 2010 & 2011 in Ikot Abasi in the Niger Delta region of Nigeria where crude oil contamination is prevalent, to investigate the mean weight of tuber (g/tuber) and total tuber yield (t/ha) of cassava cultivar (NR 41044) grown in crude oil contaminated soil enriched with amendments. Soil sampling and analysis were carried out, land preparation and field layout was done, experimental design used was the randomized complete block design (RCBD) with four replications. The total area used for cultivation was 27m x 21m (567m²) equivalent to 0.0567ha consisting of 12 subplots marked 5 x 5m² with 25 plant density. Application of organic amendments to each subplots were 0, 25, 50kg/ha of each of OPBA and DPD respectively, as well as DPD + OPBA combinations. Manual weeding was done. Laboratory analysis of soil and organic amendments were performed according to the method of Udo and Ogunwale (1986) and mean values of physico – chemical properties were expressed. Data collection was done at harvest. The average values of soil properties, mean weight of tuber (g/tuber) and total tuber yield (t/ha) of the 1st and 2nd cassava cropping were subjected to analysis of variance (ANOVA) and the means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

The results of physico-chemical properties showed that the crude oil contaminated soil was low in Organic carbon (1.74%), Nitrogen (0.043%) and available Phosphorus (5.83 cmol/kg). Analysis of organic amendments also showed that DPD was rich in Nitrogen (4.84%), Potassium (2.54%) and Calcium (4.33%). Whereas OPBA recorded the presence of high Potassium (5.3%) and low Calcium (2.03%), Magnesium (1.60%) and Phosphorus (1.52%). The mean weight of tuber (g/tuber) and total No. of yield (t/ha) was significantly influence by DPD at 5% level of probability. OPBA had no significant effect as compared to DPD. The mean weight of tuber (g/tuber) and yield (t/ha) produced at 50kg/ha rate of DPD was significantly higher than the other levels that produced statistically similar results. The interaction between DPD and OPBA for mean weight of tuber and yield (t/ha) was not significant. Therefore, this study is recommended to agronomists to be guided with the optimal level of application of organic amendment to contaminated soil before cultivation of crops (Osu *et al.* 2006).

CONCLUSIONS

From the study, there is ample evidence to show that DPD enhanced mean weight of tuber and total tuber yield more than OPBA in crude oil contaminated soil of the humid tropics. Hence DPD is recommended for efficient bioremediation practice. However, much longer time of incubation is needed for effective decomposition of DPD to enhance the rate of soil improvement.

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Keywords: Amendments, Cassava, crude-oil, dried poultry droppings, oil palm bunch ash, tuber-yield

GRAIN YIELD RESPONSE OF RAINFED MAIZE TO N, P AND K FERTILIZATION IN LONG-TERM TRIALS IN THE NORTHWEST PROVINCE

WM Otto¹, AJ van Vuuren¹ and C van Gerve¹

¹NWK Ltd., PO Box 107, Lichtenburg 2740

E-mail: willem@nwk.co.za

INTRODUCTION

Fertilizer inputs in maize production is a major input cost and optimal use must be ensured at expected yield potential levels. Rainfall in the maize production region of the Northwest Province decreases from east to west. The yield potential of maize therefore differ between these subregions as well as the optimal fertilizer requirement. Trials were established in 1988 in the three subregions overlapping the service area of NWK. The aim of these trials were to test and verify recommendations for N, P and K fertilizer applications in the long-term, as affected by different yields, soils and rainfall. The use of these recommendations would assist to reduce the risks of maize production in these areas.

MATERIALS AND METHODS

Permanent trial sites were established at Koster (NPK), Delareyville (NP) and Lichtenburg (NP) where fertilizer treatments were applied to the same plots each consecutive season. These localities lie within the different subregions based on long-term average rainfall. Conventional cultivation and agronomic production practices were followed. Fertilizer treatments (3 N x 3 P x 2 K levels) were planted in a randomised block design with 4 replications. Conventional medium growth period white maize cultivars were used throughout. Physiological and yield data were collected during each season. Data were analysed using GENSTATS, relevant statistical parameters and yield responses for the different treatments calculated.

RESULTS AND DISCUSSION

Localities differed significantly in grain yields, and yields responded positively to the fertilizer treatments where total rainfall increased in a given season. Nitrogen application resulted in the highest yield responses compared to the control, followed by P application that showed a decreasing trend as levels increased. Response to K applications was limited. Significant NxP interactions in yields were recorded.

CONCLUSIONS

The results confirm the fertilizer recommendations for maize production based on yield potential for these subregions. The significant NxP interactions indicate that a balanced approach to fertilization of maize must be followed.

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Keywords: Fertilizer, grain yields, maize, rainfall

COMPUTER-BASED DOSAGE FOR MANAGING *Meloidogyne* SPECIES IN TOMATO PRODUCTION USING BOTANICALS

OM Pelinganga¹ and PW Mashela¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: osvaldopelinganga_7@hotmail.com

INTRODUCTION

Successful utilisation of allelochemicals in managing plant-parasitic nematodes depends on their degree of phytotoxicity. Conventional methods of determining phytotoxicity are tedious, with inconsistent results (Pelinganga *et al.*, 2012). Plants respond to increasing dosages of allelochemicals in a density-dependent growth pattern, which allows the use of the Curve-fitting Allelochemical Response Data (CARD) computer-based model to determine the mean dosage stimulation range of the used botanical. The objective of this study was to use CARD model to determine the mean dosage stimulation range (MDSR) of fermented dried crude extracts of wild cucumber (*Cucumis africanus*) fruit in tomato (*Solanum lycopersicum*) production.

MATERIALS AND METHODS

Treatments, namely, 0, 2, 4, 8, 16, 32 and 64% were arranged in randomised complete block design, with 10 replications. Each plant was infested with 1 500 eggs and juveniles of the southern root-knot (*Meloidogyne incognita* race 2) nematode. Treatments were applied on weekly basis through botinemagation (use of nematicide from botanicals/plants through irrigation).

RESULTS AND DISCUSSION

At 56 days, dry root mass, dry fruit mass, dry shoot mass, plant height, stem diameter and nematode numbers in roots and soil were subjected to ANOVA. Plant variables where treatments were significant at 5% level were further subjected to the CARD model to determine six biological indices. At lower dosages, the material stimulated plant growth, whereas at higher dosages inhibition occurred as observed previously (Pelinganga *et al.*, 2012). The MDSR was computed as the mean of the first two biological indices (2.64%). The MDSR should improve plant growth and suppress nematode numbers.

CONCLUSION

CARD model suggested at 2.64%, fermented crude extracts of *C. africanus* fruit are suitable for use as a bio-nematicide without being phytotoxic to tomato plant. However, a validation study would be required.

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Keywords: Allelochemicals, *Cucumis africanus*, ground leaching technology, mean stimulation range, *Meloidogyne incognita*

OPTIMISING APPLICATION FREQUENCY OF FERMENTED *Cucumis africanus* FRUIT FOR MANAGING *Meloidogyne incognita* IN TOMATO PRODUCTION

OM Pelinganga¹ and PW Mashela¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: osvaldopelinganga_7@hotmail.com

INTRODUCTION

Botanicals are useful in managing plant-parasitic nematodes. However, the materials are highly allelopathic to most crops (Pelinganga *et al.*, 2012). Dosages of fermented wild watermelon (*Cucumis africanus*) fruit were optimized for managing nematode numbers and improving growth of tomato (*Solanum lycopersicum*) plants at 3% dilution. The objective of this study was to investigate the application interval of 3% dilution in tomato production.

MATERIALS AND METHODS

Treatments, namely, application interval at one, two, three and four intervals per 30-day month, were arranged in a randomised complete block design, with 12 replications. Four-week old tomato cultivar 'Floradade' seedlings were each inoculated with 5 000 second-stage juveniles of *Meloidogyne incognita* race 2. Treatments were applied through botinomagation (use of nematicide from botanicals/plants through irrigation) within a 30-day-month cycle.

RESULTS AND DISCUSSION

At 56 days, dry root mass, dry fruit mass, dry shoot mass, plant height and stem diameter versus the application frequency had quadratic relationships each. The model explained 63-99% total treatment variation in variables. Mean integrated optimum application frequency was 2.4 weeks, which translated to 18-day application interval. At this interval, final nematode population densities were low, while plant growth was improved as observed in previous studies (Pelinganga *et al.*, 2012).

CONCLUSION

At 18-day application interval, the 19 to 43-day nematode life cycle would invariably be disrupted, while plant growth is improved. Thus, the material is suitable in botinomagation.

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Keywords: Botinomagation, *Cucumis africanus*, *Cucumis myriocarpus*, fermented crude extracts, mean stimulation range, *Meloidogyne incognita*

DOSAGE OF FERMENTED FRESH *Cucumis myriocarpus* FRUIT ON TOMATO PLANTS FOR MANAGING *Meloidogyne incognita*

O Pelinganga¹, PW Mashela¹ and MT Malapane¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: mokone.malapane@gmail.com

INTRODUCTION

A bio-nematicide is being developed using wild cucumber (*Cucumis myriocarpus*) fruit for managing *Meloidogyne* species in tomato production (Pelinganga *et al.*, 2012). However, the material is highly allelopathic to tomato plants. Fruit of *C. myriocarpus* contain cucurbitacin A, which is soluble in water. A curve-fitting allelochemical response data (CARD) computer-based model was used to determine non-allelopathic dosages (Pelinganga and Mashela, 2012). The objective of this study was to determine the form (fresh or dried) of *C. myriocarpus* fruit which was less phytotoxic and more effective in suppressing *M. incognita* race 2.

MATERIALS AND METHODS

Tomato cv. 'Floradade' seedlings were infested at 3 000 eggs and juveniles each. Fresh pieces of *C. myriocarpus* fruit were fermented using effective microbes (Pelinganga *et al.*, 2012). In each form, treatments, namely, 0, 10, 20, 30, 40, 50 and 60% dilutions were arranged in a randomised complete block design, with 10 replications. At 56 days after weekly application of each treatment, dry shoot mass, dry root mass, dry fruit mass, plant height, stem diameter and nematode numbers were each subjected to analysis of variance. Variables with significant ($P = 0.05$) treatment means were further subjected to CARD model to generate six biological indices (Pelinganga *et al.*, 2012). Mean dosage stimulation range (MDSR) was computed for each variable using inhibition point (D_0) and saturation point (R_h) biological indices (Pelinganga *et al.*, 2012).

RESULTS AND DISCUSSION

In both fresh and dried forms total k value was 3 units. This biological index is an indicator of phytotoxicity – with the degree of phytotoxicity being inversely proportional to the k value (Pelinganga *et al.*, 2012). Integrated MDSR for the fresh material was at 5%. Relative to the untreated control, at 5%, the fresh material reduced nematode numbers by 94%, whereas Integrated MDSR for dried material at 3% dilution, the material reduced final nematode population density of *M. incognita* by 90%.

CONCLUSION

In fresh form, fermented crude extracts of *C. myriocarpus* fruit are suitable for use in the management of *M. incognita* race 2 in tomato production at 5% dilution, whereas in dried form fermented crude extracts of *C. myriocarpus* are suitable for stimulation of tomato plant and suppression of nematode numbers at 3% dilution.

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Keywords: *Cucumis myriocarpus*, effective micro-organisms, botinemagation, phytotoxicity, *Meloidogyne incognita*

DEVELOPING STORAGE GUIDELINES AND PREDICTING SHELF LIFE FOR SOUTH AFRICAN MACADAMIA KERNEL

MG Penter¹, FJ Kruger, EM Nkwana, YK Nxundu and AD Sippel

¹*Agricultural Research Council, Private Bag X11208, Nelspruit 1200*

E-mail: mark@arc.agric.za

INTRODUCTION

Exceptional growth in the South African macadamia industry has resulted in nuts being held on-farm and in processing plants for extended periods. Processed kernel is also held by processors for a year or more prior to export. Relatively little work has been carried out in South Africa to determine how long kernel may be kept before quality declines and there is limited information on the optimum conditions for holding packaged kernel. There is no commercial test to predict the shelf life of each batch of kernel. There are also questions as to how kernel quality changes through the season and whether different kernel styles have different storage potential. The current study examined the optimum storage temperatures for commercially packaged kernel and sought to elaborate on the relationship between kernel style, time of harvest and quality. This study also examined the potential of an accelerated oxidation (rancimat) test for determining the shelf life of batches of kernel.

METHODS AND MATERIALS

Commercially packed style 1 (whole) and 5 (chipped) kernel was sourced from a macadamia processor in the early, middle and late parts of the 2009 season. Three replicates of kernel from each combination of style and sampling date were stored at four temperatures (-5°C, 5°C, 15°C, and ambient). After 6, 12 and 18 months of 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 (rancimat method) was evaluated as a means of predicting shelf life, and thus sell-by dates. The test was conducted using oil pressed from each combination of style and sampling date (n = 6). The test was conducted at 120°C.

RESULTS AND DISCUSSION

The results indicate that kernel quality and storage potential declines as the season progresses. In general early and mid-season harvests in both styles could safely be held under vacuum for up to 18 months, provided temperatures of 15°C or less were maintained. Early and mid-season style 5 kernel can also be held under vacuum at ambient temperature for 6 months, whilst style 1 kernel can be held up to 18 months. In contrast, late season style 5 kernel should be stored at 15°C or less if held for 6 months and 5°C or less if a retail shelf life longer than 4 months is desired. Late season style 1 kernel can be held at ambient temperature for 6 months but should be held at 15°C if stored for 12 months or more and 5°C or less if stored for 18 months or longer. The rancimat test shows a reduction in induction time, and thus shelf life, as season progresses. For mid- and late season kernel there was also a reduction in induction time for style 5 kernel relative to style 1 kernel, indicating lower storage potential for style 5 than style 1. This agrees with the results of the storage trials.

CONCLUSION

Storage potential of commercially packed kernel declines as the season progresses. Chipped styles have lower storage potential than whole kernel. The results of the rancimat test are broadly in agreement with the storage trial results, indicating the potential of this test as a predictor of shelf life.

Keywords: Nut, post-harvest, processing, quality, rancimat, storage

ASSESSMENT OF THE BIOFUMIGATION EFFECT OF CANOLA (*Brassica napus*) ON SOIL MICROBIAL COMMUNITY FUNCTION AND STRUCTURE

C Potgieter¹, S Claassens¹ and M de Beer¹

¹Unit for Environmental sciences and Management, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520

E-mail: 20672322@nwu.ac.za

INTRODUCTION

The incorporation of soil with *Brassica* plant species as a green manure crop can be used as an alternative for chemical fumigants in disease control. However, little is known about the effect of such biofumigants on the natural soil microbial communities. The aim of the current study was to determine the effect of canola (*Brassica napus*) on the soil microbial community function and structure.

MATERIALS AND METHODS

A glasshouse experiment was done that consisted of 4 treatments of 8 replicates each. The treatments included: sunflowers in soil only; sunflowers in soil inoculated with *S. sclerotiorum*; sunflowers in soil incorporated with green manure and sunflowers in soil incorporated with green manure and inoculated with *S. sclerotiorum*. Soil microbial activity was characterised by means of dehydrogenase assays, functional diversity with Biolog® Ecoplates, community structure and biomass by phospholipid fatty acid analysis and sunflower plant vitality with a Plant Efficiency Analyse.

RESULTS AND DISCUSSION

The incorporation of canola manure into the soil had a stimulating effect on the dehydrogenase activity. The soil microbial communities showed a high resilience as they returned to similar compositions after the experimental disturbance. The inoculation of the soil with *S. sclerotiorum* only had a suppressive effect on the sunflowers during the vegetative growth stage.

CONCLUSIONS

The incorporation of canola (*Brassica napus*) green manure into the soil has an effect on the soil microbial community function and structure. Nonetheless, this biofumigation effect is short-lived and microbial communities can return to their initial compositions after the disturbance.

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ACKNOWLEDGEMENTS

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Keywords: Biofumigation, Canola, Microbial community, *Sclerotinia sclerotiorum*

PHYSIOLOGICAL AND YIELD RESPONSE OF *Zea mays* L. TO FOLIAR TREATMENT WITH INORGANIC NUTRIENTS

JC Pretorius¹, RA Buitendag¹ and J Allemann¹

¹Department of Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300

E-mail: pretorjc@ufs.ac.za

INTRODUCTION

It was postulated that foliar application of inorganic fertilizers can improve yields in certain crops. Limited references in this regard could be traced in the literature. Ankorion (1995) claimed that late foliar application of mono potassium phosphate (MKP) to crops, whether fruit or seed bearing, enhanced sugar as well as starch accumulation in the harvestable products. However, Sawyer and Barker (1999) reported contradicting results namely that foliar application of a 10% MKP solution to maize reduced the yield. This supplied the rationale for the underlying study.

MATERIALS AND METHODS

Zea mays L., cv. DKC 78-15B, was foliar treated with two inorganic fertilizers under rain fed conditions over two seasons using a complete randomized block design while treatments were replicated six times. During the first season MKP and potassium nitrate (KNO₃) solutions were foliar applied at 4% (w/v; 0.91 kg/ha P and 1.14 kg/ha K) and 3% (w/v; 1.14 kg/ha K) respectively during two growth stages, V3 and V8. During the second season both salts were additionally applied at double rates, but only at V8. Physiological parameters measured included chlorophyll a fluorescence as well as sugar and starch content in kernels at different grain filling stages. In this way photosynthetic capacity was correlated with sugar and starch content in kernels at selected stages of ear development as it related to final yield.

RESULTS AND DISCUSSION

Treatment with MKP at V8 contributed to enhanced probability for an absorbed photon to move an electron into the electron transport chain (ETo/ABS) that lead to the improvement of the overall performance output (Plabs) of photosystem II. Concomitantly, the latter treatment resulted in the detection of higher sugar and starch levels in kernels, corresponding with an increase in yield and confirming its superiority over treatment at V3. The higher rates for both nutrients applied in the second season did not differ significantly from the lower dosage rates in terms of both the physiological and yield response of maize.

CONCLUSIONS

From the obtained results there is a strong indication that a 4% MKP solution applied as a foliar spray at V8 can be a rather inexpensive method to improve maize yield by approximately 650 kg ha⁻¹ or 13%.

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Keywords: Chlorophyll a fluorometry, foliar fertilizer, maize, starch, sugar, yield

THE PRODUCTION OF A NEW PINEAPPLE HYBRID, THE MD-2 OR DELMONTE GOLD[®], IN SOUTH AFRICA

EC Rabie¹, HA Tustin¹ and BW Mbatha¹

¹ARC-ITSC, Hluhluwe Research Station, PO Box 194, Hluhluwe 3960

E-mail: erabie@mtuba.co.za

INTRODUCTION

Prior to 1996 the world pineapple export industry was relatively small and based mainly on the Smooth Cayenne cultivar, focusing more on the canned product. Since then this industry has undergone a remarkable change, with the introduction of the MD-2 pineapple as a fruit for fresh consumption. Fruit of the MD-2 are firmer and more fibrous than those of the Smooth Cayenne. The flesh is also more yellow and has a good flavour, with a 1-2% higher TSS (total soluble solids) as well as lower acidity. It also has a high resistance to internal browning and black spot disease and therefore has an extremely long shelf-life. The first commercial plantings of MD-2 in Hluhluwe occurred in 2007, most of them from tissue cultured plants. Mother material originated from different countries.

In South Africa the Queen pineapple is mainly produced for the fresh market, and a small percentage of the smaller sizes are exported by air to Europe, the Middle East and the Far East, where, due to its size, it is often purchased as a decorative piece and not for consumption. As an eating pineapple, the bigger export sizes competed with the Smooth Cayenne due to its superior taste but sales came under pressure with the arrival of the bigger and good tasting MD-2 fruit.

MATERIALS AND METHODS

To study the phenology and adaptability of the MD-2 pineapple under South African growing conditions, two successive plantings of the MD-2 hybrid were made. The first planting were made in 2008, comparing plants from 4 different origins. Suckers of these plantings were used in a second planting in 2010. Length of the growth cycle (vegetative and reproductive), fruit quality as well as pest and disease occurrence were evaluated.

RESULTS AND DISCUSSION

The MD-2 was bred on the island of Hawaii (Taniguchi *et al.*, 2008), and due to the latitude of the South African plantations, the weaknesses of the MD-2 hybrid became more prevalent. Winters with low temperatures and minimal rainfall enhance the occurrence of translucency or waterlogging during the early summer, which affect fruit quality and shelf life. Percentage TSS is low and fruit very acid, although fruit though of the later summer months is of good quality and taste.

The short winter days and low temperatures also induce natural flowering in a higher degree than in the tropics, which makes plantation management difficult. The number of days from fruit induction to harvest is also much longer than in the tropics. As with *Rotylenchus reniformis* in Hawaii (Taniguchi *et al.*, 2008), the MD-2 is more tolerant to *Pratylenchus brachyurus* than the Queen cultivar in Northern Kwazulu Natal.

CONCLUSIONS

MD-2 production in South Africa is at this stage still a challenge but the hope exists that it will be adapted to the South African growing conditions in the long run.

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Keywords: Export market, natural flowering, resistance, *Pratylenchus*, translucency

REVIEW OF TRAP CROP MANAGEMENT STRATEGIES TO CONTROL STINK BUGS IN MACADAMIA ORCHARDS

T Radzilani¹, PS Schoeman², B Botha³ and HC de Lange⁴

¹Subtropical Growers Association of South Africa, Tzaneen, South Africa; ²Agricultural Research Council, Institute for Tropical and Subtropical Crops, South Africa; ³Tshwane University of Technology, Department of Chemistry, Pretoria, South Africa; ⁴Tshwane University of Technology, Department of Crop Sciences, Pretoria, South Africa

E-mail: tshifhiwa@subtrop.co.za

INTRODUCTION

Stink bugs are polyphagous insects that inflict economic damage on many crop species. *Pseudotheraptus wayi* brown (Hemiptera: Coreidae) and *Bathycoelia natalicola* distant (Hemiptera: Pentatomidae) are of particular concern in the South African macadamia industry. At present, the control of stink bugs in South Africa and other countries relies heavily upon insecticides. Most of these products are disruptive to natural enemies and, as such, are a major stumbling block to integrated pest management. Various trap crops were evaluated as a means of monitoring stink bug levels.

MATERIALS AND METHODS

A field study was carried out at the ARC Institute for Tropical and Subtropical Crops experimental farm in Levubu. The trial was laid out as a randomized complete block design with four trap crops replicated four times. This was done to make provision for infestation from any direction. The growth stage of trap crops was included as a sub-plot factor in the analysis of variance (ANOVA). The experiment was repeated over two years (2010/11 and 2011/12 growing seasons). The data for the two years were tested for homogeneity of variances using Levene's test. Student's t-Least Significant Differences were calculated at the 5% level to compare treatment means of significant effects (Snedecor & Cochran, 1980). All analyses were done using SAS v9.2 statistical software (SAS, 1999).

RESULTS AND DISCUSSION

Stink bugs were recovered from all four trap crops. However, none of these trap crops appeared to be a good host for the coconut stink bug (*P. wayi*) as no *P. wayi* oviposition was observed on any of the trap crops trialed. Nevertheless, after completion of this trial, an alternative host crop was identified. There were significant differences between the four trap crops for *Nezara viridula*, *B. natalicola*, *B. rhodaini*, *N. pallidoconspersa* and unidentified pentatomides. For *P. wayi* there was only a significant difference in insect counts between the two growth stages (flowering and fruiting stage). There was also a significant interaction between trap crop and growth stage for *Nezara viridula* and the unidentified pentatomides.

CONCLUSIONS

In all of the trap crop species tested, differences were consistent over two seasons. Trap crops are a cost effective short to medium term alternative for stink bug monitoring, whilst other monitoring methods are being developed.

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ACKNOWLEDGMENTS

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Keywords: Stink bug, trap crops, insecticides, polyphagous

MAIZE/DRY BEAN INTERCROP PERFORMANCE IN RESPONSE TO MAIZE POPULATION AND DRY BEAN ARRANGEMENT

NT Ramagoshi¹, IK Mariga¹ and MP Mabapa¹

¹University of Limpopo, Department of Plant Production, Soil Science and Agricultural Engineering Private Bag X1106, Sovenga 0727

E-mail: ntaki.kgau@gmail.com

INTRODUCTION

Cereal- legume intercropping is commonly practiced in the Limpopo Province (Ayisi *et al.*, 2004), but there is no documentation for maize density and bean arrangement recommended for dryland maize/bean intercropping. Therefore the study was undertaken to determine the optimum combination of maize density and dry bean arrangement that can maximize yield of the intercrop system under dryland conditions.

MATERIALS AND METHODS

An experiment was conducted under dryland conditions at the University of Limpopo Experimental Farm during the 2009/10 and 2010/11 growing seasons. The trial was laid out as a 2 x 3 factorial arrangement of three maize plant populations (18500, 24700 and 37000 plants ha⁻¹), and two dry bean arrangements (single and double row arrangement) with 3 replications. Pure stands of both component crops were added to enable determination of the effect of cropping system. Data were subjected to analysis of variance (ANOVA) using Statistix 9.0 package. Differences between means were separated using the Least Significant Difference (LSD=_{0.05}) procedure.

RESULTS AND DISCUSSION

The results showed that maize density of 18500 plants ha⁻¹ yielded significantly lower grain yield of 640.4 and 656.5 kg ha⁻¹, while the density of 37000 plants ha⁻¹ gave a higher grain yield of 1318.4 and 1388.8 kg ha⁻¹ in season I & II, respectively. The combination of 37000 plants ha⁻¹ with double row dry bean arrangement achieved the highest maize yield >1400 kg ha⁻¹ in both seasons. The double row bean arrangement resulted in higher dry bean grain yield >600 kg ha⁻¹ in both seasons. The interaction of 24700 plants ha⁻¹ and double row arrangement produced the highest dry bean yield of 711.5 kg ha⁻¹. Intercropping maize and dry bean was advantageous at the different dry bean arrangement x maize density combinations with all achieving Land Equivalent Ratio (LER) values greater than one. Intercropping of maize at a density of 37000 plants ha⁻¹ with a double row of dry bean gave the highest LER value of 1.76 in 2009/10 season while in 2010/11 maize density of 18500 plants ha⁻¹ with a double row of dry bean arrangement achieved the highest LER value of 1.92.

CONCLUSION

The optimum combination was found to be 37000 maize plants ha⁻¹ with a double row arrangement of dry bean as it achieved the highest yield.

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Keywords: Dry bean arrangement, grain yield, intercropping, maize population

GROWTH AND YIELD RESPONSES OF TWO CHINESE CABBAGE CULTIVARS TO DIFFERENT LEVELS OF NITROGEN

PM Ramavahle¹, IK Mariga¹ and FR Kutu¹

¹University of Limpopo, School of Agricultural and Environmental Sciences, Private Bag X1106, Sovenga 0727

E-mail: patience0226@gmail.com

INTRODUCTION

Chinese cabbage, which is locally called mutshaina in Tshivenda, is a traditional vegetable grown by smallholder farmers in the north-eastern part of South Africa for both home consumption and selling. Little research has so far been conducted on this vegetable, particularly the local varieties (Tshikalange and Van Averbek, 2006). Information on fertilizer management in mutshaina is lacking. Nitrogen application is expected to influence growth of vegetable leaves. A trial was conducted to evaluate the growth and yield response of a local mutshaina variety (Dabadaba – *B. rapa*) and a commercial one (Florida broadleaf – *B. juncea*) to nitrogen fertilizer application.

MATERIALS AND METHODS

A trial was conducted at the University of Limpopo experimental farm (23°50'36.86"S and 29°40'54.99"E) during the winter season of 2012. The two mutshaina varieties and four levels of nitrogen (0, 14, 28 and 42 kg/ha), applied as Lime ammonium nitrate (28%N), were laid out in a factorial arrangement in a randomized complete block design with four blocks per treatment. Leaf length, leaf width, leaves per plant, and total leaf fresh and dry weight were measured, as well as time to flowering. Leaf nutritional status is still being evaluated.

RESULTS AND DISCUSSION

Dabadaba and Florida broadleaf flowered 42 and 81 days after transplanting, respectively. Florida broadleaf significantly ($P < 0.001$) outperformed Dabadaba in leaf length and width, and total leaf fresh weight, but they had similar leaf dry matter % and number of leaves per plant. Florida broadleaf and Dabadaba reached maximum leaf lengths of 76.4cm and 25.23 cm, respectively. Nitrogen level did not affect all the parameters measured. Variety by nitrogen level interaction was significant. Maximum fresh weight attained by Florida broadleaf with 14 and 28 kgN/ha (1874.2 and 1733.4 kg/ha, respectively) were significantly higher than for Dabadaba at all nitrogen levels.

CONCLUSION

Florida broadleaf outperformed Dabadaba in yield and its yield potential could further be improved by increasing its leaf size by N fertilization and increasing the duration to flowering. Both mutshaina cultivars have potential to perform well without nitrogen fertilizer on soils of moderate fertility.

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Keywords: Chinese cabbage, nitrogen, growth, yield

YIELD RESPONSES OF COMMERCIAL SUGARCANE CULTIVARS TO TRASHING IN DIFFERENT ENVIRONMENTS

S Ramburan¹ and N Nxumalo¹

¹SASRI, Private Bag X02, Mount Edgecombe 4300

E-mail: Sanesh.Ramburan@sugar.org.za

INTRODUCTION

Trashing in sugarcane agriculture involves retaining leaf residue on the ground after harvesting, thereby creating a surface mulch for the following ratoon crop. The benefits of trashing include improved soil moisture retention, soil health, and cane and sucrose yields. However, there have been isolated reports of negative responses of certain cultivars to trashing. The objective of this study was to evaluate the cane yield and quality responses of sugarcane cultivars to trashing in three production regions of South Africa.

MATERIALS AND METHODS

A field trial was established in each of the three major sugarcane production regions (North Coast, Irrigated North, Midlands) in 2008. Each trial comprised eight of the most popular cultivars for the respective regions. Trials were planted as 2 x 8 factorial strip-plots with four replicates, with burning vs. trashing as the main plot (strips) and cultivar as sub-plots. The trashed treatments involved retention of the dead and green leaf residue as a surface mulch for the following ratoon, while the burnt treatments involved complete removal of all residue through burning prior to harvest. The Coastal and Irrigated trials were harvested over three seasons (ratoons), while the Midlands trial was harvested for one ratoon. Cane yields (TCANE), estimated recoverable crystal percentage (ERC) and ERC yields (TERC) were determined at each harvest.

RESULTS AND DISCUSSION

Trashing significantly improved TCANE, ERC, and TERC of all cultivars in all three seasons on the Coast ($p < 0.001$). The TERC improvements due to trashing ranged from 16% for cultivar N35, to 44% for cultivar N47. In contrast, trashing had no significant effects on TCANE, ERC, and TERC of any cultivar in the Irrigated region. The TERC responses to trashing ranged from a 6.5% improvement for cultivar N43 to an 8% decline for cultivar N25. On average, however, there were no significant differences between the burn and trash treatments. In the Midlands trial, trashing significantly reduced TCANE, ERC, and TERC of most cultivars, except for N31, which showed a non-significant 9% improvement in TCANE ($p < 0.05$). The variability in responses to trashing due to differences in climatic conditions and management practices across the regions is discussed.

CONCLUSIONS

The practice of trashing is not beneficial in all regions of the industry. Trashing improved, reduced, and had no effect on yields in the Coastal, Midlands, and Irrigated regions, respectively. No significant crossover cultivar x trash interactions were observed for all three trials suggesting that the current commercial cultivars grown will show the same yield response to trashing within a particular region.

Keywords: Cultivar, sugarcane, trashing

PERFORMANCE OF STONE FRUIT IN A SUMMER RAINFALL AREA, SOUTH AFRICA

ML Ramphinwa¹, F Thovhogi¹, GRA Mchau¹ and E Reinten²

¹University of Venda, Department of Horticultural Sciences, Private bag X5050, Thohoyandou 0950; ²Agricultural Research Council (ARC) Infruitec-Nietvoorbij, P/Bag X5026, Stellenbosch 7599

E-mail: mmaanea@univen.ac.za

INTRODUCTION

Stone fruit production is a new initiative for improving incomes at household level among communities in the Limpopo Province. Being a temperate crop, this sub-tropical region provides a challenging climate for the cultivation even of low chilling cultivars. Delayed foliation has already been established as a problem for some cultivars grown commercially in other parts of South Africa.

OBJECTIVES

To evaluate and compare four quantitative growth and yield parameters, namely stem circumference, duration to first flowering, fruit diameter and total fruit mass (yield per tree).

MATERIALS AND METHODS

A field experiment was conducted during winter in 2009 and 2010. The experimental design was a completely randomized design with six trees (experimental units) randomly selected for each of the four stone fruit types i.e. plums, nectarine, apricot, and peaches ('Charisma', 'Summersun', 'Pioneer' and 'Mayglo' respectively). Growth measurements were recorded two days per week. Analysis of Variance was performed on all variables using the GLM (General Linear Model) procedure of SAS statistical software version 9.2 (SAS Institute Inc., Cary, NC, USA). Shapiro-Wilk Test was performed to test for normality (Shapiro, 1965).

RESULTS AND DISCUSSION

Flower bud opening in 2010 was earlier than in 2009 possibly because of a colder winter. During the 2009 winter, 'Mayglo' and 'Summersun' trees, but not 'Pioneer' and 'Charisma' flowered under subtropical condition but flowering was erratic. There appeared to be little negative effect of the climate.

CONCLUSIONS

Some of the stone fruits can grow well and produce quality fruits in terms of size and colour in Vhembe area in Limpopo Province.

ACKNOWLEDGEMENT

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Keywords: Bud break, chilling units, flowering, fruiting, stone fruits

ANTIFUNGAL AND ANTIOXIDANT PROPERTIES OF *Moringa oleifera* LAM. (Moringaceae) EXTRACTS FROM TREES GROWING IN PRETORIA, SOUTH AFRICA

N Ratshilivha^{1,4}, JN Eloff², ES du Toit¹, BM Petja⁴, JT Vahrmeijer¹ and DM Awouafack^{2,3}

¹Department of Plant Production and Soil Science, University of Pretoria, Pretoria 0002;

²Phytomedicine Programme, Department of Paraclinical Sciences, University of Pretoria, Private Bag X04, Onderstepoort 0110; ³Laboratory of Natural Products Chemistry, Department of Chemistry, P.O. Box 67, Dschang, Cameroon; ⁴Limpopo Department of Agriculture; Private Bag X9487, Polokwane 0700

E-mail: nmudziwa@webmail.co.za

INTRODUCTION

Moringa oleifera Lam. is a member of the Moringaceae family and is also commonly known as the Horseradish tree. The tree, originally from India, is currently widely spread throughout the tropical regions of Africa and Asia. *M. oleifera* is a rich source of natural antioxidants and has medicinally and nutritionally valuable compounds, providing protection against some degenerative diseases, including cancer and coronary heart disease. The aim of this study was to investigate the antimicrobial and antioxidant properties of *M. oleifera* leaves from different trees (six vegetative trees versus six with both leaves and pods) grown under the relatively harsh cold winter conditions of Pretoria, South Africa.

MATERIALS AND METHODS

The leaves of 12 *M. oleifera* trees (six with pods and six without) were collected from the University of Pretoria Experimental farm (25°45'S, 28°16'E) in August 2012. Microdilution and DPPH free radical scavenging methods were used to determine the antifungal and antioxidant activities of the acetone extract of the leaves respectively.

RESULTS AND DISCUSSION.

The antifungal activity of the acetone extract of *M. oleifera* leaves was determined against *Candida albicans* (isolate), *C. albicans* (ATCC), *Aspergillus fumigatus* and *Cryptococcus neoformans*. Results revealed that *M. oleifera* leaf extracts had weak antioxidant activity but, to some extent, inhibited growth of all fungi tested. The results demonstrate moderate antifungal activity and average Minimum Inhibitory Concentration (MIC) values, of which the most active were 0.86 (L40), 0.79 (L1 and L29), and 0.94 mg/ml (L41, L17 and L3). A lower total activity of 7.07 ml/g was obtained for LP38 against *A. fumigatus* while L29 had the highest value of 97.54 ml/g against *C. albicans* (ATCC). Samples L40 and LP38 had higher antioxidant activity with IC₅₀ of 3.24 and 3.13 mg/ml respectively, whereas others were weakly active with IC₅₀ values between 4.10 – 140.89 mg/ml compared to the positive control of ascorbic acid (IC₅₀ of 1.00 mg/ml).

CONCLUSION

M. oleifera leaf extracts had a moderate to weak antioxidant activity and showed moderate inhibition on the growth of all fungi tested. The significant variation in the antioxidant activity of these samples could possibly be justified by the observed differences in the physical aspects of the different *M. oleifera* trees investigated. This might be associated with the presence of polyphenolic compounds as a protective measure against damage during the time of collection (winter). Further investigation on the same samples collected during the summer is in process.

ACKNOWLEDGEMENT

Funding was provided by the Limpopo Department of Agriculture of South Africa. UP Technicians at the Hatfield Experimental farm for their support during the collection of plant materials.

Keywords: *Moringa oleifera*; leaves; acetone extract; antifungal; antioxidant.

EFFECT OF 1-METHYLCYCLOPROPENE, STORAGE PERIOD AND STORAGE TEMPERATURE ON THE RIPENING AND QUALITY OF "HASS" AVOCADO FRUIT

NJR Roets¹ and FJ Kruger¹

¹*Agricultural Research Council - Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200*

E-mail: nico@arc.agric.za

INTRODUCTION

The ethylene inhibitor, 1-methylcyclopropene (1-MCP), is used to delay ripening and retain the quality of avocado fruit during export. However, certain service providers who ripen the fruit for retail chains report from time to time that the fruit do not soften in a synchronized way when artificially ripened. The aim of the present study was to determine the effects and characterize the interactions between 1-MCP, storage period and storage temperature in so far as the ripening/internal quality of 'Hass' avocado fruit is concerned.

MATERIALS AND METHODS

The factorially designed trial consisted of, respectively, two 1-MCP rates (0 and 300 ppb); three cold storage temperature regimes (5.5°, 7.0° and 7.0° reduced to 4.5°C during the last three days of cold storage) and four cold storage periods (15, 20, 25 and 30 days). After cold storage the fruit were ripened at 20°C and evaluated for the mean number of days to ripen (DTR) and the incidences of diffuse mesocarp discolouration (DMD) and post-harvest fungal infections. The data was analysed using analysis of variance (ripening) and the χ^2 -test (internal quality data) with significant differences between treatments being determined at $P = 0.05$.

RESULTS AND DISCUSSION

The storage period had a significant effect on the mean DTR with a general decrease as the storage period increased. A 1-MCP treatment was found to significantly delay ripening compared to the control for up to 25 days of storage. After this, the effect that the treatment had on the DTR waned. Storage temperature had no significant effect on the mean DTR. For the shorter cold storage periods the incidence of DMD was low. 1-MCP significantly reduced the development of DMD during the longer storage periods. Storage temperature did not affect the DMD incidence.

Delayed ripening by 1-MCP tended to increase the incidence of post-harvest fungal infections for the 15 to 25 days cold storage treatments. However, after 30 days of storage, the fungal infection rate tended to be higher in the control fruit compared to the 1-MCP treated fruit. The effect of storage temperature on fungal infection rate was non-significant.

CONCLUSION

From the results it is evident that the cold storage period has the most significant effect on the ripening and quality of 1-MCP treated fruit. It is recommended that commercially treated 1-MCP fruit be stored for 30 days before being artificially ripened.

Keywords: Avocado, diffuse mesocarp discolouration, fungal infections, 1-methylcyclopropene, ripening

WATER STRESS EFFECTS ON GROWTH AND YIELD OF SUGARCANE

R Rossler¹, A Singels¹, FC Olivier¹ and JM Steyn²

¹South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa; ²Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

E-mail: ryan.rossler@sugar.org.za

INTRODUCTION

Irrigation water in the Mpumalanga Lowveld is often limited necessitating the prioritization of available water to different fields on a farm to maximize economic return. This requires knowledge about how water stress at different phases of crop development affects yields. The objective of this study was to gain some of this knowledge by measuring a sugarcane crop's response to deficit irrigation applied during different development phases.

MATERIALS AND METHODS

Cultivar N49 was planted in November 2011 at Komatipoort, South Africa. The drip irrigated trial was a completely randomized block design comprising of four water treatments (5 replicates each), a well-watered control (WW) and water stress applied (1) through the tillering phase only (T), (2) through the stalk elongation phase only (SE), and (3) through both T and SE phases (T+SE). Water stress was imposed by maintaining available soil water (ASW) between 30 and 60% of capacity (ASWC), while ASW was maintained above 60% of ASWC for unstressed treatments and during phases where stresses were not imposed. Stalk elongation, stalk population, leaf number, leaf water potential (ψ_L), soil water potential (ψ_s), and soil water content were measured non-destructively on a regular basis. Destructive biomass samples were taken at the start of the stalk elongation phase and after 11 months at harvest.

RESULTS AND DISCUSSION

The WW and T treatments received 1142 and 985 mm of irrigation respectively and experienced few days with stress, while ψ_s fluctuated between -5 and -40 kPa. The SE and T+SE treatments received much less irrigation (809 and 633 mm respectively) and endured 92 and 126 days of water stress respectively, while ψ_s fluctuated between -10 and -80 kPa. No significant differences in stalk population, height, leaf number or ψ_L were found between stressed and unstressed treatments at the end of the tillering or stalk elongation phase. Stalk elongation rate was highly sensitive to water stress, agreeing with the findings of Inman-Bamber (1995). However recovery was rapid after irrigations, allowing stressed plants to maintain average growth rates similar to unstressed plants. This rapid recovery explains why final cane and sucrose yield did not differ significantly between treatments.

CONCLUSIONS

Results suggest that sugarcane can achieve reasonable economic yields (93% of the potential) with deficit irrigation during the stalk elongation phase provided the stress periods are short (<5 days) and mild ($\psi_s > -80$ kPa). Applicability of these findings for other cultivars, soils and climates needs to be confirmed.

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ACKNOWLEDGEMENTS

Funding from SASRI and assistance from the SASRI technical team are gratefully acknowledged

Keywords: cane yield, deficit irrigation, stalk elongation rate, water stress, soil water potential

WEB-BASED SYSTEM FOR NEAR REAL-TIME AGROMETEOROLOGICAL APPLICATIONS

MJ Savage¹, MG Abraha¹, NC Moyo¹ and ENS Babikir¹

¹*University of KwaZulu-Natal, P/Bag X01, Scottsville 3209*

E-mail: savage@ukzn.ac.za

INTRODUCTION

A web-based teaching, learning and research system was developed for near real-time agrometeorological and environmental applications. The system displays data encompassing agricultural and environmental sciences in the form of tables and graphs. The data were obtained from field-based measurement systems including automatic weather station (AWS) with additional radiation sensors (including diffuse), and infrared thermometry (IRT). Reference evapotranspiration (ET_o), energy balance and radiation balance were calculated, while carbon dioxide and water vapour concentrations were also displayed. The main objectives were to present the system details and to use it for various near real-time teaching and research applications in agrometeorology: 1. estimation of leaf wetness duration (LWD) above a short-grass surface; 2. estimation of frost duration; 3. early-prediction of surface, grass and air temperature minima based on sub-daily pre-dawn measurements; 4. surface energy balance using surface renewal, temperature variance and dissipation theory; 5. measurement of forestry nursery microclimate, and control.

MATERIAL AND METHODS

The main station, four inter-connected datalogger stations and two towers formed the basis for the system and was setup at the Agrometeorology site in Pietermaritzburg, KwaZulu-Natal. Shortened surface energy balance components were measured in near real-time using surface renewal (SR), temperature variance (TV), and surface renewal-dissipation theory (SRDT) methods. For SR, a real-time iterative procedure was used. Radiation balance was measured using a four-component net radiometer. Dielectric leaf wetness sensors (LWS) and a grass minimum thermometer were used for frost and LWD.

RESULTS AND DISCUSSION

Measurements, including air temperature profile, water vapour and carbon dioxide concentrations, frost duration, LWD, nursery conditions, and soil water content were displayed in various information screens (<http://agromet.ukzn.ac.za:5255>). The LWS method was consistent in determining LWD. The LWS method for determining frost was problematic, while the grass- and/or IRT-temperature methods proved more desirable for frost duration.

CONCLUSIONS

To increase the value of AWS measurements, AWS systems should include grass temperature for frost determination and possibly also to estimated LWD if relative humidity measurements are available. Furthermore, timeous email and SMS alerts with near real-time data and graphics of LWD for the current day, week and month displayed on the Internet, as used in this investigation, would considerably enhance the data product. The web-based system is useful for demonstrating, to under- and postgraduates, different agrometeorological and environmental applications.

ACKNOWLEDGEMENTS

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Keywords: Near real-time data and information system

TEACHING IN HORTICULTURAL SCIENCE

M Schmeisser¹

¹*Univ. Stellenbosch. Dep. of Horticultural Science, Private Bag X1, Matieland 7602*

E-mail: schmeisser@sun.ac.za

“The future has already arrived. It’s just not evenly distributed yet.” William Gibson

In the era of the digital world, it is becoming increasingly evident that we as educators need to change, adapt and almost revolutionise our teaching strategies, to successfully address changes in how students learn, as well as to ensure that students possess the skills deemed necessary for the 21st century. Be that as it may, in addition to the more familiar skills of being able to communicate clearly, find, digest and integrate information, show critical thinking and solving problems, work collaboratively with others, make judgements and decisions etc., there appears to be an ever increasing weight placed on information, media and technological skills. Therefore in addition, our 21st century student should possess new skills that were not deemed crucial before, at least not to the current degree. These include computer literacy, having a command of the internet and other digital communicative skills. We, as teachers, have at least some obligation to instill these skills in our students.

This presentation attempts to answer questions commonly asked by lecturers, such as: what is e-learning; what e-tools are available and is it at all sensible to incorporate e-learning into the horticultural lecturing environment?

Keywords: teaching, e-learning, students

COMPARISON OF LEAF CUTICLE THICKNESS OF SOME CITRUS CULTIVARS

SM Scholly¹, PJ Robbertse¹, CF Van der Merwe¹ and JT Vahrmeijer²

¹University of Pretoria, Private Bag x20, Hatfield, Pretoria, 0028, RSA; ²University of Pretoria, Private Bag x20, Hatfield, Pretoria, 0028, RSA; Citrus Research International, PO Box 28, Nelspruit 1200, RSA

E-mail: u04409655@tuks.co.za

INTRODUCTION

Plant species, organ types and developmental stages of the plant organ may result in differences in cuticle ultrastructure that influences the absorption of foliar applied chemicals. Emerging organs may have a procuticle and the formation of the mature cuticle may be completed during or at the ceasing of tissue expansion (Kannan, 2010). This study focuses on comparing leaf cuticles of the following citrus cultivars: lemon, grapefruit, mandarin, navel and Valencia.

MATERIALS AND METHODS

Young and mature leaf samples were collected from different citrus cultivars. Leaf segments were prepared for SEM imaging according to the method as described by Bondada *et al.* (2006), but finally coated with carbon instead of gold.

RESULTS AND DISCUSSION

All leaves were hypostomatic with indents on the adaxial surface indicating the presence of oil glands.

Cuticle Measurements

	Abaxial Cuticle		Adaxial Cuticle	
	Thinnest	Thickest	Thinnest	Thickest
Young leaves	Washington Navel	Satsuma Mandarin & Midnight Valencia	Washington Navel	Satsuma Mandarin & Baianinha Navel
Mature leaves	Satsuma Mandarin	Midnight Valencia & Baianinha Navel	Baianinha Navel & Genoa Lemon	Satsuma Mandarin & Star Ruby

CONCLUSIONS

Washington navel had the thinnest cuticle of the young leaves and Satsuma the thickest in all but the abaxial cuticle measurements. The abaxial cuticle of Midnight Valencia was thickest in both the young and mature leaves. Abaxial cuticle measurements of young leaves ranged from $\pm 430\text{nm}$ to $\pm 2290\text{nm}$ thick, and for mature leaves, ± 1300 to $\pm 2250\text{nm}$. For adaxial cuticles, ranges were $\pm 460\text{-}2170\text{nm}$ (young leaves) and $\pm 1630\text{-}2490\text{nm}$ (mature leaves).

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ACKNOWLEDGEMENTS

CRI and Zinchem for funding.

Keywords: Citrus, leaf cuticles, foliar spraying, SEM

EFFECT OF WORM-BED LEACHATE AND MINERAL NUTRIENT SOLUTION APPLICATION ON GROWTH AND NUTRIENT CONTENT OF *Amaranthus tricolor*

KA Seetseng¹ and CP du Plooy¹

¹Agricultural Research Council-Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria 0001

E-mail: kseetseng@arc.agric.za

INTRODUCTION

The nutrient content in plants fluctuates according to the stage of development and the demand within plant tissues. Plants need to be supplemented with nutrients for optimum growth and yield. It has been reported that daily application of worm-bed leachate (WBL) increased stem diameter and results in the broadening of leaves of tomatoes (Zaller, 2006), thus indicating that WBL can be a potential source of nutrients to plants. A pot trial experiment was established in a glasshouse at the ARC-VOPI, Roodeplaat, South Africa to determine the effect of mineral nutrient solution and WBL (vermiculture) application on growth, yield and mineral content of *Amaranthus tricolor*.

MATERIALS AND METHODS

The experiment was arranged in a randomized complete block design (RCBD) with the following three irrigation treatments: DIW (de-ionized water), MNS (complete mineral nutrient solution – Hoagland solution) and WBL, replicated four times. WBL was collected from vermicompost (kraal manure, grass and lettuce). The chemical composition of the leachate was analysed before usage. Seedlings of *A. tricolor* were established in river sand and irrigated at 100 ml MNS per day for the first two weeks after planting. As from the third week, plants were irrigated, starting with 100 ml of DIW, MNS and WBL applications, respectively, per day. As plant growth progressed, the irrigation applications increased to 200 ml per day (week 6 onwards). Two weeks after commencement of treatments, data collection commenced. Plant height, leaf number, leaf fresh mass and dry mass were recorded bi-weekly. Levels of N, P, K, Ca and Mg were only determined once in plant leaves harvested at the peak of the season (week 8 after transplanting). At the end of the season (week 12), the plants were uprooted to measure plant height, number of leaves, number of branches, root development and total dry mass.

RESULTS AND DISCUSSION

The results showed a linear increase in all measured parameters for both the MNS and WBL treatments until week 8, after which biomass and leaf number started to decline. The MNS treatment resulted in significant increases for all yield parameters, in comparison to the other two treatments. All parameters for the WBL treatment were also significantly better than the DIW treatment. The MNS and WBL treatments resulted in significantly higher N and K content of the leaves, respectively, as compared to the DIW treatment.

CONCLUSION

This study revealed that WBL application significantly increases yield parameters, as well as N and K content of *A. tricolor*, compared to DIW, and can thus be utilised as a nutrient supplement. MNS, however, gave the best results in terms of yield parameters. Results will be confirmed with additional studies.

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Keywords: *Amaranthus tricolor*, nutrient solution, worm-bed leachate

TOWARDS GUAVA WILT DISEASE RESISTANCE IN SOUTH AFRICA

AA Severn-Ellis¹, MH Schoeman¹, S Willemse¹, AD Sippel¹, J Rees², M de Castro² and J Featherstone²

¹ARC-ITSC, P/Bag X11208, Nelspruit 1200, South Africa; ²ARC Biotechnology Platform, 100 Old Soutpan Road, Onderstepoort 0110, South Africa

E-mail: anitas@arc.agric.za

INTRODUCTION

The outbreak of Guava wilt disease (GWD) in the 80's resulted in devastating losses of more than half of the guava industry in the northern and eastern regions of South Africa. A resistant guava selection (TS-G2) was developed by the ARC-ITSC. This cultivar was successfully used to replace many of the production areas affected by GWD. In 2009 a second outbreak of GWD occurred, which in turn also affected the tolerant TS-G2. Control of the disease has been hampered by a limited understanding of the genetic and biochemical basis of pathogenicity, including mechanisms of infection and host resistance. Host resistance remains the most logical choice for control as alternatives are not available. The lack of known sources of plant resistance and additional pathogen races are obstacles in the development of GWD-resistant selections. Studies currently undertaken at the ARC-ITSC are aiming at providing some insight into the Guava wilt disease complex.

MATERIALS AND METHODS

The guava wilt pathogen was isolated from diseased guava trees from different areas affected by renewed outbreaks of GWD. Additional isolates were obtained from Forestry and Agricultural Biotechnology Institute, University of Pretoria (FABI). DNA was extracted using the Qiagen DNeasy Plant kit. PCR amplification and sequencing of the internal transcribed spacer region and 5.8S rDNA (ITS) and the partial nuclear large subunit ribosomal DNA (LSU) was carried out.

Next Generation Sequencing libraries were prepared from 50ng genomic DNA from *Nalanthamala* isolates. The DNA was simultaneously fragmented and tagged with sequencing adapters according to the Nextera DNA Sample Preparation Kit. The libraries were sequenced on an Illumina HiScanSQ using version 3 reagents for cluster generation and sequencing. Illumina version 1.5.15.1 software was used for image acquisition and base calling. CLC Genomics Workbench version 5.1 was used for de novo assembly. Genomic contigs were screened for the presence of single sequence repeats (SSR) and primer sites were identified using BatchPrimer3.

RESULTS AND DISCUSSION

Fungal ribosomal DNA regions of the large sub-unit (LSU) and internal transcribed spacer (ITS) sequences of the new *N. psidii* strains were found to be identical to the *N. psidii* reference strain (CBS 439.89) previously isolated in South Africa.

De novo assembly of *N. psidii* reads rendered 9 396 contigs with an average length of 3834bp and 20-fold coverage. After mitochondrial hits were removed, 5966 genomic contigs contained SSRs. A total of 15 645 SSRs with suitable sites for primer design were identified.

CONCLUSION

Exact pathogen species diagnosis is an important precursor to the development of guava cultivars with resistance to guava wilt disease. Pathogen strains isolated from newly infected 'TS-G2' trees were all positively identified as *N. psidii*. Although species diagnosis was possible using the single copy regions, it was not possible to show geographic distribution nor determine pathogenicity relationships.

ACKNOWLEDGEMENTS

THRIP and the Mpumalanga and Northern Guava Growers for funding and support received. The ARC Biotechnology Platform for the NGS of the guava and *N. psidii* genomes.

Keywords: Guava, wilt disease, *Nalanthamala*, sequencing

ASSESSMENT OF GENETIC DIVERSITY IN COWPEA [*Vigna unguiculata* (L.) Walp.] GERMPLASM USING PHENOTYPIC MARKERS IN SOUTH AFRICA

A Shegro¹, WS Jansen van Rensburg¹, SM Laurie¹, PO Adebola¹

¹Agricultural Research Council – Vegetable and Ornamental Plant Institute (ARC-VOPI),
Private Bag X293, Pretoria 0001, South Africa

E-mail: agerrano@arc.agric.za

INTRODUCTION

Information on the nature and degree of genetic diversity would help the plant breeder in choosing the best genotype as a parent for hybridization (Souza, 1991). The overall effect of plant breeding on genetic diversity has been a long standing concern in the evolutionary biology of crop plants (Simmonds, 1962). The yield potential of underutilized vegetables like cowpeas has not yet been fully exploited. Therefore, it is important to characterize and evaluate the existing cowpea germplasm in order to select superior genotypes for the traits of preference for further breeding programme. This is a critically and important step in a breeding programme. Therefore, the objectives(s) of the current study was to assess the extent of genetic diversity among the cowpea genotypes using phenotypic markers.

MATERIALS AND METHODS

Field experiment was conducted at Roodeplaat research farm of the Agricultural Research Council-Vegetable and Ornamental Plant Institute (ARC-VOPI) in 2011-2012 summer cropping season (latitude 17° 49'S, longitude 31° 04'E). The genotypes were evaluated in field that were laid out in a randomized complete block design with three replications. Data was analysed for ANOVA and correlation using Agrobase Generation II (2008). Data was also subjected to Principal component and cluster analyses using the Number Cruncher Statistical System (NCSS, 2004).

RESULTS AND DISCUSSION

The analysis of variance revealed high significant ($p=0.01$) differences among the genotypes studied for all phenotypic traits indicating high genetic diversity among the 25 cowpea genotypes. The Pearson correlation coefficient of vegetative growth, yield and yield related traits showed that there were significant ($P=0.01$) correlation among some of phenotypic traits. Genetic distances from 0.78 to 1.56 were observed in the pair-wise combinations, indicating that the cowpea genotypes were diverse for the phenotypic traits measured.

CONCLUSION

Characterisation of germplasm accessions and clustering them on the basis of their phenotypic traits and genetic similarity will help in identification and selection of the best cowpea parents for future breeding programme. Therefore, the grouping of genotypes by multivariate methods of analysis based on their similarity in the present study would be valuable for cowpea breeders in that the most important genotypes in the population may be selected from different clusters for improvement programmes in South Africa.

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Keywords: Cowpea, Genetic diversity, Phenotype, Principal component analysis

EFFECT OF ORGANIC FERTILIZER APPLICATION ON THE COOKING PROPERTIES OF IMPROVED UPLAND RICE VARIETIES

TA Shittu¹, ST Lawal¹, AA Oyekanmi², KA Okeleye², D Sivakumar³ and P Soundy³

¹Department of Food Science and Technology, Federal University of Agriculture, Abeokuta 110001, Nigeria

²Department of Plant Physiology and Crop Production, Federal University of Agriculture, Abeokuta 110001, Nigeria

³Department of Crop Sciences, Tshwane University of Technology, Pretoria 0001, South Africa

E-mail: taofiks159@gmail.com or shittuta@funaab.edu.ng

INTRODUCTION

The NERICA is the group name of the inter-specific rice varieties developed by the Africa Rice Center (WARDA) derived from crosses between the Asian rice, *Oryza sativa* and the African rice *O. glaberrima* combining the high yielding trait of the former with stress resistance of the latter. Many scientists have worked on rice to improve its yield and developed technology to boost rice production. Previously, the physical and water absorption properties of some of the new rice cultivars have been studied (Shittu et al., 2012). The objective of this study was to determine the effect of variety and organic manure on the cooking and sensory properties of improved upland rice. This could assist in their wider adoption and consumer acceptability.

MATERIALS AND METHODS

Paddy rice from three NERICA cultivars (NERICA 1, NERICA 2 and ITA 150) were grown at the organic farm plot Federal University of Agriculture, Abeokuta. Three different organic manures namely, cow dung (CD), swine faeces (SF), and poultry droppings (PD) at 0-90 kg/ha dosages were applied. Brown rice was produced from each harvested cultivar following the local rice processing procedure. The cooking properties tested include cooking time (CT) (min), water uptake capacity (WUC (mL/g), cooking solid loss (SL) (g/mL), pH and turbidity of residual cooking water. Sensory attributes of the cooked rice samples were conducted using quantitative descriptive analysis and general acceptability test.

RESULTS AND DISCUSSION

Insignificant differences were observed in the CT, pH of cooked water and WUC among the rice samples regardless of the cultivar, manure type and dosage level. However, increment of PD and CD from 45 to 90 kg/ha caused significant increase in SL of ITA 150. Similar increased dosage of CD caused increased turbidity in NERICA 2 ($p < 0.05$). A significant positive correlation was observed between CT and WUC. Cooked forms of NERICA 1 and ITA 150 grown with manure application had significantly lower acceptability than the control. The effect of manure type and dosage was most pronounced on the whiteness, glossiness and aroma of the cooked rice samples. ITA 150 cultivated with 90 kg/ha of poultry dropping was the most acceptable in cooked form.

CONCLUSIONS

The descriptive sensory properties of cooked rice samples were more affected than the physicochemical properties as a result of different organic manure application.

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Keywords: Africa Rice Center (WARDA), *Oryza sativa*, *Oryza glaberrima*

FOOD VALUE OF *Sesamum radiatum* - AN UNCULTIVATED TROPICAL LEAFY VEGETABLE

TA Shittu^{1,3}, TS Oladele¹, AW Salau², D Sivakumar³ and P Soundy³

¹Department of Food Science and Technology, Federal University of Agriculture, Abeokuta 110001, Nigeria

²Department of Horticulture, Federal University of Agriculture, Abeokuta 110001, Nigeria

³Department of Crop Sciences, Tshwane University of Technology, Pretoria 0001, South Africa

E-mail: shittuta@funaab.edu.ng or staofeek0904@yahoo.com

INTRODUCTION

Sesamum radiatum is found mostly as either wild species in the middle belt and Northern part of Nigeria as well as in the dry regions of West Africa. It is called *karkashi* and *morogbo* among the Hausa and Yoruba people of Nigeria, respectively. The leaves may be dried and ground to powder for use in sauces or cooked freshly with condiments and consumed as soup. The soup's sliminess makes it a good accompaniment with swallowed staples. The plant also has several medicinal uses (Dansi *et al.*, 2012). However, data on the food values of *S. radiatum* is scarce. Hence, this study compares the nutrient composition and sensorial quality of *S. radiatum* as draw soup vegetable with that of *Corchorus olitorius*, which is a well acceptable draw soup vegetable worldwide.

MATERIALS AND METHODS

Freshly harvested samples of *Sesamum radiatum* (*Morogbo*) and *Corchorus olitorius* (*Ewedu*) were analyzed for the moisture, ash, crude fat, crude fiber, crude protein, total carbohydrate, phosphate, mineral content and selected anti-nutritional factors. Sensory acceptability of draw soup from the two vegetables was compared using a 20 member panelist group. Mean values of *S. radiatum* and *C. olitorius* composition and sensory attributes (appearance, taste, aroma, drawiness and overall acceptability) of the draw soups were compared using paired sample T-test performed with SPSS 12.0 statistical package.

RESULTS AND DISCUSSION

All the chemical compositions of the two leafy vegetables were significantly different ($p < 0.05$) except for crude fat and fiber content. The ascorbate, phosphate, calcium, iron, magnesium and crude protein contents of *S. radiatum* were significantly higher than that of *C. olitorius*. However, *S. radiatum* had higher phytate and tannin than *C. olitorius*. Sensory evaluation of their draw soups showed that both vegetable have similar drawiness. The lower preferences of the other sensory attributes of *S. radiatum* soup may imply that separate culinary steps could be devised to improve on its eating quality.

CONCLUSION

Further studies are required to determine the detailed micronutrient and phytochemical composition, processing and storage stability of *S. radiatum*.

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Keywords: Sensory acceptability, *Sesamum radiatum*, Underutilized leafy vegetable

THE EFFECT OF METHYL JASMONATE AND SALICYLIC ACID ON THE SUPPRESSION OF REACTIVE OXYGEN SPECIES PRODUCTION AND INCREASE IN CHILLING TOLERANCE ON “EUREKA” LEMONS

XI Siboz¹ and I Bertling¹

¹*Horticultural Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa*

E-mail: BertlingI@ukzn.ac.za

INTRODUCTION

Certain markets have phytosanitary requirements which stipulate exposing lemons to temperatures below 0°C during exportation. This exposure can result in development of chilling injury (CI), primarily caused by accumulation of reactive oxygen species (ROS). Methyl jasmonate (MJ) and salicylic acid (SA) have shown potential in this regard (Siboz et al. 2012). However, their role in how CI is reduced required investigation.

MATERIALS AND METHODS

Lemon fruit were dipped into various MJ and SA solutions as described by Siboz et al. (2012). Fruit were waxed with Citrashine® and stored at -0.5°C. Fruit were weekly removed from cold storage up to 42 days and transferred to room temperature for seven days to simulate shelf life. The development of CI symptoms on the lemon fruit rind was evaluated. Changes in levels of the rind ROS concentration and membrane lipid peroxidation were examined.

RESULTS AND DISCUSSION

Occurrence of CI symptoms increased sharply after 14 days of storage. Treatment with MJ and SA significantly ($P = 0.05$) reduced and delayed CI symptoms. However, the effect of MJ and SA was concentration-dependent. Treatment with 10 µM MJ + 2 mM SA was most effective in reducing as well as delaying CI symptoms on fruit. Treatment with either MJ and / or SA enhanced the total antioxidant capacity (TAC) of the lemon rind. The increase in TAC enhanced cell membrane stability and protected cells from possible ROS damage. Treatments with 10 µM MJ, 2 mM SA as well as with 10 µM MJ + 2 mM SA significantly ($P = 0.05$) suppressed ROS accumulation and reduced membrane lipid peroxidation, thus, reducing the CI index during extended cold storage.

CONCLUSION

Applications of MJ and / or SA should be further investigated as tools to reduce CI in lemons.

ACKNOWLEDGEMENTS

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Keywords: Chilling injury, lipid peroxidation, methyl jasmonate, reactive oxygen species, salicylic acid, total antioxidant capacity

SALICYLIC ACID AND METHYL JASMONATE INDUCE PHENOLIC COMPOUNDS AND PHENYLALANINE AMMONIA-LYASE WHILE INHIBITING PEROXIDASE AND POLYPHENOL OXIDASE TO IMPROVE CHILLING TOLERANCE IN COLD STORED LEMONS

XI Siboya¹, I Bertling¹ and AO Odindo¹

¹Horticultural Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa

E-mail: xisiboya@gmail.com

INTRODUCTION

Chilling injury (CI) may result from the degradation of membrane integrity which can be attributed to phenolic oxidation, activated by polyphenol oxidase (PPO) and peroxidase (POD) - enzymes responsible for tissue browning. Phenolics are anti-oxidant compounds associated with chilling tolerance in lemons; they are implicated in the maintenance of cell membrane integrity and act by scavenging reactive oxygen species (González-Aguilar *et al.*, 2004, Ali *et al.*, 2007). Phenylalanine ammonia-lyase (PAL) is an enzyme that is also reported to be involved in cellular defence mechanisms and acclimation against chilling stress (Martínez-Téllez & Lafuente, 1993). Increase in PAL activity in citrus during cold storage could therefore be important for enhancing CI resistance (Lafuente *et al.*, 2004). It was hypothesised that treatment with methyl jasmonate (MJ) and salicylic acid (SA) may enhance chilling tolerance in lemons by inducing the synthesis of total phenolics and PAL while at the same time inhibiting the production of POD and PPO.

MATERIALS AND METHODS

Lemons were collected from three locations characterised by temperature (warm, cool or cold). Fruit were treated with 10 µM MJ or 2 mM SA or the combination of the two. Thereafter, fruit were stored at -0.5, 2 or 4.5°C for four weeks and subsequently transferred to room temperature for a week (shelf-life). Evaluation of CI was performed at the end of cold storage and after shelf-life with sampling intervals of 0, 1, 2, 3, and 4 weeks. Lemons were also evaluated for total phenolic content, changes in PAL, POD and PPO activities after shelf life.

RESULTS AND DISCUSSION

Farm location, storage temperature and duration significantly ($P = 0.05$) affected CI symptoms. Chilling damage was severe on untreated lemons but lower on lemons stored at -0.5°C than at 2°C or 4.5°C. Lemons from the warm region were more chilling-tolerant than those from the coolest region. Treatment with 10 µM MJ plus 2 mM SA significantly ($P = 0.05$) reduced CI and increased total phenolics and PAL activity. The induction of these compounds is possibly part of a protection mechanism triggered by MJ and/or SA. Treatment with 10 µM MJ plus 2 mM SA significantly ($P = 0.05$) inhibited POD activity which might have contributed to delaying manifestation of symptoms. Polyphenol oxidase (PPO) was found to not be a good biochemical marker of CI.

CONCLUSIONS

The combination of 10 µM MJ plus 2 mM SA was effective in enhancing chilling tolerance possibly as a result of increased production of total phenolics and PAL activity. Furthermore, the results suggest that MJ and SA may inhibit the production of POD and PAL activities. This may have reduced the incidence of CI symptoms observed in the lemon fruit. Therefore, treatment with 10 µM MJ plus 2 mM SA could be commercially used to alleviate CI symptoms in lemons and enhance chilling tolerance.

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ACKNOWLEDGEMENTS

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Keywords: methyl jasmonate, peroxidase, phenylalanine ammonia-lyase, salicylic acid, total phenolics

RESPONSES OF A BAMBARA GROUNDNUT (*Vigna subterranea* L. Verdc) LANDRACE TO SEED PRIMING AND WATER STRESS

F Sinefu^{1,2}, AT Modi¹ and T Mabhaudhi¹

¹Crop Science, School of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg 3209, South Africa; ²Agricultural Research Council, Small Grain Institute, Bethlehem

E-mail: Fikiles.20@gmail.com

INTRODUCTION

Unpredictable yields of bambara groundnut (*Vigna subterranea* L. Verdc) under rainfed conditions have been attributed, but not exclusively limited, to variable or poor field stand due to poor seedling establishment (Linnemann & Azam-Ali, 1993). Previous research by Mabhaudhi and Modi (2011) on maize landraces reported that under such circumstances hydro-priming could improve germination speed, vigour and emergence. This study investigated the effects of priming bambara groundnut landrace seeds on germination and subsequent crop growth under water stress conditions.

MATERIALS AND METHODS

Seeds were collected from subsistence farmers in Jozini, KwaZulu-Natal, and sorted into three distinct colours: red, white and brown. Experiment was conducted at the University of KwaZulu-Natal's Controlled Environment Research Unit (CERU), Pietermaritzburg. Salt concentrates, were prepared and 50 seeds of each colour were suspended over each of the three salt concentrates (NaCl, LiCl, and KNO₃) and distilled water and sealed in a container and stored in a germination chamber at 20°C for 8 hours. The control treatment consisted of dry (unprimed) seeds. After 8 hours, 30 seeds of each colour were sampled and used to evaluate seedling establishment in seedling trays for 22 days. Seedlings were later transplanted to 90 pots to evaluate growth responses of bambara groundnut to water stress (25&75% Field Capacity). Weekly measurements of plant height, leaf number and yield components were determined in a completely randomised experimental design replicated thrice. Data were analysed using GenStat® Version 14 to separate means at a significant level of difference being $P = 0.05$.

RESULTS AND DISCUSSION

There was a significant interaction ($P < 0.05$) between seed colour, priming and final seedling emergence. Seeds primed with NaCl and KNO₃ resulted in tall plants (19.63% and 5.84%) with the highest number of leaves (15.49% and 8.57%) per plant, respectively. There was a significant interaction ($P < 0.05$) between seed colour, priming and water regimes for plant height, leaf number and pod yield. However, seedlings produced from seeds primed with NaCl and KNO₃ were most affected by water stress conditions.

CONCLUSIONS

Priming was shown to improve germination and early crop establishment of bambara groundnut landraces. However, yield per plant did not improve in response to priming when subjected to water stress.

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Keywords: Bambara groundnut, priming, water stress

POTENTIAL USE OF VERMICOMPOST AS MEDIUM AMENDMENT FOR SWISS CHARD (*Beta vulgaris*) SEEDLING PRODUCTION

NL Skenjana¹ and BP Kubheka¹

¹Döhne Agricultural Development Institute, Stutterheim

E-mail: leo_mlanj@yahoo.com

INTRODUCTION

Resource poor farmers struggle to raise vegetable seedlings as they often cannot afford commercial growing media. They grow seedlings on soils, which in some parts of the province have been reported to be unsuitable for vegetable seedling production (Mhlontlo *et al.*, 2009). Vermicompost is reported to have great potential as medium for plant growth (Arancon *et al.*, 2002). The study therefore sought to determine whether, Swiss chard (*Beta vulgaris*) can grow on Hygrotech growing medium amended with varying quantities of vermicompost.

MATERIALS AND METHODS

Experiment was arranged in a complete randomized blocked design with the following treatments: control (Hygrotech growing medium + 0% vermicompost) and other treatments had 20%, 40%, 60% and 80% vermicompost in the growing medium. Treatments were replicated three times on seedling trays in a nursery. Data collected was on seedling emergence and plant growth.

RESULTS AND DISCUSSION

At seedling emergence, 60% vermicompost showed significantly ($p < 0.05$) the highest SVI and revealed the lowest MET, whilst 20% vermicompost had the least FEP. The variations could be attributed to the percentage of vermicompost in the growing medium. Concerning plant growth, 80% vermicompost seedlings were significantly the tallest, with the highest shoot mass, with a shoot: root ratio of 17, which was the highest in all the treatments. These results could be due to nutrients in vermicompost being in readily available forms for plant uptake, promoting better plant growth (Theunissen *et al.*, 2010).

CONCLUSION

Swiss chard seedlings can successfully be grown in hygrotech medium amended with 40, 60 and 80% vermicompost. The 60 and 80% vermicompost treatments significantly exceeded the commercial growing medium in performance.

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Keywords: Growing medium, swiss chard seedlings, vermicompost

HIGH TEMPERATURE AND WATER STRESS – POSSIBLE CAUSES OF BRACT BROWNING IN *Protea* CV. PINK ICE?

A Smith^{1,2}, EW Hoffman² and WJ Steyn^{2,3}

¹Elsenburg Agricultural Training Institute, PO Box 54, Elsenburg 7607; ²Horticultural Science, Private Bag X1, Stellenbosch 7602; ³Fruitgro Science, PO Box 12789, Die Boord, Stellenbosch 7613

E-mail: annalines@elsenburg.com

INTRODUCTION

Involucral bract browning in *Protea* is characterised by brown blemishes that develop pre-harvest on the tips and margins of the floral involucral bracts, resembling a dirty nail, hence the common term of “dirty nail syndrome”. This disorder affects the aesthetic quality of the stems, making them unsuitable for export. Bract browning has been studied in *Telopea* spp., an Australian Proteaceae cut flower (Martyn, 2004), but no research has been conducted on the factors that might cause bract browning in *Protea*. The aim of this study was to determine the effect of high temperature and water stress on the incidence and development of involucral bract browning in *Protea* cv. Pink Ice.

MATERIALS AND METHODS

Potted *Protea* cv. Pink Ice plants were exposed to a combination of Ambient and Ambient $\pm 1.6^{\circ}\text{C}$ temperatures and 3 irrigation schedules, viz. half, optimal and double optimal irrigation, within a greenhouse environment. Elevated temperatures were created by means of infra-red lamps. The data recorded included incidence of bract browning and marketability of the stem, plant growth, inflorescence colour development and the ecophysiological status of the plants estimated by stomatal conductivity, stem water potential, leaf and inflorescence temperature.

RESULTS AND DISCUSSION

No interaction was found between the 2 environmental stresses. Each stress had a significant effect on the occurrence of bract browning. At elevated temperatures, the incidence of bract browning was found to be significantly higher. There was a significant difference between the half optimal watering regime and the other two water treatments, but no significant difference between optimal and double optimal irrigation.

CONCLUSIONS

Elevated temperatures that can lead to even mild thermal stress, as well as water stress within the plant, can both significantly increase the development and occurrence of bract browning thereby reducing the marketability of the product. Optimal irrigation should be supplied during the inflorescence growth period and the cultivation of bract browning susceptible *Protea* species should be avoided in areas that consistently experience temperatures above 35°C in summer or during the final stage of inflorescence development.

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ACKNOWLEDGEMENTS

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Keywords: Proteaceae, heat stress, stomatal conductance, stem water potential

THE EFFECT OF LONG TERM CONSERVATION TILLAGE CROP ROTATION PRACTICES ON SOIL ORGANIC CARBON (W.CAPE, RSA)

JDV Smith¹, AG Hardie¹ and JA Strauss²

¹*Department of Soil Science, Stellenbosch University, P/Bag X1, Matieland 7602;*

²*Department of Agriculture: Western Cape, P/Bag X1, Elsenburg 7607*

E-mail: 15052052@sun.ac.za

INTRODUCTION

Concerns about global warming and food security have led to increasing interest in soil carbon sequestration in agricultural ecosystems. Consequences of severe depletion of SOC due to intensive cultivation of agricultural soils are low agronomic yield, soil structure degradation and low use efficiency of added input. Thus grain farmers in the Western Cape are increasingly switching to conservation tillage (no-till and zero-till) practices. However, no data is currently available on the extent or mechanisms of C stabilization in conservation tillage-managed soils of the Western Cape.

MATERIAL AND METHODS

A long-term field experiment has been conducted since 2002 is situated at the Tygerhoek Experimental farm (Riviersonderend, Southern Cape). The soils are shallow, shale-derived soils with a loamy texture and high content rock fragments. Five different crop/pasture rotation systems and naturally vegetated soils were evaluated and compared, ranging from no disturbance (100% pastures) to a system that is disturbed every year (100% crops). No-till land preparation approach is applied to the management of all treatments. Soil samples were divided into four depth increments: 0-5, 5-10, 10-20, 20-30 cm. To elucidate the possible organic C stabilizing mechanisms operating in the soils the relationship between organic C and selected soil and plant properties were examine. The soil CO₂ efflux of the different treatments was also measured.

RESULTS AND DISCUSSION

The total carbon of the MMWW (M = medic, W = wheat) treatment was significantly higher than all the other treatments, including the MMW treatment at all depths. This can be attributed to the lower below ground C input from the grazed medics in the MMW treatment compared to the MMWW treatment as significant correlation has been found between C and root density. The MMW and MMWW treatment was found to have a lower C:N ratio than the WBCWBL (B = barley, C = canola, L = lupin) treatments making it more easily mineralizable. This correlates well with the higher CO₂ efflux found in the MMW and MMWW treatment. The MMW treatment had the highest aggregate stability with least stable aggregates in the WBCWBL treatment which corresponds with the low C content found in the WBCWBL treatment, possibly due to more disturbances.

CONCLUSIONS

Different crop rotation systems under no-till land preparation definitely have an effect on the C content of soil which in turn can affect soil quality and sustainability of production. This is dominantly attributed to the quantity and quality (C:N ratio) of C input. However, disturbance of the soil, even under no-till, lowers the aggregate stability of the soil and therefore, possibly the stabilized C content.

Keywords: soil carbon stabilization, conservation practices, soil organic matter, crop rotation

INVESTIGATION OF SOIL QUALITY (HEALTH) IN COMMERCIAL PRODUCTION OF ROOIBOS TEA (*Aspalathus linearis*) IN THE WESTERN CAPE, SOUTH AFRICA

JFN Smith¹, AG Hardie¹ and A Botha²

¹Department of Soil Science, Stellenbosch University, P/Bag X1, Matieland 7602;

²Department of Microbiology, Stellenbosch University, P/Bag X1, Matieland 7602

E-mail: 15451151@sun.ac.za

INTRODUCTION

It was noted by rooibos farmers that production usually decreases dramatically after the first 5-year planting cycle on cleared virgin fynbos soil. We hypothesized that this decrease in production is most likely related to changes in soil quality (health) and ecology. Thus, the aim of this study was to examine soil (chemical, physical and microbiological properties) and plant quality parameters in cultivated rooibos fields and adjacent, rooibos stands in pristine fynbos. Ultimately, the results will be used to diagnose the decline in rooibos production, and to suggest sustainable management strategies to improve commercial rooibos production.

MATERIALS AND METHODS

Experimental sites were selected in the Clanwilliam district, within two (Nardouwsberg and Seekoeivlei) of the six main rooibos producing areas. Virgin fynbos, young rooibos fields (2 years) and older rooibos fields (10-30 years) were selected as sampling sites. The soil and 2-year old plants at each site were sampled in triplicate. The following soil physico-chemical and biological parameters were measured; pH, total C and N, exchangeable cations and acidity, plant-available P and micronutrients, texture, bulk-density, protist counts, and total microbial biomass. The total above- and below-ground biomass, foliar nutrient content, tea quality and yield, mycorrhizae counts and N nodule counts were studied on the plants.

RESULTS AND DISCUSSION

It was found that continuous cultivation resulted in significant decreases in plant above- and below-ground biomass yields, soil C and N, and basic cations. Cultivation also led to decreases in the total microbial biomass, soil protist and root mycorrhizae counts, but an increase in extent of root N-nodulation, indicating a greater dependence on symbiotically fixed N than soil N. Soil P increased with continuous cultivation, as well as, plant foliar P content. A negative correlation was found to exist between foliar P content and the above ground biomass yields ($R^2 = 0.52$), as well as tea quality ($R^2 = 0.71$). It has been previously established that fynbos plants species, such as rooibos, are unable to regulate P uptake, leading to toxic P accumulation and associated trace metal unavailability within the plant, and ultimately to increased susceptibility to fungal rot and plant death. A positive correlation was found between foliar B content and above ground biomass yield ($R^2 = 0.69$). A positive correlation was also found to exist between foliar Na content and plant size in the Seekoeivlei area soils, potentially indicating the importance of Na in plant quality.

CONCLUSIONS

Continuous cultivation resulted in several changes in soil quality, most significantly: decreased soil C, exchangeable basic cations and the associated decrease in soil microbial activity, but increased soil and plant P levels. Plants in continuously cultivated fields also showed a greater dependence on N-fixation. The rooibos plants showed P toxicity and reduced growth in fields with a high P content. In the next part of the study, we will evaluate different organic amendments and foliar sprays to address the deficiencies identified during this pioneering study.

ACKNOWLEDGEMENTS

SA Rooibos Council, for the funding.

Keywords: Rooibos tea, soil quality, soil health

CARBON STOCKS IN NO-TILL SOILS OF THE BERGVILLE/WINTERTON AREAS, KWAZULU-NATAL PROVINCE

M Steinke¹ and DJ Beukes¹

¹*Agricultural Research Council, Institute for Soil, Climate and Water, Private Bag X79, Pretoria 0001*

E-mail: steinkem@arc.agric.za

INTRODUCTION

The soil organic carbon (SOC) content on agricultural lands as influenced by tillage practices was evaluated. The effect of no-till on the carbon sequestration potential of soils in SA is as yet unquantified. The Okhahlamba district was chosen for this study, as the vast majority of no-till (Nt) lands older than 10 years are to be found in the Bergville/Winterton areas.

MATERIALS AND METHODS

A chronosequence of sites which had been subject to no-till practices from 0 to 25 years were selected. Samples were collected on twenty five sites with known histories. Soil organic carbon was determined using the Walkley-Black and dry combustion methods. The depths of sampling were 0-5, 5-10, 10-30 and 30-60 cm.

RESULTS AND DISCUSSION

The data obtained was analyzed using stepwise regression procedures. The SOC content was positively correlated with the number of years under no-till ($p < 0.05$) for the top 5 cm of soil. The carbon sequestration rate in no-till lands in the Bergville/Winterton area deduced from this chronosequence was 24.3 g.m⁻² yr⁻¹ for the upper 5 cm of soil. This compares favourably with values obtained on the Canadian prairies of 32 + 15 g.m⁻² yr⁻¹ which consisted of profiles with a mean depth of 17 cm (VandenBygaart, 2003). The relationship between soil silt content and SOC levels was significant. The influence of clay content on SOC levels was less prominent. Precipitation differences did not play a significant role in determining SOC levels.

CONCLUSIONS

No-till on the selected sites in the Okhahlamba district has significantly increased SOC levels in the 0 – 5 cm soil layer. In order to make more precise projections it will be necessary to measure carbon stocks on selected sites over time.

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Keywords: no-till, soil organic carbon

WATER PRODUCTIVITY OF SWEET SORGHUM (*Sorghum bicolor* L.) IN RESPONSE TO WATER SUPPLY DURING DIFFERENT GROWTH STAGES

JM Steyn¹, HT Araya¹, HB Hlope¹, ES du Toit¹

¹*Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0028*

E-mail: martin.steyn@up.ac.za

INTRODUCTION

Sweet sorghum has recently received renewed interest as a feedstock for biofuel (ethanol) production because of its high biomass yield, high sugar content and drought tolerance. However, good yield response to supplementary irrigation has also been reported. The objective of this study was to study the effect of withholding irrigation during different growth stages on growth, biomass production, ethanol yield and water productivity of sweet sorghum under local conditions.

MATERIALS AND METHODS

The study was conducted at the Hatfield Experimental Farm of the University of Pretoria, South Africa, under field conditions during the 2010/11 and 2011/12 seasons. Four water regimes were applied, viz. dryland production, full irrigation, supplemental irrigation in the early vegetative stage, or supplemental irrigation in the late vegetative stage. The trial was drip irrigated and soil water content was measured weekly. Growth analyses were carried out two-weekly to determine sweet sorghum growth parameters for the Soil Water Balance (SWB) model. Fresh and dry total biomass yield, stalk yield and sugar content were measured at final harvest. Theoretical ethanol yield was calculated from the sugar yield.

RESULTS AND DISCUSSION

Full irrigation throughout the growing season (control) resulted in the highest total biomass and stalk yields. However highest sugar and ethanol yields were produced by the treatment that received supplemental irrigation in the early vegetative stage. Supplemental irrigation in the late vegetative stage did not improve sugar and ethanol yields. Water productivity can therefore be improved by applying supplementary irrigation in the early vegetative stage, if needed. The SWB model was successfully calibrated for sweet sorghum and could simulate growth, biomass yield and soil water balance components reasonably well for all irrigation treatments.

CONCLUSIONS

These trials have shown that sweet sorghum sugar and ethanol yields respond positively to irrigation during the early vegetative stage. It can therefore be concluded that the late vegetative stage is the best stage to save irrigation water without losing productivity. The SWB model could provide a handy tool to estimate yield potential and develop irrigation strategies for sweet sorghum production in other areas of the country.

ACKNOWLEDGEMENTS

The Water Research Commission and National Department of Agriculture, Forestry and Fisheries are acknowledged for funding of this research.

Keywords: Sweet sorghum, water productivity, biomass yield, sugar yield, ethanol, modelling

LONG-ROTATION NO-TILL CROPPING SYSTEM PERFORMANCE IN THE SOUTHERN CAPE

JA Strauss¹ and WR Langenhoven¹

¹*Department of Agriculture: Western Cape, P/Bag X1, Elsenburg 7607*

E-mail: johannst@elsenburg.com

INTRODUCTION

The rural economy of the southern Cape is driven by dry-land agricultural production enterprises. Deregulation and the withdrawal of state subsidies for commercial agricultural production have exposed commercial agriculture to the competitive forces of international markets. These negative economic forces together with the increasing input costs and unpredictable climatic conditions have had severe negative impacts on the agricultural economy of southern Cape region. The aim of this study, therefore, was to determine the most feasible long-rotation cropping system(s) for the production area based on average gross margin data over five years.

MATERIAL AND METHODS

Long-rotation systems were therefore evaluated on selected farms within the southern Cape region. Appropriate sites were identified in each of two areas (Riversdal & Swellendam districts) to test the relevant long-rotation systems. Three replicates of each rotation system (complete randomised block design) were established at each site starting with the first crop following on 5 years of lucerne in each system. Rotation systems were as follows: (A) Riversdale: 1. Wheat-Lupin-Wheat-Canola-Wheat, 2. Wheat-Canola-Wheat-Lupin-Wheat, 3. Wheat-Barley-Canola-Wheat-Barley, 4. Canola-Triticale-Lupin-Wheat-Wheat, 5. Canola-Wheat-Lupin-Wheat-Canola and (B) Swellendam: 1. Wheat-Barley-Canola-Wheat-Barley, 2. Wheat-Wheat-Barley-Canola-Wheat, 3. Wheat-Barley-Lupin-Wheat-Canola, 4. Wheat-Canola-Wheat-Barley-Triticale, 5. Wheat-Barley-Barley-Canola-Wheat, 6. Wheat-Barley-Canola-Wheat-Wheat. All crops were planted (no-till) and harvested with commercial farming equipment. The only exception was system 6 at Swellendam, where a soil scarifying-action was applied during late summer (general practice for the district) to determine whether the added action would positively or negatively influence crop production and, ultimately the gross margins, compared to the standard no-till treatments at the site. Gross margins was determined annually within systems and combined at the completion of the trial period to obtain average system gross margin data per system.

RESULTS AND DISCUSSION

From the data of the five production years at the Riversdale site, it is clear that any of the five systems tested could be used successfully in long rotation with lucerne. System 5 had the highest average gross margin, while system 2 and 3 had the lowest. At the Swellendam site the average gross margin of system 6 was 59% lower than system 1, 55% lower than system 2, 37% lower than system 3, 44% lower than system 4 and 56% lower than system 5. There was no difference between systems 1, 2, 4 and 5, while system 3 showed a slightly lower average gross margin than systems 1, 2, 4 and 5.

CONCLUSIONS

It is clear that there are differences between different long-term cropping systems in gross margin data. With added information on crop management and yield data for each crop system tested the results obtained from this study can provide useful guidelines for producers regarding the management and economic implications of no-till grain production.

Keywords: crop rotation, gross margin, no-till, sustainability

NUMEROUS HAPLOTYPES FOR RWA RESISTANCE GENE *Dn4* IDENTIFIED

SL Sydenham¹ and VL Tolmay¹

¹ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700

E-mail: sydenhams@arc.agric.za

INTRODUCTION

Russian wheat aphid (RWA) is a major pest that predominantly occurs on winter wheat grown in the Eastern Free State production areas. RWA can cause significant yield losses. The development of host plant resistance to RWA is complicated by large variations observed in phenotypic responses which are dependent on plant genotype, aphid biotype, aphid dosage and duration of infestation. Additionally, there are no truly diagnostic molecular markers for RWA resistance *Dn* genes to assist wheat pre-breeders. The aim of this study was to validate and compare known published *Dn4* gene marker haplotypes within different *Dn4* containing genotypes.

MATERIALS AND METHODS

The original donor source of *Dn4* was contained in PI 372129. In this study 28 different wheat genotypes that contained *Dn4* (25 genotypes) and *Dny* (3 genotypes) were genotyped and haplotyped with 14 SSR markers from the 1D chromosome of the wheat consensus map. The leaf material of 12 plants per genotyped were sampled and a CTAB DNA extraction was carried out. The DNA quantity and purity was then analysed with a Nano Drop 2000. For SSR PCR amplification the DNA concentration was diluted to 50ng/μl. PCR reactions were carried out in a final volume of 20 ul and placed in a Bio-Rad My cycler PCR system. The SSR PCR products were run on a high resolution Agarose gel stained with GRGreen Nucleic acid stain. The gel was run at 100-150 V for 2-3 hours. Each SSR allele present was sized and scored per individual plant of each genotype.

RESULTS AND DISCUSSION

Of the 14 SSR markers tested on a smaller sample set, 8 SSR markers did not give any polymorphisms between any of the genotypes tested and were excluded from further analysis. Markers, *Xgwm337*, *Xgwm191*, *Xbarc119*, *Xgwm106*, *Xcfd92* and *Xcfd61*, amplified a number of different alleles across individuals of each tested genotype. The previously published *Dn4* associated SSR markers *Xgwm337* and *Xgwm106* amplified four and three different alleles across all the *Dn4* containing genotypes respectively. For marker *Xgwm337*, alleles of 175 bp, 185 bp, 195 bp and 225 bp were identified in different *Dn4* containing germplasm. The three different alleles amplified by SSR marker *Xgwm106* were 125 bp, 140 bp and Null allele. Markers *Xcfd92* and *Xcfd61* both amplified two alleles each. However, Marker *Xcfd61* could only differentiate between *Dn4* and *Dny* containing genotypes.

CONCLUSIONS

These findings are the first suggestion of the occurrence of a variety of different allelic forms of the *Dn4* gene within different *Dn4* containing genotypes. Marker *Xcfd61* positioned further along chromosome 1D, possibly indicates the position of *Dny* to be on chromosome 1D along with an allelic series within the *Dn4* locus. This linkage with *Dny* will be investigated further with other markers. This study strongly suggests that there may be a *Dn* gene allele/biotype specific interaction that needs to be thoroughly investigated.

ACKNOWLEDGEMENTS

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Keywords: Allele, *Diuraphis noxia*, *Dny*, Microsatellites, Russian wheat aphid, wheat

WATER USE OF MACADAMIAS

NJ Taylor¹, NA Ibraimo¹, JM Steyn¹, S Ghezehei¹, MB Gush² and JG Annandale¹

¹*Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0028;* ²*CSIR - Natural Resources and the Environment, PO Box 320, Stellenbosch 7599, South Africa*

E-mail: nicollette.taylor@up.ac.za

INTRODUCTION

Water stress often limits tree growth, as well as the set, retention, growth and quality of macadamia nuts. Water stress can be controlled by applying the correct amount of irrigation water at the correct time. This implies knowing how much water macadamia trees use throughout the season, which varies depending on a number of factors. Understanding how these factors impact water use is critical for predicting water use across orchards and growing conditions. As a result of this need for improved understanding the Water Research Commission of South Africa solicited a project to quantify water use of fruit tree species in 2006 (Project K5/1770).

MATERIALS AND METHODS

Transpiration of a six year-old macadamia orchard was continuously monitored, using the sap flow technique, for two years (from 2010 to 2012) at White River, South Africa. Soil evaporation and crop evapotranspiration was measured for four window periods during spring, winter, summer and autumn seasons. Measured crop evapotranspiration and soil evaporation data were used to parameterize and validate an improved dual-source model, which estimates the partitioning of canopy transpiration and soil evaporation. Additional measurements of weather variables, leaf stomatal conductance and canopy size were also performed.

RESULTS AND DISCUSSION

Total yearly water use of six year old drip irrigated macadamia trees was approximately 800 mm, with 500 mm partitioned to canopy transpiration and 300 mm to soil evaporation. Transpiration and leaf stomatal conductance of macadamia trees were well correlated with solar radiation and atmospheric evaporative demand and poorly linked to temperature and vapour pressure deficit. Transpiration tended to be higher in trees with bigger canopies, which was independent of trunk size. A dual-source model was able to adequately estimate water use of macadamia trees.

CONCLUSIONS

The water use of irrigated macadamia trees is primarily driven by solar radiation and atmospheric evaporative demand and an increase in canopy size also tends to increase transpiration. The dual-source model showed great potential to estimate water use of macadamia trees, which can be used, in future, as a tool to extrapolate results across various orchards and climatic conditions in South Africa.

ACKNOWLEDGEMENTS

Funding support is provided by the Water Research Commission and the National Department of Agriculture, Forestry and Fisheries.

Keywords: Transpiration, soil evaporation, evapotranspiration, stomatal conductance, sap flow

***Eragrostis curvula* PRODUCTION IN MUNICIPAL SLUDGE AMENDED SOILS: BENEFITS VS. CONCERNS**

EH Tesfamariam¹, JG Annandale¹, JM Steyn¹ and RJ Stirzaker²

¹University of Pretoria, P.O.Box X21, Hatfield, 0028, Pretoria; ²CSIRO Land and Water, Australia

E-mail: eyob.tesfamariam@up.ac.za

INTRODUCTION

Land application of sludge has been shown to improve soil properties and aid crop growth but the possibility of constituent nutrients such as nitrogen and phosphorus reaching environmentally toxic levels has caused governing authorities to set limits to how much sludge can be applied to agronomic land. The high nitrogen utilization potential of pasture grasses suggests that more sludge can be used in this cropping system without the risk of excess nitrate accumulation in the soil profile or leaching below the active root zone. This study investigates the effect of exceeding the South African sludge application limit on hay yield, soil nitrates and phosphorus.

MATERIALS AND METHODS

Field experiments were conducted at the East Rand Water Care Works (ERWAT), Johannesburg, Gauteng, South Africa. The study site is situated at an elevation of 1577 m above sea level, latitude 26° 01' 01" S and longitude of 28° 16' 55" E. The mean annual rainfall of the area ranged between 405 mm in 2006/07 and 710 mm in 2007/08, mainly during the months of October to March. The soil of the experimental site is a clay loam, Hutton soil form with a clay content of 38%, and pH (H₂O) of 5.73. Field plots of 25 m² were arranged in a randomized complete block design comprising four replications of four sludge treatments (0, 4, 8, and 16 t ha⁻¹). Anaerobically digested sludge was applied into the soil and planted to *Eragrostis curvula*. Plant samples were collected twice a year for hay yield as well as N and P uptake determination. Annually soil samples were collected diagonally from each plot to make a composite sample and were analyzed for N (Carlo Erba NA1500 C/N analyzer), P (Inductively Coupled Plasma Optical Emission Spectrometer), nitrate and ammonium (KCl extractable), and Bray1-P measurements.

RESULTS AND DISCUSSION

Eragrostis curvula hay yield increased with increase in sludge rate. Highest hay yield was harvested from years which experienced high rainfall. Sludge applied according to the WRC initial limit of 8 t ha⁻¹ yr⁻¹ was not sufficient to satisfy weeping lovegrass N demand. Doubling the limit did not cause the accumulation of nitrate and ammonium in the soil profile. The total P, however, increased by 1316 kgs while the Bray-1P increased by 38% compared with the initial soil profile concentration.

CONCLUSIONS

Results over four growing seasons indicate that exceeding the recommended limit increased hay yield and nitrogen uptake and did not cause the accumulation of nitrate and ammonium in the soil profile, however, both total and Bray-1P accumulated over years..

Keywords: *Eragrostis curvula*, nitrogen, phosphorus, sludge

EFFECT OF PLANT GROWTH TEMPERATURE ON MORINGA (*Moringa oleifera*) LEAF ANTIOXIDANTS

SZ Tesfay¹ and AT Modi¹

¹*Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa*

E-mail: tesfay@ukzn.ac.za

INTRODUCTION

This study is designed using the rationale that the proline-associated phenolics may play a crucial role under temperature stress in moringa and, as a result, phenolic phytochemicals can effectively counter oxidative stress within the cell through phenolic biosynthesis and stimulation of the antioxidant compounds. *Moringa oleifera*, a typical tropical plant, is known for its potential 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 different levels of growth temperatures 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 temperatures (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 total antioxidant, phenolics, proline and carbohydrate analyses. Statistical analysis was carried out using GenStat[®] version 14.1.

RESULTS AND DISCUSSION

Temperature significantly ($P < 0.05$) affected the leaf phenolics, proline and fructose. The 35/18°C had the highest total phenolic concentration, followed by 30/15°C and 25/12°C respectively. Similar results were also found for total proline concentrations, where the 35/18°C had the highest levels compared with the other two growth conditions. However, 30/15°C increased the total non-structural soluble carbohydrates. 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 responds to high temperature and it can be measured by antioxidant accumulation. A future study will investigate plant adaptation to stress environments and how it can be linked to some specific antioxidant compounds.

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Keywords: Moringa oleifera

QUANTIFYING AND PREDICTING SOIL WATER EVAPORATION AS INFLUENCED BY RUNOFF STRIP LENGTHS AND MULCH COVER

WA Tesfahuney¹, LD Van Rensburg¹ and S Walker¹

¹University of the Free State, PO Box 339 (60), Bloemfontein 9300, South Africa

E-mail: weldit78@yahoo.com

INTRODUCTION

A better understanding of soil evaporation (E_s) losses is needed to lead to the development of alternative production systems that can improve crop productivity. In semi-arid climates, it is crucial to understand how E_s is affected by mulches for the broader application of in-field rainwater harvesting (IRWH) with different runoff strip lengths (van Rensburg, 2010). The purpose of this study was to quantify the effect of crop shading and mulch levels from each 1 m section of IRWH and accordingly to evaluate the Ritchie and Stroosnijder soil evaporation (E_s) models.

MATERIALS & METHODS

A microlysimetric method has been used to measure E_s from beneath maize canopy for three consecutive drying cycles across the basin and runoff sections. Ritchie and Stroosnijder soil evaporation models were used to calculate soil evaporation by parameterizing wetness at the soil surface (α method) or the soil water diffusion resistance (β method).

RESULTS & DISCUSSION

The insignificant effect of RSL treatments on E_s implies the dynamics of spatial distribution of soil water and energy that influence evaporation were resulted according to the effect of "green mulch" or shading cover (CS) on E_s beneath the maize canopy. As a result, less restrictive E_s properties were developed from bare surface and efficient E_s restrictive were found under high mulch and shading cover treatments. Furthermore the interaction effect of the ML and CS gave a better insight into the range of variations in α' and β values in terms of time and E_{pot} , for different position of IRWH. The α' and β values range from 2.34 to 4.26 mm d^{-0.5} and from 1.38 to 2.06 mm d^{-0.5}, respectively. In all the treatments the simulated cumulative E_s (ΣE_s) were underestimated by the Ritchie model and in contrast overestimated by the Stroosnijder model.

CONCLUSION

The main effect of shading was due to the dominant effect of energy limited evaporation (stage-1), while the mulched treatments were mainly driven by soil limited stage (stage-2) of evaporation. The time (α model) performed well to estimate ΣE_s from the basin area and the potential evaporation (β model) from the unshaded runoff strips. Thus, consideration of weather parameters may have an advantage, since the microclimate of the cropping system changes according to surface treatments in the system of IRWH.

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Keywords: Mulch, shade cover, soil water evaporation, Ritchie and Stroosnijder models

HISTORICAL TRENDS IN DAILY POSITIVE UTAH CHILL UNITS AT BETHLEHEM, SOUTH AFRICA

PC Tharaga¹, AS Steyn¹ and GM Engelbrecht¹

¹*University of the Free State, PO Box 339, Bloemfontein 9300*

E-mail: phumudzo.tharaga@weathersa.co.za

INTRODUCTION

Endodormancy is an internal condition in temperate zone plants, preventing growth irrespective of favourable external conditions, and can only be terminated by temperatures above freezing. The chilling requirement to break endodormancy for bud-break and flowering refers to the amount of cold needed by a specific plant. Production of most fruit trees is marginal today, with trees barely meeting their chilling requirements in certain areas. Such production might become problematic in the near future due to changes in the climate.

The main objective of this study was to calculate if there were any noticeable changes in the amount of accumulated chill units over the past decades within the study area, using the Daily Positive Utah chill unit model.

MATERIALS AND METHODS

The historical observed weather data used for the study was the hourly temperatures for the period 1981 to 2010 obtained from the South African Weather Service station in Bethlehem. The Daily Positive Utah chill unit model – a derivation of the Utah chill unit model - is a more accurate model for areas with warm midday winter temperatures and only uses the so-called “positive chill units” (PCUs). The same unit allocation as for the Utah model is used but if the daily total is negative it is ignored and not subtracted from the season's total.

A Cumulative Distribution Function (CDF) was used to determine the probability of accumulating certain threshold PCU values during a particular season. The seasonal PCUs from 1981 to 2010 (presented as three consecutive 10-years periods) were also calculated and analysed for linear trend.

RESULTS

The CDF for Bethlehem revealed that the thresholds for below-normal and above-normal accumulated PCUs were 781 and 877, respectively. There is a 73% probability that the accumulated PCUs will not exceed 1000 in a given season, while the chances of accumulating less than 600 PCUs are very slim. This implies that in terms of chilling, peaches and apple cultivars like Cripp's Pink and Granny Smith are well suited to this area, while cherries and Royal Gala apples will encounter problems from time-to-time in terms of meeting their chilling requirements. There was no point in trying to fit a linear trend to the entire 30-year period as the accumulated PCUs showed a clear cyclic behaviour. Instead, linear trends were fit to three consecutive 10-year periods. These linear trend lines revealed a general decrease of about 44 PCUs per year during the 1980s, an increase of 19.5 PCUs per year during the 1990s, followed by a decline of 3.9 PCUs per year during the 2000s. It was therefore interesting to note that 33% of the variation in accumulated PCUs could be explained by using a 4th order polynomial.

CONCLUSION

On average, more than 6 PCUs were accumulated per day during June and July within the study area. The CDF revealed that in almost 1 out of 5 years the accumulated PCUs will fail to reach 1000 units, causing problems for some of the high chill requirement fruit types. There was no clear long-term linear trend in the accumulated PCUs, but rather a cyclic behaviour. Future work will aim to determine the wavelength(s) of this oscillation.

ACKNOWLEDGEMENT

Special thanks to Inkaba yeAfrica for funding this project.

Keywords: Endodormancy, accumulated chill units

EVALUATION OF PHOTO-SELECTIVE NETTING ON TOMATO PLANT GROWTH AND YIELD

PP Tinyane¹, MM Maboko², D Sivakumar¹ and P Soundy¹

¹Department of Crop Sciences, Tshwane University of Technology, Pretoria 0001;

²Agricultural Research Council - Vegetable and Ornamental Plant Institute, Roodeplaat, Pretoria 0001

E-mail: tinyanepp@gmail.com

INTRODUCTION

Shade nets are used to regulate/modify environmental factors such as temperature, humidity, and light quality affecting crops growth and yield. The nets may also provide protection against physical agents such as birds, hail, insects, pathogenic infection and excessive radiation. Several studies have been conducted on shading effect on leafy vegetables, but few have been conducted on tomatoes. This study was conducted to determine the effect of colored net shading on the growth performance and yield of tomatoes (*Solanum lycopersicum*).

MATERIALS AND METHODS

Three tomato cultivars ('AlfaV', 'Irit', 'SCX 248') were planted under photo-selective nets (red, pearl and yellow) and black commercial net (control). The treatments were replicated three times in a randomized complete block design (RCBD). Microclimate (temperature and %RH) and photo-synthetic active radiation (PAR) data were recorded from transplanting to harvest period. Data on growth parameters and yield was also recorded and subjected to statistical analysis using the GenStat ® program.

RESULTS AND DISCUSSION

Plant height was lower in plants grown under black nets. SCX 248 produced higher number of fruit under black, yellow and pearl nets, while fruit production was higher for 'AlfaV' under red nets. 'Irit' produced higher number of fruits under yellow nets. Leaf miner infestation was high in all three cultivars under black net. However, pearl net showed reduced incidence of leaf miner infestation. Early blight infection was lower in all three cultivars grown under black nets. The investigation showed that microclimate and PAR influenced plant growth, fruiting pattern, and incidence of fungal and insect infestation.

CONCLUSIONS

The developed technology of shade netting provides a new tool that can be implemented within protected cultivation practices for improving crop performance and overall profitability of agricultural crops.

ACKNOWLEDGEMENT

The authors wish to acknowledge the financial support of the National Research Foundation of South Africa (under the competitive funding for rated researchers program).

Keywords: Photo-selective netting, protected cultivation, *Solanum lycopersicum*

EVALUATION OF *Dn4* AND *Dny* CONTAINING GERMPLASM WITH RUSSIAN WHEAT APHID BIOTYPE RWASA3

VL Tolmay¹, A Jankielsohn¹ and SL Sydenham¹

¹ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700

E-mail: tolmayv@arc.agric.za

INTRODUCTION

Host plant resistance can effectively manage Russian wheat aphid (*Diuraphis noxia*) Kurdjumov (Homoptera: Aphididae) in areas where it is an economically important pest of wheat (*Triticum aestivum* L). Notwithstanding its wide distribution, *D. noxia* is a particularly problematic pest in specific sub-regions characterised by medium to lower yield potentials, rain-fed conditions and sporadic droughts, such as the Free State Province in South Africa and an elliptical area in the Western Great Plains of the USA. Biotypes of *D. noxia* virulent on wheat containing resistance gene *Dn4* have been reported in both the USA and South Africa. This study aimed to confirm the virulence of biotype RWASA3 on *Dn4*-mediated resistance in various genetic backgrounds and to determine whether *Dny*-mediated resistance had been overcome by RWASA3.

MATERIALS AND METHODS

Thirty wheat genotypes, including susceptible Yuma, resistant Cltr2401 as well as 25 genotypes containing *Dn4* and three genotypes containing *Dny* were planted under greenhouse conditions in Bethlehem, South Africa, and infested with RWASA3 from a clone colony, at the two-leaf stage. Individual plants were scored 21 days after infestation using a 1-10 damage rating scale. The percentage score (%Score) was calculated as the total damage rating score of the three plants in each replicate divided by the total possible score for three plants (i.e. 30), expressed as a percentage. The Logit of the %Score was also calculated. The mean damage rating, and both calculated parameters were subjected to ANOVA using GenStat for Windows[®] 14th Edition (Payne et al. 2011) after confirming orthogonality of design and homogeneity of variance.

RESULTS AND DISCUSSION

RWASA3 caused susceptible damage symptoms in MTRWA92-145, Ankor, Halt, Bond CL, 18FAWWON-SA 262, Prowers99, 18FAWWON-SA 264, Hatcher, Yumar, Corwa and Thunder CL, all reported to contain the *Dn4* resistance gene. Genotypes PI586956, Stanton and 18FAWWON-SA 257, containing *Dny* were susceptible to RWASA3. Coinciding development of virulence to resistance genes *Dn4* and *Dny* was also reported in the USA. However, in this study 13 *Dn4*-containing genotypes showed moderate resistance when screened with RWASA3 alluding to a more complex biotype-gene-interaction.

CONCLUSIONS

These findings could indicate that *Dn4* and *Dny* may be related and possibly share a similar or common resistance factor. Further studies will be aimed at explaining these results investigating the possibility of an allelic cluster or series for *Dn4*, possibly including *Dny*.

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ACKNOWLEDGEMENTS

The ARC and WCTrust are acknowledged for funding project GK05/12.

Keywords: *Diuraphis noxia*, host plant resistance, *Triticum aestivum*

RELATIVE PHYTOTOXICITY OF FERMENTED FRESH AND DRIED *Cucumis africanus* FRUIT ON TOMATO PLANTS AND NEMATODE SUPPRESSION

PE Tseke¹, OM Pelinganga¹ and PW Mashela¹

¹University of Limpopo, Private Bag X1106, Sovenga 0727

E-mail: tsekepe@gmail.com

INTRODUCTION

Fermented crude extracts of wild watermelon (*Cucumis africanus*) fruit are being used in managing numbers of *Meloidogyne incognita* race 2 in tomato production (Pelinganga *et al.*, 2012). Fruit of this plant species contain cucurbitacin B, which is insoluble in water. Non-phytotoxic dosages of dilutions of this material have been determined using a curve-fitting allelochemical response data (CARD) computer-based model (Pelinganga and Mashela, 2012). The objective of this study was to determine whether fresh and dried forms of *C. africanus* fruit had similar phytotoxicities to tomato plants and therefore similar efficacies in suppression of *M. incognita* race 2.

MATERIALS AND METHODS

Tomato cv. 'Floradade' seedlings were infested with 3 000 eggs and juveniles each. Equivalent fresh (minus water mass) and dried mass of *C. myriocarpus* fruit were fermented using effective microbes (Pelinganga *et al.*, 2012). In each form, treatments, namely 0, 2, 4, 8, 16, 32 and 64% dilutions were arranged in a randomised complete block design, with 10 replications. At 56 days after applying each treatment weekly, dry shoot mass, dry root mass, dry fruit mass, plant height, stem diameter and nematode numbers were each subjected to analysis of variance. Variables with significant ($P = 0.05$) treatments were further subjected to CARD model to generate six biological indices (Pelinganga *et al.*, 2012). Mean dosage stimulation range (MDSR) was computed for each form using inhibition point (D_0) and saturation point (R_h) biological indices (Pelinganga *et al.*, 2012).

RESULTS AND DISCUSSION

In fresh and dried forms total k values were 3 units and 5 units, respectively. On the basis of k values, in dried form the material was less phytotoxicity to tomato than in fresh form (Pelinganga *et al.*, 2012). Integrated MDSR for fresh and dried forms were 7% and 3%, respectively. In fresh form, MDSR is higher with higher toxicity, while in dried form MDSR is lower with low phytotoxicity. Relative to untreated control, at 7% (fresh) and 3% (dried) the material reduced population levels of *M. incognita* race 2 by 93% and 86%, respectively.

CONCLUSION

In terms of k and MDSR values, in dried form, fermented crude extracts of *C. myriocarpus* fruit is more suitable for use as a bio-nematicide against *M. incognita* race 2 in tomato production.

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Keywords: phytotoxicity, *Cucumis africanus*, effective microbe organisms, ground leaching technology, root-knot nematode

SILICON DEPLETION FROM A DOLERITE DERIVED ARCADIA SOIL

R van Antwerpen¹, N Miles¹ and T Wettergreen¹

¹*South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa*

E-mail: rianto.van.antwerpen@sugar.org.za

INTRODUCTION

Mounting evidence of the role of silicon (Si) in enhancing sugarcane yields and mitigating biotic and abiotic stresses in the crop has intensified interest in the Si nutrition of sugarcane. Data were collected to quantify Si relationships in the long-term 'BT1 Trial' at Mount Edgecombe (the oldest sugarcane trial in the world).

MATERIALS AND METHODS

The BT1 Trial, established in October 1939, is located on an Arcadia soil with 50% clay. The soil has an average depth of 0.5 m and overlies a stratum of well-weathered dolerite. Residue management treatments in the trial are green cane harvesting (brown and green leaves retained = 'trashed') and pre-harvest burning with green leaves ('tops') either spread or removed. Half of the plots of each of these treatments receive fertiliser (N, P and K). The remainder have not received any fertiliser since 1939. Laboratory methods were; pH: 1:2.5 soil:water, organic carbon by Walkley-Black, K, Ca and Mg extracted with 1.0N NH₄OAc and soil Si was extracted with 0.01 M CaCl₂.

RESULTS AND DISCUSSION

Yields were consistently higher in the fertilised treatments, with residue management not having as great an impact as fertiliser on yields. Soil test data (0-200 mm) revealed significantly greater decreases in pH and in the nutrients Ca, Mg and Si in fertilised treatments relative to the unfertilised. While soil Ca and Mg reserves are still substantial and appear unlikely to become marginal for some years to come, soil Si, however, has reached marginal status (40-50 mg/L) for the unfertilised treatments and is deficient (<40 mg/L) for the fertilised treatments. Leaf Si followed a similar trend with levels being sufficient in the unfertilised and deficient (<0.75%) in the fertilised treatments. Leaf Si levels were enhanced under residue retention, but only in the unfertilised treatments.

CONCLUSIONS

Data from this trial provides striking evidence of the depletion of soil Si reserves through crop removals. These findings underline the value of long-term field trials in eliciting the sustainability of nutrient management practices. As sugarcane is generally cultivated on soils with inherently lower Si reserves than those in the soil in this study, it is suggested that Si depletion is an important and underrated contributory factor in the phenomenon of sugarcane yield decline, which is of current concern to the local and international sugar industries.

Keywords: Arcadia, depletion, fertility, long-term trial, Si, sugarcane

ESTIMATING THE BLUE, GREEN AND GREY WATER FOOTPRINT OF CROP PRODUCTION IN SOUTH AFRICA USING SWB AND DSSAT

M van der Laan¹, JG Annandale¹, JT Vahrmeijer^{1,2} and KL Bristow^{1,3}

¹University of Pretoria, Private Bag X20 Hatfield, Pretoria 0028, RSA; ²Citrus Research International, PO Box 28, Nelspruit 1200, RSA; ³CSIRO Land and Water, PMB Aitkenvale, Townsville, QLD 4814, Australia

E-mail: michael.vanderlaan@up.ac.za

INTRODUCTION

Water footprint assessments have been proposed as a comprehensive approach to quantify the consumption and pollution of water resulting from a specific human activity. Blue water refers to surface water and groundwater available to multiple users, green water is rainfall stored in the soil and available for vegetation growth, and grey water is the amount of freshwater required to assimilate effluent pollutant loads. The aim of this study was to assess the use of mechanistic crop models in estimating the total water footprint of a crop.

MATERIALS AND METHODS

Water footprint assessments were done for irrigated sugarcane produced in Pongola and several vegetable crops produced on the Steenkoppies Aquifer near Krugersdorp. The crop models were calibrated using measured field data and blue and green water consumption determined according to standard methodology. Different approaches to estimate the grey water footprint were also evaluated.

RESULTS AND DISCUSSION

As expected, water consumption per unit yield differs widely between crops. While consumption per unit yield produced remains relatively constant for a specific crop, the ratio of green to blue water consumption is dependent on the total volume and distribution of rainfall during the growing season as well as the irrigation scheduling approach. High green to blue water consumption ratios are viewed favourably in irrigation as a result of the high opportunity cost associated with blue water. Further work is required to improve the quantification of water footprints in a geographic context in South Africa so that site-specific impacts can be better understood and problem areas or 'hotspots' identified.

CONCLUSIONS

It is expected that water footprint information will play an important role in water resource management at farm, catchment, basin and national scales in the future. Additional challenges in quantifying the impact of crop production on water quality to estimate the grey water component of a total water footprint lie ahead.

Keywords: blue water, green water, sugarcane, vegetables, SWB, DSSAT-Canegro

UNLOCKING SUCROSE YIELD POTENTIAL IN SUGARCANE THROUGH CHEMICAL RIPENING

PDR van Heerden¹, M Adendorff¹ and T Mbatha¹

¹South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa

E-mail: riekert.vanheerden@sugar.org.za

INTRODUCTION

The chemical ripeners 2-chloroethyl phosphonic acid (Ethephon) and fluazifop-p-butyl (Fusilade Forte) are applied to the sugarcane leaf canopy from approximately 3 months before harvesting. Suppression of leaf and stalk elongation by these chemicals accelerates sucrose storage with a concomitant increase in stalk sucrose content (Donaldson 2002). Chemical ripeners have the recognised ability to increase sucrose yield potential, especially in vigorously growing irrigated crops. However, varieties differ in their response to chemical ripeners. Hence, a key objective of chemical ripener research is to assess these differences for development of variety-specific recommendations. In this paper the magnitude by which ripeners increase sucrose yield potential in different varieties under small-plot experimental and large-scale commercial growing conditions is highlighted.

MATERIALS AND METHODS

A small-plot drip-irrigated field trial was planted to varieties N53 and 01F1920 on 6 April 2011 in Pongola (South Africa). The plant crop was harvested on 4 April 2012. Each of the chemical ripener treatment plots consisted of 6 cane rows, each 8 m long and spaced 1.4 m apart. The experimental design was a randomised block with six replications per treatment (Control, Ethephon, Fusilade Forte and Ethephon/Fusilade Forte combination). Treatments were applied by CO₂-pressurised spraying equipment with an overhead boom. In addition to the small-plot field trial a commercial strip trial was conducted on a private farm in Pongola where the treatments were applied by air to a large field (40 ha) of variety N43.

RESULTS AND DISCUSSION

Ripener treatments increased cane quality as indicated by recoverable value percent (RV%) by up to 2.6 and 4.3 % units in N53 and 01F1920 respectively. Growth suppression by the chemicals reduced cane yield by a maximum of 13 t ha⁻¹ but the increase in RV% over-compensated for this reduction and increased RV yields by up to 4.7 t ha⁻¹. Under large-scale commercial conditions ripeners increased RV% by up to 2.7 % units and reduced cane yield by a maximum of 7 t ha⁻¹ in variety N43. The increase in RV% over-compensated for cane yield reduction and increased RV yields by 2.1 t ha⁻¹. In all three varieties Fusilade Forte proved to be the treatment of choice.

CONCLUSIONS

Chemical ripeners increased RV yields by between 2.1 – 4.7 t ha⁻¹ under small-plot field trial and large-scale commercial conditions. Unlocking sucrose yield potential in these varieties led to an estimated increase in farmer revenue of between R6 500 - R14 500 ha⁻¹.

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Keywords: cane quality, chemical ripening, Ethephon, Fusilade Forte, sugarcane, sucrose yield

PROPOSAL FOR THE AMENDMENT OF THE DIAGNOSTIC ORGANIC O HORIZON IN SOUTH AFRICA

CW van Huyssteen

Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein

E-mail: vanhuyssteencw@ufs.ac.za

INTRODUCTION

The occurrence of organic matter in soil is used in wetland delineation through the recognition of the Champagne soil form as a permanently wet wetland zone (DWAF, 2005). Soils can, however, accumulate organic matter under diverse environmental conditions. This paper aims to highlight the conditions under which organic carbon can accumulate in soils and then propose criteria for the objective classification thereof.

BACKGROUND

Soil organic matter accumulates when mineralisation of organic matter is slower than the addition of fresh organic matter. Because mineralisation is driven by micro-organisms this happens when environmental conditions do not favour the existence of micro-organisms responsible for mineralisation. These include conditions that are too cold, too wet, and/or too acidic. [Conditions that are too alkaline probably also result in a very low addition of organic matter.] Conditions that are too cold probably do not occur in South Africa, although it is conceivable in the higher reaches of the Drakensberg. The South African soil taxonomy therefore focuses only on organic matter accumulation under wet (Champagne) and acidic (humic soils) conditions.

PROPOSAL AND DISCUSSION

It is therefore proposed that organic matter rich soils are classified based primarily on the primary factor governing the accumulation thereof. These would be wet, acid, and cold soil forms. To accommodate the variation in organic matter content and base saturation observed, it is proposed that family criteria be used. For the Champagne 4-10% (soils below the current norm), 10-20% (soils not qualifying as peat), and >20% OC (peat soils) families are proposed. Humic soils will then not qualify as wetland soils, because poor drainage is excluded. Humic soils occurring in basic environments should either have a basic qualifier or be classified as a humic-rich orthic A horizons.

Keywords: classification, peat, wetland

FROM GENTIC SOIL HORIZONS TO HYDROPEDOLOGICAL FUNCTIONAL UNITS

JJ van Tol¹, PAL le Roux², M Hensley² and SA Lorentz³

¹University of Fort Hare, PO Box 14, Adelaide 5760; ²University of the Free State, Bloemfontein 9300; ³University of KwaZulu-Natal, Pietermaritzburg 3209

E-mail: jvantol@ufh.ac.za

INTRODUCTION

Soil properties and their spatial distribution can serve as indication of hydrological behaviour. Specific soil properties are captured in different genetic soil horizons. This enables soil horizons to be the vehicle for relating soil to hydrology (hydropedology). Hydrologist agrees that soil properties and their spatial distribution are important to capture in hydrological models but they lack the knowledge to interpret standard soil maps. This study aims to bridge the pedological classification of horizons with their hydrological behaviour by converting them to hydrological functional units. The functional units therefore describe the hydrological behaviour of a specific soil horizon.

MATERIALS AND METHODS

Data from several hydropedological studies, soil surveys and the Land Type data base were used as basis for the conversion. Where measurements of important hydrological properties were absent in the dataset, suitable pedotransfer functions were used to derive the values. The dataset was then subjected to a series of virtual experiments (Hydrus 2/3D) to obtain suitable functional units for different soil horizons.

RESULTS AND DISCUSSION

The horizons of the South African soil classification system were ultimately divided into 15 hydropedological functional units. Under different environmental conditions (e.g. aridity index, position in the landscape, antecedent moisture conditions etc.) the hydrological function of a soil horizon might differ. A specific soil horizon might therefore form part of a number of functional units; this was highlighted using four case studies. The first show how the underlying material will influence the function of orthic A horizons using data from the Weatherley catchment. The second study illustrates how Vertic A horizons can behave differently with different antecedent moisture conditions. The third example demonstrates that not all E horizons are associated with lateral flow and the last example show the distinct hydrological function of lithocutanic B horizons. A flow diagram, serving as a template, was compiled to simplify the conversion of the soil horizons into functional units.

CONCLUSIONS

This study will aid hydrologist to convert widely available, but often incomprehensible, soil information (soil maps and profile descriptions) into a more accessible and useable format and will thereby (confidently) improve the efficiency of hydrological models.

ACKNOWLEDGEMENTS

Water Research Commission; Academic Cluster: Water management in water scarce areas, UFS

Keywords: Hydrological modelling, hydrological response, soil maps

MODIFIED VEGETATIVE PROPAGATION METHODS OF AVOCADO (*Persea americana* Mill.) ROOTSTOCKS

S van Tol¹, RJ Blakey² and NJ Taylor¹

¹Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0002; ²Westfalia Technological Services, PO Box 1103, Tzaneen 0850

E-mail: u28094248@tuks.co.za

INTRODUCTION

Avocado rootstocks in South Africa are largely vegetatively propagated to produce genetically identical rootstocks, thereby reducing variation between trees in an orchard, leading to more efficient orchard management. Avocado is regarded as a difficult-to-root species (Hartmann *et al.*, 2007), resulting in the current commercial method of propagating clonal rootstocks using a nurse seed and double grafting. This method is labour intensive, costly and time consuming (de Villiers & Ernst, 2007). If stem cuttings taken directly from mature avocado trees could be rooted at a high percentage, the efficiency of the vegetative propagation of avocado could be substantially increased. The aim of this study therefore was to experiment with treatments that can potentially increase the rooting percentage of cuttings made from mature avocado trees.

MATERIALS AND METHODS

Treatments applied included: (i) spraying mature avocado trees with gibberellic acid (GA₃) at three different concentrations (200, 400 or 800 mg.L⁻¹); shoots were sprayed twice with a seven day interval and cuttings were made 10 days after the second spray; (ii) blanching (on-tree etiolation) the base of the cuttings with velcro strips for six weeks prior to making the cuttings and (iii) dipping the cutting base in 3.5% (w/v) hydrogen peroxide immediately prior to planting.

RESULTS AND DISCUSSION

Applying GA₃ on the mature trees and dipping the base of the cuttings in hydrogen peroxide didn't show any potential in terms of increasing rooting ability of cuttings. Blanched cuttings showed a higher rooting ability than the control. After 45 days after making the cuttings, 48% showed root formation compared with 0% from the control.

CONCLUSIONS

Blanching shows some potential to increase the rooting of avocado cuttings.

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Keywords: avocado, difficult-to-root, vegetative propagation

TRANSCRIPTOME ANALYSIS OF NODULE DEVELOPMENT AND SENESCENCE IN SOYBEAN

SG van Wyk¹, M du Plessis², KJ Kunert³ and BJ Vorster¹

¹Department of Plant Production and Soil Science, University of Pretoria, Pretoria, South Africa 0002; ²Department of Plant Science, University of Pretoria, Pretoria, South Africa 0002; ³Centre for Plant Sciences, University of Leeds, Leeds, UK, LS2 9JT

E-mail: juan.vorster@up.ac.za

INTRODUCTION

The symbiotic association between soybean (*Glycine max* L.) and *Bradyrhizobium japonicum* (Kirchner), allows for the fixation of atmospheric nitrogen by the bacteria inside root nodules. The life of a nodule is however very short, only 11-13 weeks, after which nitrogen fixation declines rapidly as the nodules age. Nitrogen fixation has ceased by the time pod-filling starts. Early losses in nitrogen fixation capacity induced by age or environmental stresses, lead to nitrogen limitation within the plant, which has a major impact on seed production, crop quality and yield. The public release of the soybean genome in 2010 has made an important resource available for genome wide studies related to soybean biology. In this project we aim to understand the genetic control of nodule development and the signals that result in natural senescence as well as stress induced nodule death.

MATERIALS AND METHODS

Soybean seeds of cultivar Williams were inoculated with *B. japonicum* strain WB74-1 (SoyGro Bio-Fertilizer Ltd, South Africa) and grown in fine grade vermiculite to provide a nitrogen-free environment until the formation of actively growing crown and lateral nodules. Plants were grown under well-watered conditions and supplied with N-free Hoagland's solution twice per week. Nodules were harvested at 4, 8 and 14 weeks after planting and RNA extracted. Using the Illumina platform the nodule transcriptome were sequenced at these time points. The sequence data was mapped backed to the soybean reference genome and gene expression analysed and compared between the three time points.

RESULTS AND DISCUSSION

Transcriptome analysis identified a large number of genes that are differentially regulated between the three different time points. These genes can be grouped according to the biological and molecular processes they are involved with. The amount of differentially expressed genes represented in these biological processes gives an indication of the relevant importance of these processes during nodule development as well as senescence. The data also allowed us to identify specific members of gene families, such as proteases, that are expressed exclusively in nodules at specific stages during the development.

CONCLUSIONS

Generating and comparing large scale gene expression profiles during different stages of development allow us to gain a holistic understanding of the different processes involved in complex plant systems as well as the identification of key regulators that influence these processes. This could allow us to identify potential markers that could be used to select cultivars with enhanced nodule characteristics.

Keywords: Nodule development, senescence, soybean, transcriptome

SOIL SUITABILITY MAPS WITH DSM: CASE STUDY NEAR NAMARROI, MOZAMBIQUE

GM van Zijl¹, D Bouwer¹, JJ van Tol² and PAL Le Roux¹

¹University of the Free State, PO Box 339, Bloemfontein 9300; ²University of Fort Hare, Alice 5700

E-mail: vanzijlgm@ufs.ac.za

INTRODUCTION

Soil suitability maps plays an integral role in the establishment of new forest plantations. However, the process is tedious, often delaying the projects. Digital Soil Mapping (DSM) methods have been proven to reduce production time. DSM were used to create suitability maps for a large area for a new plantation establishment in Mozambique.

MATERIALS AND METHODS

Observation points were determined using different methods. Sampling across the attribute space of the area was ensured by using the Conditioned Latin Hypercube Sampling (cLHS) method, with different topographical layers used as input. Between cLHS sampling points, observations were made at the discretion of the soil surveyors. Observations were also made on selected transects to develop and improve tacit knowledge. The area was divided into six smaller areas with homogeneous topography. Suitability groups were developed and delineated using SoLIM. Thirty percent of the observations were used for validation. Soil properties were assigned to suitability classes and soil property maps created.

RESULTS AND DISCUSSION

The method showed an adequate accuracy to create soil suitability maps on medium scale/resolution for commercial enterprises. Soil properties were mapped using soil suitability map units implying that soil morphology and soil types are reliable transfer functions. For this study the transfer function was not restricted by diagnostic criteria to soil forms, as defined in classification systems, but tailor made, to match the requirements and objectives of the land use type.

CONCLUSIONS

DSM methods are useful to create suitability maps. Soil properties could be mapped using soil morphology as a transfer vehicle.

ACKNOWLEDGEMENTS

Digital Soils Africa
Research Cluster 4: University of the Free State

Keywords: Digital soil assessments, expert knowledge, production units, soil properties, terrain analysis

EVALUATION OF THE EFFECT OF AN ORANGE OIL-BASED SOIL AMELIORANT ON SELECTED SOIL PHYSICAL PROPERTIES

DW Viljoen¹ and JE Hoffman¹

¹*University of Stellenbosch, Private Bag X1, Matieland 7602*

E-mail: dwv@sun.ac.za

INTRODUCTION

A new soil ameliorant was recently introduced to the market. The aim of this study was to get a better understanding of the working mechanism of the product in the soil by studying the effects it might have on selected soil physical properties.

MATERIALS AND METHODS

The product under investigation is a soil ameliorant that contains orange oil and a blend of nonionic and anionic surfactants as main constituents. Trials with the product were done in two citrus orchards in Limpopo Province, one on a sandy clay loam (22% clay) where flood irrigation is used and the other on a loamy sand (7% clay) with micro irrigation installed; in a vineyard block in the Western Cape with sandy loam soils (20% clay) with drip irrigation installed, and in a plum orchard established on a single grained sandy soil (3-4% clay) with micro irrigation installed. The farms in Limpopo Province were investigated a second time to study the longevity effect of the product.

The soil physical properties under investigation were the bulk density determined according to the core method and sand fill method, aggregate stability percentage (ASP) determined according to the wet sieve method, and shear strength determined using the pocket vane tester.

RESULTS AND DISCUSSION

The texture analysis was used as an aid to describe the results of the other properties under investigation. No significant differences obtained for the bulk density. The differences might have been due to soil variation.

The application of the product showed no significant difference on the ASP. At the 5 cm depth, the control tended to have a lower ASP on the farms where the last application of the product was applied within 7 months prior to field studies. This may be due to the effect of the anionic surfactant which decreases aggregate stability. On the farms where the longevity was studied the opposite results were obtained. It can be attributed to the nonionic surfactant which has the ability to increase aggregate stability. Unlike the anionic surfactant that moves with the soil water, the nonionic surfactants sorbs to the soil particles on application to the soil.

There were no significant differences in the shear strength data. At the 5 cm depth the control tended to have higher shear strength values for the soils with clay contents below 10%. At the 5 cm depth the soils with 20% or more clay tended to have shear strength values which were lower for the control than for the treated soils.

CONCLUSION

The product did not have a significant effect on the selected soil physical properties. The immediate effect of the product might cause a decrease in aggregate stability, but over time the aggregate stability might increase. For the shear strength the effect of the product was opposite for the sandy soil compared to the soil with a more clay. Application of the product on hard, silica cemented soils can cause a decrease in shear strength which may enhance root growth.

Keywords: Aggregate stability, shear strength, surfactant, unsaturated hydraulic conductivity

FARMERS PERCEPTIONS OF THE TEN MOST IMPORTANT POTATO PESTS IN THREE PRODUCTION AREAS

D Visser¹

¹ARC-VOPI, Private Bag X293, Pretoria 0001

E-mail: dvisser@arc.agric.za

INTRODUCTION

More than 60 arthropod pest species are known to attack potatoes in South Africa (Visser, 2005). However, except for the key pests, it is currently uncertain which of these pests are prevalent in which potato production area and which production areas are experiencing yield losses due to which pests. A potato pest survey was initiated whereby potato farmers in the different production regions were interviewed regarding arthropod pests.

MATERIALS AND METHODS

A list of 20 potato farmers for each potato production area was obtained from Potatoes South Africa. Farmers were interviewed on-farm by using a 35-point questionnaire. A photo library with 104 photographs was shown to each farmer. These photographs included all pests ever recorded on potato and the farmer only had to indicate whether a pest has been a problem on his farm before. For each farmer a final list of 10 pests was finalized, each pest categorized into one of three ranks, i.e. high, medium or low.

RESULTS AND DISCUSSION

Three potato production areas have been completed, i.e. Limpopo, Loskop Valley and the Eastern Free State. The perception of the importance of certain pests varied between the three production areas. The potato tuber moth was the only pest reported in all three areas as being medium or high in importance. Leaf miners and nematodes were reported as important in two areas. Significant differences relating to pests and pest statuses that were never known before can now be observed for the first time for the different areas that were surveyed. Preliminary comparisons include: pests in Loskop, but not in Limpopo: millipedes and white grubs; pests in Limpopo, but not in Loskop: sucking bugs and spider mites; pests in Loskop, but not in E-Free State: loopers and white flies; pests in Limpopo, but not in E-Free State: sucking bugs, loopers and white flies; pests in E-Free State, but not in Limpopo: black maize beetle, white grubs, snout beetle and millipedes; pests in E-Free State, but not in Loskop: black maize beetle and snout beetle.

CONCLUSIONS

For the first time, data on the importance of potato pests in individual potato production areas are gathered and compared on a national scale.

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ACKNOWLEDGEMENTS

Potatoes South Africa (PSA) for funding.

Keywords: Potato farmers perceptions, potato pests, survey

THE PRODUCTION OF VEGETABLE PEST TRAINING VIDEOS FOR GAUTENG EXTENSION OFFICERS

D Visser¹ and S Netshifhefhe²

¹ARC-Roodeplaat, Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria 0001; ²Gauteng Department of Agriculture and Rural Development, 68 Eloff St., Diamond Corner Building, Johannesburg

E-mail: dvisser@arc.agric.za

INTRODUCTION

More than 300 pests attack vegetables in South Africa. Nearly all of these pests have been documented and presented in full colour in a vegetable pest book (Visser 2009). However, none of them have been documented on video. An audio-visual resource in the form of short documentary training videos, with accompanying sound to explain the pest, its ecology, as well as the damage it causes, will be of enormous value to Gauteng extension officers and small scale farmers. It can be seen as representing the ultimate technology transfer tool.

MATERIALS AND METHODS

The project is divided into four phases: 1. Studying of the main pest complexes to compile scripts as screenplays for individual videos; 2. Planting field trials with selected vegetable crops at the ARC-Roodeplaat VOPI for pest infestation purposes; 3. Daily scouting and videoing of pests and natural enemies within planted vegetable plots – an SLR camera with high definition capabilities and special lenses and lighting are used for videoing; 4. The production of high quality, high definition video clips in the Windows Media Video (wmv) format.

RESULTS AND DISCUSSION

The project is a two year assignment and currently at the halfway mark. All four phases of the project have been initiated. Screenplays for the proposed 39 vegetable pests and natural enemy training videos are in progress. Each screenplay is designed to contain all relevant information by using voice, text, stills and video. The aim will be to convey a detailed description of each pest and its damage inflicted on the relevant vegetable crop in the designated 20 minutes allowed for each video. The current technical specification of each video is: standard high definition (1280x720p); frame rate, 25fps; the bit rate of a video file will vary between 5 and 10 Mbps to make it fit on a 700MB CD. Each training video will be a single file, playable on any computer that is compatible with the wmv file format.

CONCLUSIONS

Documentary training videos will be invaluable tools in future training of extension officers and small scale farmers. It can be used as a technology transfer tool and to do presentations for many years, even after the experts have left the institution.

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ACKNOWLEDGEMENTS

Gauteng Department of Agriculture and Rural Development (GDARD) for funding.

Keywords: Extension officers, natural enemies, technology transfer, training videos, vegetable pests

HILLSLOPE HYDROLOGY AND CLIMATE CHANGE

MN Wasserfall^{1,2} and WP de Clercq²

¹*Farmsecure*; ²*University of Stellenbosch, Private Bag X1, Matieland 7602*

E-mail: nico.wasserfall@gmail.com

INTRODUCTION

Hillslope hydrology represents a complex system with several interacting processes influencing the movement of water through the landscape. The Western Cape region of South Africa is expected to be influenced by a change in climate and the importance of water management will increase in the future. As climate is the driving factor behind the hydrological system, future predictions of what the impact of climate change will be on hydrological conditions are important for water management programs.

MATERIALS AND METHODS

The researched system is situated on the Langgewens Experimental Farm, north of Malmesbury in the Swartland region of the Western Cape. Six specifically selected sites in a variety of different vegetation, land use and expected soil types were investigated along a toposequence. Through monitoring different components of the hydrological cycle, including rainfall, overland flow, infiltration, soil water content, base flow and water table depth at the different sites, the movement of water through the landscape can be defined. The baseline data obtained during this process is used in hydrological modelling to determine the accuracy of model predictions together with expected future climate conditions to determine the possible effect of a change in climate on the hydrological system.

RESULTS AND DISCUSSION

The research confirmed the complex interaction between different processes within the hydrological system. Soil properties were the most significant factor influencing water movement through the landscape, directly impacting infiltration, overland flow, lateral water flow and deep percolation. By comparing soil water content measurements with modeled water content throughout the season, accurate hydrological responses were created for different measuring points in the landscape. By using predicted climate data of two different weather generators, accurate estimations of expected soil water content were possible.

CONCLUSION

Water movement through the landscape is influenced by several processes and landscape properties. Soil properties are the most important factors influencing the movement of water through the landscape. Through monitoring hydrological conditions, accurate hydrological model responses indicate that droughts can be expected on a regular basis in the future.

Keywords: Climate change, hillslope hydrology, hydrological modeling, soil properties, water movement

DO SUGARCANE VARIETIES HAVE DIFFERENT NITROGEN REQUIREMENTS?

A Weigel¹ and N Miles^{1,2}

¹South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300;

²School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Durban 4000

E-mail: Annett.Weigel@sugar.org.za

INTRODUCTION

Nitrogen-balances for sugarcane indicate that up to 50% of the applied N may be lost and unavailable to the plant. This emphasizes a requirement for improved N-management strategies for the crop. Previous findings suggest that sugarcane varieties differ in N use efficiency (NUE), and therefore have varying N requirements (Schumann *et al.*, 1998). However, N recommendations provided by SASRI's Fertiliser Advisory Service (FAS) currently make no provision for varietal differences in N demand, and are based largely on the responses of variety NCo376 in field trials undertaken in the various climatic regions of the industry.

MATERIAL AND METHODS

Commencing in 2002, field trials have been undertaken in various climatic regions to determine the NUE of 15 commercial varieties. This paper deals with results of the first two drip irrigated field trials undertaken in Mpumalanga on a shallow Shortlands soil. These trials included three N levels (0, 50 and 100 kg N ha⁻¹) and four varieties (N19, N32, N25 and N36) in a randomized design. The N uptake of the crop was measured by destructive harvest of one meter cane row and analysis of the N content in the fractions stalk, green leaves, tops and trash in a C/N analyser. Fertilizer NUE (amount of applied N fertilizer per unit yield) and internal NUE (N uptake of the crop per unit yield) have been compared.

RESULTS

Variety N19 was found to have higher fertiliser NUE than variety N32. Thus, for optimum yield of N19, the FAS-recommended N rate could be reduced by approximately 20 kg ha⁻¹, whilst a reduction in N would not be appropriate for N32. A comparison of varieties N25 and N36 revealed a higher fertiliser NUE for the former variety. However, the internal NUE showed that N-usage for N25 was even higher than for N36. Indications are, therefore, that N25 was able to more efficiently exploit soil N reserves than N36, with this observation being supported by evidence of much higher N-uptakes from the zero N-plots. The possibility exists that as soil N reserves become depleted more fertiliser N would be required by N25, in particular for lighter soils with low N mineralisation capacity.

CONCLUSION

The results confirm that sugarcane varieties differ appreciably in their N-requirements. A more accurate determination of N requirements per variety would result in a reduction of N losses with potential saving for the grower and less impact on the environment.

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Keywords: Genotype, N-balance, N-mineralisation, Nitrogen Use Efficiency

EVALUATION OF THE EFFECTS OF AN ORANGE OIL BASED SOIL AMELIORANT ON SOIL WATER MANAGEMENT

N Wright¹, JE Hoffman¹ and DC Uys¹

¹*University of Stellenbosch, Private Bag X1, Matieland 7602*

E-mail: nordely@sun.ac.za

INTRODUCTION

The management of irrigation water and optimizing crop production is a field of study that warrants much attention. Due to increasing food demand, soil improvement and conditioning is always desirable. A new soil ameliorant that contains orange oil as a base and a mixture of surfactants was investigated. The current use of this soil ameliorant by farmers has made an impact on crop production on many farms. The effects of this soil ameliorant on selected soil properties and plant traits were evaluated by performing a pot trial.

MATERIALS AND METHODS

A greenhouse pot trial was performed to evaluate the effect of the soil ameliorant on soil properties and the plant traits of *Zea mays* L. An ameliorant treatment and an untreated control were each tested with four different plant available water depletions (PAWD), namely 10%, 50%, 50% with surface covering (denoted 50%C) and 80% PAWD. The trial with five single pot replicates per treatment combination was laid out according to a randomized block design. Plastic sheeting was used to prevent evaporation from the soil surface. The properties evaluated included evapotranspiration, dry root and shoot biomass, Biomass Water Use Efficiency (BWUE), Leaf Area Index (LAI), plant height and aggregate stability.

RESULTS AND DISCUSSION

The soil ameliorant application produced significant improvements. The dry root biomass was increased by 5% for the 10% PAWD and up to 45% for the 50%C PAWD. The dry shoot biomass showed a trend of increased production for ameliorant treated pots. LAI of the ameliorant treated pots was increased for all PAWD's. The ameliorant treated pots had a higher BWUE than that of the control for all the PAWD's except the 80% PAWD. The aggregate stability of the treated pots was improved for the 10% and 50%C PAWD while that of the 50% and 80% PAWD showed a decrease for the treated pots. There were no significant changes in the evapotranspiration attributed to the ameliorant treatment.

CONCLUSION

The application of this soil ameliorant made significant improvements in various facets of plant growth and aggregate stability. Aggregate stability was improved only under certain irrigation conditions. The dry root biomass, BWUE and the LAI were all significantly improved indicating larger and better performing plants. There is still much opportunity for research in this field and many questions remain, especially those pertaining to the mechanisms involved in the workings of a soil ameliorant.

Keywords: Aggregate stability, biomass water use efficiency, soil water management and surfactants

SOIL WATER SIMULATION OF FALLOW PLOTS OF VARYING RUNOFF STRIP LENGTH UNDER IN-FIELD RAINWATER HARVESTING

MG Zerizghy¹ and LD van Rensburg¹

¹*University of the Free State, PO Box 339, Department of Soil, Crop & Climate Sciences, Bloemfontein 9300*

E-mail: Mossesg@yahoo.com

INTRODUCTION

Fallowing under in-field rainwater harvesting system can create an opportunity for boosting the amount of water stored in the profile. Water storage is the result of gains and losses of water. This can fairly be represented by using models of the components of soil water balance. The objective of this study was to evaluate the storage gains achieved by different basin to runoff strip length (RSL) ratios during fallow period.

MATERIALS AND METHODS

To characterise the water balance of the IRWH system, models of the components of the water balance were integrated. Validated runoff and evaporation models, drainage curve and daily rainfall data were used to observe the daily soil water change.

RESULTS AND DISCUSSION

The plot level rainwater storage efficiency (RSE) values ranged from 8 to 33% and 29 to 58% for the long and short fallows, respectively. These ranges for the Paradys-Tukulu were 7 to 24% and 23 to 56% for the long and short fallows, respectively.

CONCLUSION

From the simulation conducted it can be concluded that for different scenarios of long fallow, the 1:1, 1:2 and 1:3 basin to RSL ratios does not bring much variation in the storage achieved. For short fallow, however, the amount of water stored increased with increasing RSL.

Keywords: Fallow, runoff strip length, soil water balance, soil water storage, water harvesting

PROJECTED IMPACTS OF 21ST CENTURY CLIMATE ON CROPS IN SOUTHERN AFRICA

N Zinyengere¹, O Crespo¹ and S Hachigonta²

¹*Climate Systems Analysis Group (CSAG), Department of Geography and Environmental Science, University of Cape Town, P Bag X3, Rondebosch 7701, Cape Town;* ²*Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN), 141 Creswell Street, Weavind park 0184, Pretoria*

E-mail: nkulumo@csag.uct.ac.za

INTRODUCTION

It is common to find incomplete and in some cases inconsistent information on how the impacts of climate change on crops in southern Africa will unfold. This is due to the different methodologies and tools applied in climate change impact assessments and have severe implications on how decisions on climate change are made at policy level. This study sought to draw out the overall picture of how climate change will impact crops in the region by reviewing and consolidating recent studies.

MATERIAL AND METHODS

Several studies which quantitatively project the impacts of climate change on crops in SA and published over the period of 2001-2011 were reviewed. In the end, 19 studies were included in the analysis. The results of these studies were consolidated based on the crop modelling methodologies applied for crop response projection i.e. process-based (PB), statistical-based (SB) and Ricardian. Crop response projections were presented using basic descriptive statistics to show overall projected changes in crop yields or farm revenues per crop modelling method and period within the 21st century.

RESULTS AND DISCUSSION

Results suggest that the aggregate impact of climate change on crops in southern Africa will be negative. Maize yields are projected to decline on average by -18%. Although uncertainties remain, the collective impact of climate change on all crop yields shows a median decline of -11% and -14% respectively under process-based and statistical methodologies. Median impacts show declining crop yields through the 21st century; No significant change in the near future, -18% for the mid century and -30% for late century. GCM driven Ricardian projections are highly variable. However, uniform climate scenarios project a median revenue decline. Small holder subsistent farmers are most at risk from climate change.

CONCLUSIONS

Results indicate that climate change will negatively impact southern African crops thereby making adaptation essential, especially for subsistence farmers. Adaptation could be achieved through exploiting already existing innovations, underpinning institutional capacities to support farmers, and improved social services.

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Keywords: adaptation, climate change, crop modeling, crop production, southern Africa

SEED QUALITY OF BAMBARA GROUNDNUT (*Vigna subterranea* L. Verdc) LANDRACES BASED ON PROVENANCES AND SEED COAT COLOUR

LZ Zondi¹ and AT Modi¹

¹Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, P.Bag X01, Scottsville 3209

E-mail: zondil@yahoo.com

INTRODUCTION

Bambara groundnut (*Vigna subterranea* L. Verdc) is an indigenous African leguminous crop grown primarily for its grain. It has been identified as a drought tolerant crop capable of producing reasonable yields where other crops, such as groundnut, fail. However, the crop remains underutilised owing to limited research done. Low levels of utilization can also be linked to low and unpredictable yields, especially in low-input farming systems. Low yields have been associated with poor seed quality in terms of germination and emergence (Mabhaudhi, 2012). Recently, Mabhaudhi (2012) suggested an association between seed coat colour and improved vigour in bambara groundnut. In South Africa, bambara groundnut is still cultivated using landraces of which little is known about their seed quality. There is a need to evaluate the seed quality of bambara groundnut landraces from different locations in South Africa. The objective of this study was to determine the relationship between seed coat colour and seed quality of different bambara groundnut provenances in terms of seed performance during germination.

MATERIALS & METHODS

Bambara seeds were sourced from subsistence farmers of Tugela Ferry (KwaZulu-Natal), Deepdale (KwaZulu-Natal) and Zimbabwe during February 2011. Seeds were characterised into different colours: light brown, brown and red. Standard germination test using the paper towel method was conducted. The experiment was replicated three times and five seeds were used per rep. Daily measurements of germination were taken by counting the number of seeds that had germinated. The criterion for germination was radicle protrusion. Final germination was determined on day eight based on observations of normal seedlings. Following this, seedling root and shoot length, fresh and dry mass as well as root: shoot ratio were determined. Vigour indices, namely, germination velocity index (GVI) and mean germination time (MGT) were calculated and used to evaluate seed vigour.

RESULTS & DISCUSSION

Although final germination results showed no significant differences between seed colours and provenances, daily germination differed significantly ($P < 0.001$) between provenances and seed colour. On average, Jozini 30 (J30) was the best performing provenance (65%) compared with the lowest performing provenance, Jozini Rainfed (JRF) (51%). On average, the dark coloured seeds [brown (63%) and red (60%)] performed better than the light coloured seed selection (59%). Dark coloured seeds also performed better in vigour parameters such as shoot length, root length, dry mass and fresh mass in most provenances. Germination speed (GVI) was shown to differ significantly ($P < 0.05$) between provenances and seed colour. The light brown (4.71) selection for most provenances had a higher GVI compared with brown and red selections (4.29).

CONCLUSIONS

It is concluded that seed colour is an important variable in the identity of bambara landraces. Provenance plays a significant role in seed performance and there is a significant interaction between provenance and seed coat colour.

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Keywords: Bambara, landraces, seed coat colour, seed quality

THE EFFICIENCY OF DIFFERENT TINE IMPLEMENTS AND SHEAR TYPE ON LOOSENING SOIL

MJ du Plessis¹ and PJ van Biljon²

¹NWK Limited, PO Box 107, Lichtenburg 2740; ²ARC-IAE, Private Bag X519, Silverton, Pretoria 0127

E-mail: martiens@nwk.co.za

INTRODUCTION

Soil compaction usually forms in agricultural fields with a sandy soil texture and do injustice to plant root development. Therefore, compacted layers must be lifted regularly to optimise root development. Lifting compacted layers, especially in the subsoil, are usually done by means of deep ripping. Tine implements and shear type differ in terms of its efficiency on loosening soil. A study was initiated to establish the efficiency of different implements and shear types on loosening soil.

MATERIALS AND METHODS

The trial was executed during August 2010 on three different soil types in the districts of Koster, Lichtenburg and Vryburg, North West Province. Tillage was performed with various implement types (treatments), namely Rovic Super 32, Rovic Super 25 (standard shears and hammer head shears), Rovic Super 19, Rovic DLB 12, Kongskilde Paraplow, Kongskilde Vibro Flex (standard and grass shears), Rovic Trash Fieldspan, Rovic Trash Handicult, Erdvark Offset, Erdvark Oneway and a Vetsak moldboard shear plough. A strip approximately 50 m long was tilled, and a return trip was included for replication. On the go, approximately every one second, the forward speed, fuel ratio, engine power, drawbar power and wheel slip were recorded using a telemetry system via a data logger. The parameters were measured using GPS unit, oval meter, 3 point hitch dynamometer and a set of magnets. A profile pit was opened on every treatment and the loosened soil was removed to expose the implement's cultivation profile. The cultivation profile was logged by means of laser. Efficiency was calculated as power needed per volume of soil loosened (kN/m^2).

RESULTS AND DISCUSSION

The efficiency of the rippers with standard tines, was poor ($>80 \text{ kN/m}^2$); The Super 25 with hammer head shears performed well ($40 - 55 \text{ kN/m}^2$); Chisel ploughs performed fairly good ($60 - 80 \text{ kN/m}^2$). The grass shears on the Kongskilde Vibro Flex were more efficient than the standard shears. The efficiency of the shear plough compared well to that of the Super 25 with hammer head shears. The Erdvark One-way outmatched all the other implements.

CONCLUSIONS

The efficiency of especially tine implements varies a lot and is over all not very efficient. Equipping rippers with hammer head shears improve their efficiency a lot. The efficiency of the Erdvark One-way was surprisingly good.

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Keywords: Power tests, shear type, soil compaction, soil tillage