ABSTRACTS

ORAL PRESENTATIONS

LISTED ALPHABETICALLY

EFFECT OF TEMPERATURE STRESSED AMARANTHUS CRUENTUS L. RESIDUES AND EXTRACTS ON VEGETABLE SEED GERMINATION AND SEEDLING GROWTH

Allemann, I., Cawood, M. and Allemann, J.

University of the Free State PO BOX 339 Bloemfontein 9300

E-mail: Allemann@ufs.ac.za

INTRODUCTION

Climate change has become a big concern for researchers in the field of agriculture. The human population is ever growing and it has become imperative to protect food security. *Amaranthus cruentus* is now in the spot light as a new crop, the re-establishment of this plant is slowing gaining popularity. It has therefore become critical to understand its physiology and therefore its possible effect on follow-up crops. The aim of this trial was to examine the effect of different temperatures on the allelopathic properties of *A. cruentus* on vegetable germination and growth.

MATERIALS AND METHODS

A. cruentus plants will be exposed to temperature stress to determine if there will be an effect on the allelopathic compounds produced and how this could impact other vegetables when used in rotation systems. Plants were stressed at 40/33 °C, 28/21 °C and 14/7 °C, 12 hours daylight. The allelopathic potential of plant residues and extracts from stressed plants were evaluated. Dried leaves were finely ground and extracted with dichloromethane (DCM) and a methanol water mixture (7:3). A double layered agar (5 %w/v) technique was used to evaluate the effect of the dried plant residues (10 and 50 mg 10 mL^{-1}) and the extracts (5 and 20 mg 10 mL^{-1}) on the germination and growth of different vegetable seeds. The extracts were dissolved in the respective solvents (1 ml) and transferred to filter paper which was dried then placed between agar layers in six-well plastic dishes. Filter papers with only the solvents were used as controls. Five - ten seeds were placed on the top surface of the agar. A completely randomised bock design was used with three replicates. After three days the lengths of the radicle and hypocotyl, as well as germination percentage were determined. All results were compared to the controls and subjected to statistical analysis.

RESULTS AND DISCUSSION

Seed germination was most markedly inhibited by residues of heat treated plants on peppers by 81% followed by cucumber at 66%, lettuce at 40% and tomato at 34% at the highest concentration. Vegetables exposed to extracts have an inhibition of up to 65%. Organ length was inhibited by up to 100% and 75% for residues and extracts respectively. Further soil studies are needed to correlate with the laboratory studies.

CONCLUSIONS

Residues of all three temperature stresses caused a significant reduction in organ elongation with the greatest effect being found at 50mg 10mL^{-1}. The organ length of pepper seeds were most severally affected of all the vegetables exposed in both the residue and extract trials.

Keywords: **c**limate change, food security, temperature stress, residues, extracts

MOLECULAR IDENTIFICATION OF CULTIVARS IN *Carya illinoinensis* [(WANGENH) K. KOCH]

Allen, A., Coetzer, G.M. and Spies, J.J.

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

E-mail: devosa@ufs.ac.za

INTRODUCTION

Pecan (*Carya illinoinensis*) is an important horticultural nut crop originally from North America. The cultivars grown in South Africa adapted well to the local climate and have good characteristics, but lack genetic data. The Simple Sequence Repeat (SSR) technique is based on the PCR method and has been very informative in cultivar identification in many crops. The aim of this study is to use the SSR markers developed by Grauke et al (2003) to analyse the genetic diversity and to molecularly identify the South African pecan cultivars.

MATERIALS AND METHOD

SThe leaf material of 151 trees, representing 43 cultivars was collected. DNA was extracted using the NucleoSpin Plant II kit (Seperations). The One *Taq*® Mastermix and Standard buffer (BioLabs) protocol were used. PCR fragments were color labeled and fragment analysis was done on an ABI 3310 automated sequencer (Applied Biosystems). The relative size of the alleles was determined using GeneMarker V 2.2.0 (SoftGenetics LLC®).

RESULTS AND DISCUSSION

The results showed that the primer pair's used in this study, when combined, can effectively identify some of the cultivars. It can also aid in the cultivation and management of this crop by establishing a complete reference database of the cultivars in South Africa. The accession identity is crucial to the function of active breeding programs because it is important to associate genetic markers with the expression of phenotypic traits and this can be done by means of a linkage map.

CONCLUSIONS

With the results obtained in this study it can be concluded that the SSR technique is a very informative technique for identification and genetic diversity analysis.

REFERENCES

Grauke, L.J., Iqbal, M.J., Reddy, A.S. and Thompson, T.E. 2003. Development of microsatellite DNA markers in pecan. J. Amer. Soc. Hort. Sci. 128:374-380.

ACKNOWLEDGEMENTS

We would like to thank the University of the Free State and the National Research Foundation for contributing to this study.

Keywords: Carya illinoinensis, cultivar identification, genetic diversity, fragment analysis, microsatellites

DESIRABLE PLANT TRAITS FOR IMPROVING YIELD POTENTIAL OF UPLAND RICE (*Oryza sativa* L. *neriga*) UNDER WATER STRESS AT DIFFERENT PHENOLOGICAL STAGES

Alou, I.N., Steyn, J.M., Annandale, J.G. and Van Der Laan, M.

School of Plant and Crop Sciences, University of Pretoria Private Bag X20 Hatfield, 0028 South Africa

E-mail: u13380291@tuks.co.za

INTRODUCTION

Rice (*Oryza sativa* L.) grown in upland conditions, is exposed to variable soil water conditions and very unpredictable periods of water stress (WS). There is a paucity of knowledge on effects of WS on rice performance and this hinders improvements in adapting the crop to water limited conditions and improving water use efficiency.

MATERIALS AND METHODS

Upland rice (cv. NERICA 4®) was grown in a rain-out shelter for two seasons to investigate the impacts of WS at different growth stages (GS). In addition to a well-watered control (CT), four WS treatments were imposed by withholding irrigation for the duration of different GS: tillering (Ti), panicle initiation (PI), anthesis (AT) and grain filling (GF). Profile soil water content, plant height, tiller number, leaf area index (LAI), fractional interception (FI) of radiation, stomatal conductance during WS, and dry matter (DM) yield of stems, leaves, panicles and spikelets were measured at least weekly and grain yield and yield components were determined at harvest.

RESULTS AND DISCUSSION

Under stress at Ti and at PI, delays in flowering and anthesis or heading were highly significant ($p < 0.0001$). Plants stressed at Ti and PI maintained higher FI than the CT at the end of both seasons. Dry matter accumulation was maximum at anthesis for CT while under stress it occurred at around first flower appearance, suggesting highly plastic growth when stress occurs during PI. Days to maturity of plants from all treatments was similar as for CT, except for rice stressed during panicle initiation in the second season, when days to maturity was slightly delayed. Crop growth rate (g m-2 d-1) was correlated with stover DM ($p = 0.05$, $r = 0.41$) but not with grain yield. Grain yield was closely correlated ($p < 0.0001$) with number of spikelets m-2 ($r = 0.76$) and negatively correlated with sterility ($r = -0.74$). On average, sterility was more enhanced by stress at Ti than at AT. About a third of the grain yield is lost when stress occurs in AT and Ti stages, a quarter with stress in GF and as much as 70% of the yield is lost with stress in the PI stage. Water use efficiency decreased under stress but not considerably after AT and at GF, suggesting the possibility of saving water.

CONCLUSIONS

Water stress in PI resulted in highest grain yield losses. Increase in spikelet sterility and reduction in grain number contributed most to yield loss as a result of water stress.

Keywords: adaption, leaf area duration, new rice for Africa®, phenology

INFLUENCE OF HYDROXYLATED BENZYLADENINE AND ITS DERIVATIVES IN MICROPROPAGATION OF HORTICULTURAL AND MEDICINAL PLANTS

Amoo, S.O.[1], Moyo, M.[2], Aremu, A.O.[2], Plíhalová, L.[3], Doležal, K.[3] and Van Staden, J.[3]

[1]ARC-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001, South Africa; [2]Research Centre for Plant Growth and Development, University of KwaZulu-Natal Pietermaritzburg, Private Bag X01, Scottsvile 3209, South Africa;[3]Department of Chemical Biology and Genetics, Faculty of Science, Palacký University and Institute of Experimental Botany, Academy of Sciences of Czech Republic, Czech Republic;

E-mail: amoos@arc.agric.za

INTRODUCTION

Plant growth regulators, especially cytokinins (CKs), are indispensable additives to plant tissue culture media for regulating different physiological and biochemical processes during micropropagation. Among the CKs, benzyladenine (BA) has often been used due to its effectiveness and relative low cost. Nonetheless, the application of BA is known to result in some negative effects such as growth heterogeneity and rooting inhibition, which are attributed to its stable N9-glucoside metabolites (Werbrouck et al., 1995). This has led to the discovery and development of novel CK derivatives including hydroxylated BA. In order to determine the effectiveness of these new derivatives as alternatives in plant tissue culture, we investigated the effects of different hydroxylated BA derivatives on the growth of different horticultural and medicinal plants in comparison to the CKs previously used as the most active for their micropropagation.

MATERIALS AND METHODS

Different concentrations of hydroxylated BA derivatives [such as meta-topolin (mT), meta-topolin riboside (*m*TR) and *meta-topolin* tetrahydropyran-2-yl (*m*TTHP)] were evaluated in comparison to BA, thidiazuron (TDZ), or benzyladenine riboside (BAR). Following *in vitro* culture, the influence of applied CKs on shoot production and growth, rooting, abnormality index and phenolic compound production was recorded.

RESULTS AND DISCUSSION

In *Merwilla plumbea* culture, the treatments with *m*TTHP and *m*TR gave the highest rooting frequency and number of adventitious shoots respectively, when compared to TDZ. After one year of transfer to the greenhouse, *M. plumbea* plants treated with *m*TTHP had a significantly higher number of leaves per plant, total leaf area per plant, total leaf fresh weight and bulb diameter. The application of mT improved rooting and reduced hyperhydricity in *Aloe polyphylla*, unlike in BA and zeatin treatments. Shoot multiplication significantly increased with the use of mT and *m*TTHP in *Aloe arborescens* compared to BAR.

CONCLUSIONS

Our findings indicate the superiority of hydroxylated BA in improving shoot production and growth and reducing tissue culture abnormalities when compared in most cases to other CKs commonly used in micropropagation. The application of hydroxylated BA holds a great potential for increasing in vitro shoot production without compromising shoot quality.

REFERENCE

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Keywords: BA, cytokinins, plant tissue culture, topolin

VALIDATING SAP FLUX DENSITY MEASUREMENT METHODS IN POTTED CITRUS SINENSIS

Banda, M., Vahrmeijer, J.T. and Taylor, N.J.
Department of Plant Production and Soil Science Faculty of Natural and Agricultural Sciences, University of Pretoria, Private bag X20, Hatfield, 0028, South Africa

E-mail: mathy.banda@gmail.com

INTRODUCTION

The measurement of stem sap flow is a widely used indirect approach for estimating tree transpiration. Techniques that use heat as a tracer to determine sap flow include (i) heat ratio method (HRM), (ii) compensation heat pulse method (CHPM) and (iii) thermal dissipation probe method (TDPM). These methods tend to underestimate transpiration and species specific calibration is required in order to accurately measure transpiration. Therefore, the main aim of this study is to determine the most suitable method which accurately quantifies transpiration in citrus.

MATERIALS AND METHODS

The experimental work was conducted in a glasshouse where mass loss (transpiration) from 12 year old potted 'Midknight' Valencia trees was measured with two calibrated weighing lysimeters and compared with sap flow measurements using the HRM, CHPM and TDPM. Validation included linear regression analysis between transpiration determined from the weighing lysimeter and transpiration determined by each method i.e. HRM, CHPM and TDPM.

RESULTS AND DISCUSSION

Sap flow measurements were conducted in citrus for a period of 6 days using the HRM and good correlations were obtained between the two trees and the weighing lysimeters (Tree 1 $R2 = 0.72$; Tree 2 $R2 = 0.84$). On average the HRM overestimated transpiration for tree 1 by 8% per day, and transpiration for tree 2 was underestimated by 5%. The correlations between the TDPM and the weighing lysimeters were fairly constant for both trees (Tree 1 $R2 = 0.74$; Tree 2 $R2 = 0.75$) nevertheless transpiration was underestimated by 70% in tree 1 and 50 % in tree 2 on average per day. Results from the CHPM also resulted in a good correlation with the weighing lysimeter ($R2 = 0.80$) but transpiration was overestimated by 20%.

CONCLUSION

Sap flow techniques, which use heat as a tracer to estimate transpiration are powerful tools which provide a means of quantifying whole tree transpiration. In comparison the HRM proved to be more accurate in estimating daily transpiration than the CHPM and the TDPM in citrus.

ACKNOWLEDGEMENTS

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

Keywords: citrus, water use, sap flow measurements, transpiration

THE QUEST FOR THE BEST MATURITY INDEX FOR AVOCADO

Bertling, I. and Olarewaju, O.

Horticultural Science, UKZN, Pietermaritzburg, P/Bag X01, Scottsville, 3209

E-mail: bertlingi@ukzn.ac.za

INTRODUCTION

Commercial maturity of avocado fruit is measured by various means in the avocado-producing countries of the world; such parameters include percentage mesocarp dry matter, percentage moisture (MMC) and oil content (MOC). While MOC is considered the most reliable maturity parameter, its determination is time-consuming. The value similar to MOC, dry matter, includes other substances besides oil. The reciprocal value to dry matter, percentage moisture, is often not well-correlated to percentage oil. Despite adhering to the regulation of a certain minimum maturity standard, fruit sometimes do not ripen properly, indicating immaturity.

MATERIALS AND METHODS

To determine if oil, dry matter or total soluble solids (TSS), as a measure of the mesocarp sugar concentration, can be used as reliable maturity parameters in 'Hass' and 'Fuerte' avocados, fruit from two cool subtropical farms were harvested throughout the 2014 growing season and the alterations in MOC, dry matter and % TSS determined.

RESULTS AND DISCUSSION

While moisture content of 'Hass' and 'Fuerte' fruit decreased over the six months observation period, dry matter increased, but MOC seemed to peak in August in the one location, while it had a tendency to increase up to the last harvest in the other. The MOC was not as well correlated with any of the other parameters as expected; mesocarp TSS was found to also not consistently increase with fruit maturity and does not seem to be a reliable avocado fruit maturity indicator.

CONCLUSION

The parameters MMC and dry matter seem to be the most reliable avocado maturity measures; however, as there was no peak in these parameters, the 'optimal maturity', as previously determined by palatability, remains questionable.

Keywords: avocado, maturity, oils, sugars

CHARACTERIZATION OF *Cyperus esculentus L.* (YELLOW NUTSEDGE)

Bezuidenhout, S.R.

KZN Department of Agriculture and Rural Development, Private Bag X9059, Pietermaritzburg, 3200

E-mail: bezuidenhouts@kzndard.gov.za

INTRODUCTION

In order to maximize crop competiveness, knowledge of the biology and phenology of the weeds in the field is essential. For *Cyperus esculentus*, day length determines the vegetative and reproductive growth. Day length periods of 8-12 hours promote tuber formation and 12-16 hours are conducive for vegetative growth. Tubers are formed four to six weeks after seedling emergence. The objective of the study was to determine whether different tuber weights influence emergence, the number of tubers formed, plant vigour and flowering times of *C. esculentus* under local conditions.

MATERIALS AND METHODS

Cyperus esculentus tubers were divided into four weight classes, 0 - 0.1, 0.11 - 0.15, 0.16 - 0.2 and >0.2 g. Ten tubers of each weight class were planted into pots on 25 July 2012 and 14 July 2014 respectively. For eight weeks after emergence, plants in each weight class were removed from the pots and the tuber and stems separated, counted and weighed. Above-ground growth was dried at 70°C and the weight determined after three days. Flowering was counted when the umbel was visible. Treatments were replicated 10 times in a randomized block design and treatment means were compared using Fisher's Protected Least Significant Difference test (P=0.05).

RESULTS AND DISCUSSION

For the entire growth period, day length was measured as 10 hours. Three weeks after the first sign of emergence, the first tubers were starting to form in all the tuber weight classes. Although the different tuber classes produced similar numbers of tubers, those formed by the small tubers had a significantly lower tuber weight. The foliage dry weight reached a maximum six weeks after emergence where after no significant increases occurred. Flowers started to form three weeks after emergence. The number of flowers originating from extra-large tubers reached a maximum at five weeks while the others reached a maximum at seven weeks.

CONCLUSIONS

Tuber size as defined by different weight categories did have an influence on *C. esculentus* growth. Small tubers had a lower number of sprouts that emerged compared to the other three weight classes. Tuber size does not influence the number of tubers that are formed. However, the weight of the tubers did differ significantly. The extra-large tubers had higher tuber weights, which in turn gave rise to more vigour in plant growth. Therefore, seedlings that sprout from extra-large tubers will be more resilient. Although day length is important in tuber formation and flowering, results from this study indicate otherwise. There was little variation in day length, yet tubers and flowers were still initiated. For more effective control of this weed, control strategies must focus on the period three weeks after the seedlings are observed. Follow-up treatments must be focused on repeated defoliation as the number and vigour of sprouts will decline after each defoliation. Future work should focus on differences in tuber formation and flowering times between various ecotypes.

Keywords: Cyperus esculentus, day length, tubers

CLIMATE CHANGE RELATED IMPACT ON AGRICULTURAL PRODUCTION: A CASE STUDY ON CITRUS IN THE SOUTH AFRICAN REGION

Bijzet, Z.[1] and Weepener, H.[2]

[1]ARC-ITSC, Private Bag X11028, Nelspruit 1200; ; [2]ARC-Institute for Soil, Climate and Water, Private Bag X79, Pretoria, 0001

E-mail: zeldab@arc.agric.za

INTRODUCTION

The effects of climate change are experienced as amplified climate variability extremes as a result of global warming, which is in turn related to human activities. Across the world, climate change has already resulted in rising temperature trends and is associated with changes in atmospheric circulation patterns and higher climate variability. South Africa relies largely on rainfed agriculture and is vulnerable to the impacts of rainfall variability. This impacts on citrus with regard to higher costs of irrigation and an enlarged carbon footprint, as well as yield and quality decline of especially long-season varieties of citrus. Predicting the climate shifts with regard to the different groups of citrus, mitigation focus can be either on the physical environment, such as management practices, or on employing genotypes with enhanced tolerance/resistance to biotic and abiotic stresses.

MATERIALS AND METHODS

An ensemble of six high resolution (0.5° horizontal resolution) climate projections was employed to investigate potential changes in the suitability of the climate component with regard to the production of the different citrus types in South Africa. Environmental suitability criteria for Citrus were used to prepare a time series (1970 to 2090 at 15 year intervals) of maps to show potential shifts in production areas. The land type data has been used for soil properties. Areas unsuitable due to soil criteria are masked out in the maps and are kept as a constant over time

RESULTS AND DISCUSSION

Based on data from the countries of origin for citrus, as well as data from the current local production areas, it was found that the area suitable for citrus production in South Africa will gradually shrink over the next 75 years. For the immediate 15 year period from 2015 to 2030 the impact seems to be more pronounced for the Northern parts of South Africa, with largest impact being on Valencia and grapefruit production. However, various mitigation opportunities are available and are discussed.

CONCLUSIONS

Substantial climatic shifts in the long term have been found to be likely, with a concomitant effect on each of the citrus types produced in South Africa. These changes will need to be mitigated against in order to ensure continued production.

Keywords: climate change, citrus, climate projections, mitigation

EXPLOITING CONCEALED EXPERT KNOWLEDGE FROM LAND TYPE DATA USING TERRAIN ANALYSIS

Botha, C.C., Le Roux, P.A.L., and Van Zijl, G.M.

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

Email: jacobsc@ufs.ac.za

INTRODUCTION

The escalating awareness of the ecosystem and global health has attracted the attention of various disciplines in the last few years. Some of the soil functions society are concerned with include food security, ecosystem services, water security and infrastructure. Soil degradation is one of the large concerns due to its negative influence on natural and managed ecosystems. Along with the escalating awareness of the ecosystem comes an increased demand for high-resolution soil information. However, there is a shortage of this information, due to the cost and time constraints linked to traditional soil mapping. The solution to these constraints arrived with the development of Digital Soil Mapping (DSM). This project's objectives were to use DSM tools to disaggregate Land Type inventories, the only soil dataset which covers the whole of South Africa, into soil association maps. The main aim was to determine at which accuracy the Land Type inventories can be disaggregated.

MATERIALS AND METHODS

Land Types from two sites were disaggregated. In a simple site, Land type Ac265 from Cathedral Peak was used. The more complex site near Ntabelanga comprised two land types, Fa1003 and Db334. The Land Types were divided into hillslopes and soil associations were assigned to specific terrain morphological units with terrain analysis, which yielded the soil association maps. The maps were validated with field observations.

RESULTS AND DISCUSSION

The Cathedral Peak map achieved a Kappa value of 0.66, which indicates a substantial agreement with reality. The Ntabelanga Map achieved a Kappa value of 0.2 which is substantially less than Cathedral peak. This was expected with Ntabelanga displaying a more complex environmental setting with 3 lithologies, 2 Land Types and an intense degree of degradation.

CONCLUSIONS

The results show that there is potential in disaggregation of land types for the creation of soil association maps especially as a form of preliminary phase soil study.

ACKNOWLEDGEMENTS

Dr Johan van Tol and the South Africa Soil Surveyors Organization (SASSO) are gratefully acknowledged for the use of their field data for validation.

Keywords: digital soil mapping, disaggregation, legacy data, soil association map

INFLUENCE OF PHOTO-SELECTIVE NETTINGS ON POSTHARVEST QUALITY AND BIOACTIVE COMPOUNDS OF CORIANDER (*Coriandrum sativum* L.)

Buthelezi, N.M.D., Sivakumar, D. and Soundy, P.

Tshwane University of Technology, Department of Crop Sciences, Private Bag X 680 Pretoria, 0001

E-mail: SivakumarD@tut.ac.za

INTRODUCTION

Photo-selective netting is frequently used to protect horticultural crops from excessive solar radiation, improving the thermal climate (temperature, relative humidity and light quality), sheltering from wind and hail, and exclusion of bird and insect-transmitted virus diseases. Nets are also used to prolong or delay the harvesting period in sunny areas. Photo-selective shade nets enhance desirable physiological responses such as yield, quality (e.g. size, weight and colour) and maturation rate. Light is known to regulate not only plant growth and development, but also the biosynthesis of both primary and secondary metabolites. Phenolic biosynthesis is enhanced by light, and flavonoid formation is absolutely light dependent and its biosynthetic rate is related to light intensity and density. Temperature control is the most important aspect of good postharvest management of fresh herbs. The optimum storage conditions for most leafy vegetables and herbs are 0°C and 95-98% relative humidity (Shahak *et al*., 2004b).

MATERIALS AND METHODS

Coriander was grown under three different photo-selective “coloured” nets (red, pearl and yellow, with 40% shading intensity) and commercial black net with 25% shading intensity. The experiment was laid out in a randomised complete block design, with three replicate nets assigned to each of the four treatments (red, pearl, yellow and black nets). Coriander was produced under early summer conditions (mean temperature 26.5°C and 40% relative humidity) of 2014. Photosynthetically active radiation (PAR), air temperature and relative humidity were recorded with data loggers. At harvest and after postharvest storage, coriander was analysed for sensory quality, weight loss, CIEL colour parameters, antioxidant activity, ascorbic acid, total carotenoids, chlorophyll a and chlorophyll b, ß-carotene, flavonoids and phenols.

RESULTS AND DISCUSSION

At harvest, coriander produced under the black net had higher antioxidant activity, ascorbic acid, flavonoids and phenols. Coriander produced under pearl net had the lowest a* value (indicating greener colour of leaves). However after postharvest storage coriander produced under the black net showed greater loss in weight, ascorbic acid and chlorophyll a content, whereas it showed greater increase in antioxidants. Untrained panelists preferred coriander produced under the pearl net based on the maximum quality (visual quality, adaxial side leaf colour and typical aroma) obtained under this net and it also had the highest marketable yield (95%), ascorbic acid and chlorophyll a content.

CONCLUSIONS

Based on the panelists and postharvest results, pearl net can be recommended to produce good quality coriander.

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Keywords: coriander, light intensity, photo-selective nets, postharvest

CHEMICAL AND PHOTOMETRIC PROPERTIES OF BLEACHED TOPSOILS OCCURING ON RED AND YELLOW-BROWN APEDAL SUBSOILS

Carstens, M.E., De Clerq, W.P., Le Roux, J.L. and Clarke, C.E.

University of Stellenbosch, Private Bag X1, Matieland, 7602

Email: marileecarstens@gmail.com

INTRODUCTION

Bleached topsoils occurring on red and yellow-brown apedal subsoils are poorly understood and taxonomically not distinguished from their non-bleached counterparts. Bleaching is an important pedological indicator and should be recognised by defining clear diagnostic criteria for classification. Bleaching is identified by its colour, thus precise and objective colour measurement procedures are required to correctly identify them. This study aims at understanding the spatial distribution of these soils and the chemical, physical and spectral reflectance properties of bleached topsoils to provide clues on their genesis.

MATERIALS AND METHODS

The soil profile database and sub-samples collected from the soil store of the Institute for Soil, Climate and Water were used in this study. Soil colours were measured both visually (Munsell colour charts) and spectroscopically (Konica-Minolta spectrophotometer). Colour measurements were correlated to various soil properties and also used to classify soils as bleached or non-bleached. Classification was achieved by following the criteria outlined in the South African soil classification system (Soil Classification Working Group, 1991).

RESULTS AND DISCUSSION

Spectroscopic soil colour estimates showed stronger relationships with visual colour estimates by Munsell chart comparison in laboratory conditions, than with visual estimates made in natural daylight conditions. Spectroscopic colour tended to be redder, lighter and less colourful in terms of Munsell hue, value and chroma, which led to higher occurrences of bleaching. Difference between visual and spectroscopic measurements can mostly be attributed to methodological differences in precision level. Bleaching was significantly related to reducible Fe, exchangeable Mg percentage and lithology, with bleaching frequencies being highest in siliceous rocks. Bleached topsoils were most prevalent above yellow-brown apedal subsoils, followed by neocutanic subsoils and least prevalent above red apedal B horizons. Weak relationships exist between measured soil colour components, soil organic carbon content and total reducible Fe. Weak relationships may be due to large spatial spread of the soils and the fact that soil colour expression represents a complex interaction between chemical and physical soil components.

CONCLUSIONS

For soil applications, such as the pedological significance of bleaching, the use of instrumental colour estimates provide more reliable results to those visually matched with Munsell charts. The expression of soil colour is not merely the result of individual soil properties, but rather the intricate relationships existing between multiple soil properties.

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ACKNOWLEDGEMENTS

Acknowledging the ARC-ISCW for providing access to the Profile database and soil store.

Keywords: albic properties, ochric, ultisols, hue, value, chroma

SORGHUM–COWPEA INTERCROP YIELD AND WATER SIMULATION USING APSIM MODEL

Chimonyo, V.G.P, Modi, A.T. and Mabhaudhi, T.

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

E-mail: vimbayic@gmail.com

INTRODUCTION

Intercropping is suitable for sustainable intensification of agriculture under water limited conditions. Crop simulation models such as APSIM can be used to generate relevant information to enhance its promotion within rainfed cropping systems. The aim of the study was to evaluate the performance of the locally adapted APSIM sorghum–cowpea model.

MATERIALS AND METHODS

APSIM model (v7.7) (McCown et al., 1996) was adapted using weather and soil data obtained in situ and crop specific parameters, such as phenology (time between emergence and end of juvenile stage, end of juvenile stage and flowering), leaf appearance rate and radiation use efficiency, from field experiments conducted during 2013/14. Thereafter, the model was tested using crop phenology, biomass, and yield, crop water use (ET), water use efficiency (WUEb) for biomass from rainfed (RF), deficit (DI) and full irrigation (FI) experiments conducted during 2014/15. Model performance was evaluated using R2, root mean squared error (RMSE) and the D-index.

RESULTS AND DISCUSSION

The APSIM model simulated phenology well for sorghum and cowpea (R2 = 0.98 and 0.86, RMSE = 6.62 and 13.67 days, D–index = 0.99 and 0.98, respectively) under different water regimes. The model was able to mimic low sensitivity of crop phenology to varying water availability. Under FI and DI, model performance was good regarding estimations of biomass (2.52 and 3.69%), yield (-4.34 and 3.34%), ET (2.29 and -2.72%) and WUEb (-10.99 and 10.29 %, respectively) were marginal from observed. The Model performed poorly with regards to rainfed conditions as it underestimated biomass (-6.25%) and WUEb (-14.86%), and overestimated yield (14.93%) and ET (7.29%).

CONCLUSIONS

The APSIM model was able to simulate biomass, yield and WU of an intercrop system under varying water regimes, but performed poorly under RF conditions. There is need to improve calibrations for crop stress indices so as to improve model simulations under rainfed conditions.

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Keywords: biomass; Crop model; Leaf area index; Water use efficiency

SOYBEAN NODULE RECOVERY FOLLOWING WATER DEFICIT CONDITIONS

Cilliers, M.[1], Van Heerden, P.D.R.[1, 2] and Vorster, B.J.[1]

[1]University of Pretoria, Department of Plant Production and Soil Science, Forestry and Agricultural Biotechnology Institute, Pretoria 0002; [2]South African Sugarcane Research Institute, Mount Edgecombe 4300

E-mail: magdeleen.duplessis@fabi.up.ac.za

INTRODUCTION

Soybean's (*Glycine max*) symbiotic relationship with *Bradyrhizobium japonica* is short lived in stressfull environments leading to a decrease in the nitrogen fixation and yield. This might be due to the shortening of the nodule lifespan caused by premature senescence. It's unclear if soybean and soybean root nodules subjected to water deficit stress is able to recover on a molecular as well as a physiological level after plants are rehydrated. The effect that rehydration has on cysteine proteases that are involved in senescence and protein remobilization still needs to be investigated.

MATERIALS AND METHODS

Soybean plants were grown in a vermiculite growth medium inside a greenhouse. The plants were stressed using three water deficit conditions; 30%, 40% and 60% VWC respectively. Thereafter plants were rehydrated. The effect that rehydration has on the growth and development of the plants were investigated by weighing fresh and dry mass of all the plants organs including root nodules. The water potential of both leaves and nodules were measured using a pressure bomb and pshycrometer respectively. The nitrogenase activity was measured using the acetylene reductase assay. Furthermore, RNA was extracted using a Qiagen RNeasy ® plant mini kit and Quantitative RT-PCR was done using 200ng of cDNA to compare the expression of cysteine proteases under water deficit conditions and after rehydration

RESULTS

The vegetative development of the soybean plants were irreversibly affected as seen from the plastochron measurement. The moisture content of plant organs as well as the leaf and nodule water potential shows that plant organs can recover to some extent rehydration. The formation of new nodules can take place if the plant gets rehydrated and isn't in to an advanced state of senescence such as 30% water deficit stress. Biological nitrogen fixation from crown nodules is not able to recover after rehydration. A cross section of nodules shows that water deficit stress degrades leghemoglobin leading to the elimination of the microbial partner. It's also seen that from a nitrogenase assay that BNF is more affected by the age of the nodule than water deficit conditions.

CONCLUSIONS

Water deficit stress effects soybean plant growth and development. Even though it's seems that the plants is able to recover its moisture that were lost during water deficit conditions, plant growth were affected in an irreversible manner. Soybean root nodules have also shown that damage done by premature senescence is irreversible as their nitrogen fixation ability was negatively affected.

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Keywords: nodules, rehydration, water-deficit

EFFECTS OF ESSENTIAL OILS ON BROWN ROT DEVELOPMENT IN ARTIFICIALLY INOCULATED PEACH FRUIT

Cindi, M.D., Sivakumar, D. and Soundy, P.

Postharvest Research Group, Department of Crop Sciences, Tshwane University of Technology, Private Bag X 680, Pretoria, 0001

E-mail: SivakumarD@tut.ac.za

INTRODUCTION

Brown rot caused by *Monilinia laxa* is the main pre and postharvest disease of peaches, affecting the shelf life and marketability of the crop. Increasing consumer concern regarding food safety makes it necessary to search for natural and environmentally friendly alternative products for postharvest disease control. This study was conducted to determine the effect of essential oils on brown rot and overall postharvest quality of peaches.

MATERIALS AND METHODS

The in vivo studies were conducted according to Sellamuthu *et al*. (2013). For the curative treatment inoculated fruits were exposed to (1) thyme oil (149 µl) and (2) cinnamon leaf oil (149 µl), using (27.5 × 18.5 × 9 cm) translucent plastic containers and (3) the commercial treatment iprodione (125 µl/100ml of distilled water) was used for comparison; (4) untreated fruit served as control. For preventative treatment fruit were fumigated with thyme oil (960 µl), cinnamon leaf oil (960 µl) for 24 h, and 12 h, in translucent 10 L plastic buckets. Fruit were then analyzed for total phenolics, the defense enzymes phenylalanine ammonia-lyase (PAL), ß-1,3-glucanase and chitinase, and the antioxidant enzymes peroxidase (POD), superoxide dismutase (SOD) and catalase. A set of 0.2 g fruit samples from 6 fruit (2 mm slightly away from the wound inoculated region) were cut and collected from the 20 fruit, and thereafter homogenized with specific buffers. The assay for enzymes was done according to the method of Sellamuthu *et al*. (2013).

RESULTS AND DISCUSIONS

The present results show that brown rot decay was reduced by thyme oil. The lesion diameter was 22.3 mm in the untreated control fruit, while fumigation (preventative application) with thyme oil for 24 h suppressed the diameter of the brown rot lesion to 7.1 mm. Overall thyme oil fumigation for 24 h at 20 °C showed higher activities of defense and antioxidant enzymes in the infected fruit. The POD activities in the infected fruit fumigated with thyme oil were similar to the POD activity in infected fruit fumigated with cinnamon oil. However, PAL, chitinase, ß-1,3-gluconase and SOD were significantly ($p< 0.05$) higher in the fruit fumigated with thyme oil when compared to the other treatments adopted in this study.

CONCLUSIONS

The current study suggests that thyme oil has the ability to act as a ‘signaling compound’ that triggers a signal to induce a defense function mediated by these different enzymes in the peach fruit.

REFERENCE

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Keywords: peach, quality, disease, thyme oil, enzymes brown rot, essential oils

WATER USE AND BIOENERGY POTENTIAL OF SUBTROPICAL *POACEAE* SPECIES AS SECOND GENERATION FIELD CROPS

Cloete, H. [1], Truter, W.F.[1]., Steyn, J.M. [1]

University of Pretoria, Lynwood Road, Pretoria, 0002, Private Bag X20, Hatfield

E-mail: heinrichcloete19@yahoo.com

INTRODUCTION

Edible crops used for bioenergy production are generally not sustainable or economically attractive for large scale energy production. Knowledge is lacking in the areas of water use, potential yield and management of non-edible bioenergy crops under South African climatic conditions. The study aims to determine how biomass production and corresponding calorific value are affected by different water regimes and harvesting intervals.

MATERIALS AND METHODS

A two factorial CRBD field experiment with three water regimes, eight *Poaceae* species and three replicates (plot size 5.5m x 6m) was conducted. Three regimes of increasing available soil water were applied, namely: dryland, two weekly and weekly irrigation according to soil water content measurements. Harvesting was done monthly for three months in successive sections of each plot and this cycle was repeated three times. Poaceae species included; Pennisetum purpureum, Miscanthus gigantheus, Chrysopogon zizanoides, Hyparrhenia tamba, Brachiaria brizantha, Panicum maximum, and two Sorghum bicolor cultivars as control species.

RESULTS AND DISCUSSION

In most cases more frequent irrigation resulted in higher biomass yields. Brachiaria, Hyparrhenia and Pennisetum spp. produced markedly higher biomass yields compared to sorghum. Even under dryland conditions Pennisetum and Hyparrhenia spp. produced considerably more biomass than the control spp. under weekly irrigation. The water use efficiency of these latter two species greatly exceeded that of the sorghum spp. Almost all species tended to produce exponentially more fresh as well as dry matter biomass yields with each subsequent harvest.

CONCLUSIONS

Some of the experimental crops produced a significant amount of biomass even under dryland conditions. Therefore, certain Paoceae species show great potential as second generation bioenergy field crops. However, more frequent repeated harvests would most likely produce less total dry matter at a greater financial expense. Calorific values are still to be determined where-after energy production per unit of water used (kJ/L) can be determined and correlated to biomass production.

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Keywords: bioenergy, Poaceae, second generation crops, South Africa

ASSESSING EARLY GROWTH AND NUTRIENT UPTAKE RESPONSES OF MAIZE (*Zea mays* L.) FOLLOWING THE APPLICATION OF PHOSPHORUS AND NITROGEN SOURCES

Coetzee, P.E.[1], Ceronio, G.M.[2], Bornman, J.J.[1] and Du Preez, C.C.[2]

[1]Strategic Agricultural Services, Omnia Fertilizer, 13 Sloane Street, Epsom Down Office Park, Bryanston, Johannesburg 2021; [2]Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300

E-mail: Picoetzee@omnia.co.za

INTRODUCTION

In South Africa, maize is often produced on highly weathered soils that are low in both organic matter and base status. These soils are inherently not capable of producing good grain yields without supplementing sufficient quantities of nutrients for optimal vegetative growth. The application of inorganic phosphorus (P) and nitrogen (N) is therefore, essential for sustainable maize production (Boyhan *et al*., 2007). Nevertheless, special attention should be given to the relative proportion and form of nutrients when fertilizing.

MATERIAL AND METHODS

In a glasshouse pot experiment, growth response of maize on a sandy loam topsoil to two N sources: limestone ammonium nitrate (LAN) and urea, three P sources: monoammonium phosphate (MAP), nitrophosphate (NP) and ammonium polyphosphate (APP), and five P application levels: 0, 10, 20, 30 and 40 kg ha^{-1} were evaluated. For this evaluation aerial (leaf count, stem thickness, plant height and dry mass) and subsoil (root mass and root length) plant parameters in addition to foliar nutrient concentration and uptake were measured five weeks after emergence of maize.

RESULTS AND DISCUSSION

Plants treated with LAN resulted in superior measurements compared to urea. Monoammonium phosphate and NP yielded significantly greater aerial plant parameters as well as nutrient concentration and uptake compared to that of APP. Results of subsoil plant parameters for P sources were inconsistent. Measurements of aerial and subsoil plant parameters on the test soil which was inherently low in P, were overall significantly greater with P applied at 40 kg ha^{-1} than with the lower application rates. The 40 kg P ha^{-1} application enhanced the uptake of N, P, calcium and sulphur. No application of P led to increased N and magnesium concentrations.

CONCLUSIONS

In this slightly acidic sandy soil, LAN yielded greater plant parameter measurements than urea. Nearly all nutrients' concentration and uptake in the foliage were higher with NP, compared to MAP and APP. These glasshouse results must be verified with field trials before advocated to farmers.

REFERENCE

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Keywords: application rate, orthophosphate, polyphosphate, plant growth parameters

LONG-TERM EFFECT OF TILLAGE AND CROP ROTATION PRACTICES ON C & N STOCKS IN THE SWARTLAND, WESTERN CAPE, SOUTH AFRICA

Cooper, G.D.[1], Hardie, A.G.[1], Strauss, J.A.[2] and Labuschagne, J.[2]

[1]Department of Soil Science, Stellenbosch University; [2]Western Cape Department of Agriculture

Email: aghardie@sun.ac.za

INTRODUCTION

Soil organic C (SOC) can be regarded as one of the most important indicators of soil health, ans accumulation of SOC an important component of sustainable agriculture. Little is currently known about the long-term effect of cultivation practises on C & N stocks in the semi-arid Swartland region of South Africa, an important grain production area. Thus the aim of this study was to investigate the effect on commonly used tillage and crop rotation practices on soil C & N stocks in the Swartland.

MATERIALS AND METHODS

The trials were conducted on the Langgewens Research Farm near Moorreesburg, Western Cape. Soils in this area are a maximum 40cm deep and compose mainly of Swartland, Oakleaf and Glenrosa forms. Two 20-year long-term trials are in progress, one in its 8th year (site A: soil quality study) and another in its 19th year (site B: cropping systems). The Site A trial involves three 4-year crop rotation systems, wheat monoculture (WWWW), wheat-medic-wheat-medic (WMWM) and wheat-canola-wheat-lupin (WCWL). Three tillage treatments were studied namely, no-till (NT) – soil left undisturbed until planting, minimum till (MT) – soil scarified late Mar and conventional tillage (CT) – soil scarified late Mar then ploughed. The Site B trial consists of four 4-year crop rotations all under no-tillage: wheat monoculture (WWWW), wheat-medic-wheat-medic (WMWM), wheat-medic/clover (WMc) and a wheat-medic/clover with an additional grazing on salt bush (WMcSB). Soil samples were taken shortly after wheat planting in 2014. Total soil C and N (%) was determined using dry combustion. Bulk density was measured after harvest using the clod method.

RESULTS AND DISCUSSION

At site A (8th year), WWWW under NT had the highest total C stocks at 30.58$MgC.ha^{-1}$, closely followed by MWMW under NT at 30.26$MgC.ha^{-1}$, WCWL under CT had the lowest at 13.05 $MgC.ha^{-1}$,. WCWL preformed the worst of all rotations. This could be attributed to the greater biomass additions from crops like Wheat and Medics compared to Lupins and Canola.

Under WMWM, NT had C stocks of 30.26$MgC.ha^{-1}$ compared to 21.25$MgC.ha^{-1}$under CT. WCWL performed better under MT with a C stock of 27.74$MgC.ha^{-1}$compared to NT, 25.50$MgC.ha^{-1}$and CT 13.05$MgC.ha^{-1}$. This could be attributed to reduced soil disturbance and therefore lower SOM losses. At site B (19th year) WWWW had the highest total C stock of 45.68$MgC.ha^{-1}$followed closely by WMc SB at 42.09 $MgC.ha^{-1}$. WMc and WMWM were the lowest at $MgC.ha^{-1}$ and 32.88 $MgC.ha^{-1}$ respectively.

N stocks followed a similar pattern to C stocks with a general increase with greater biomass inputs and the addition of a legume into the rotation. WMWM having the highest N stocks with 3.62$MgN.ha^{-1}$under NT. WCWL was the lowest with 1.13$MgN.ha^{-1}$ under CT.

CONCLUSION

The adoption of reduced tillage and inclusion of a high biomass legume in the crop rotation led to an increase in both C & N stocks. NT had the highest increase in C stocks with a 36-42% increase over CT. WWWW and WMWM had a 35% increase over WCWL.

Keywords: conservation agriculture, crop rotation, soil carbon, tillage

EVALUATION OF FUNGICIDES FOR GROWTH REGULATING PROPERTIES ON SORGHUM

Craven, M.[1], Smith, K.[2], Berner, J.[2] and McLaren, N.W.[3]

[1]Agricultural Research Council – Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520, South Africa; [2]School for Environmental Sciences and Development, North West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom, 2520; [3]Department of Plant Sciences, University of the Free State, P.O. Box 339, Bloemfontein, 9300, South Africa

E-mail: cravenm@arc.agric.za

INTRODUCTION

Certain fungicides, including triazoles and strobilurins, have been shown to have plant growth regulating properties leading to e.g. delayed senescence or increased yield (Wegulo *et al*., 2011). Prophylactic use of fungicides is accordingly propagated with the promise of financial return on expenditure in the form of increased yield whether or not disease is present. The aim of the current study is to evaluate the merit of the growth regulating properties of fungicides under various climatic conditions on sorghum yield within South Africa.

MATERIALS AND METHODS

Three split-plot trials were planted during both the 2013/14 and 2014/15 seasons at Potchefstroom, Standerton and Greytown. Eleven fungicide treatments (main plots), consisting of Azoxystrobin/Difenoconazole and Epiconazole/Pyraclostrobin applied at 6, 6 & 8, 8, 8 & 10 and 10 weeks after planting and an unsprayed control, were evaluated. Four cultivars (sub-plots) were included (PAN8816, PAN8906, NS5511 and PAN8911 (2013/14)/PAN8625 (2014/15). Treatments were replicated three times. Yield, plant biomass and leaf senescence at harvest were determined.

RESULTS AND DISCUSSION

Yield response to the various treatments during 2013/14 differed between localities, with Azoxystrobin/difenoconazole applied at 8 & 10 weeks resulting in significant higher yield compared with the control at Standerton. Significant differences in plant biomass due to fungicide treatments were only recorded in Potchefstroom during the same season where lower plant masses relative to the control were recorded in some treatments. Effect on senescence was locality specific, with fungicide application resulting in delayed senescence at Greytown. During 2014/15 fungicide applications no effect on yield, plant mass or senescence was observed at any of the localities or on the cultivars included in the current study.

CONCLUSIONS

Fungicide applications early in the season did not stimulate yield, plant mass or senescence consistently over season and/or locality and/or cultivar. The recommendation that fungicides be applied prophylactically, irrespective of the presence or absence of disease, is therefore questioned.

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Keywords: growth regulating properties, plant biomass, senescence, strobilurins, triazoles, yield

MAKING CLIMATE DATA USEFUL FOR DECISION MAKERS AT THE LOCAL SCALE: THE CASES OF NKAYI DISTRICT IN ZIMBABWE AND THE FREE STATE IN SOUTH AFRICA

Crespo, O.[1], Homann-Kee Tui, S.[2], Francis, B.[3], Nangombe, S.[4], Durand, W.[5] and Tesfuhuney, W. [6]

[1]University of Cape Town, South Africa; [2]ICRISAT, Bulawayo, Zimbabwe; [3]National Universitiy of Science and Technology, Zimbabwe; [4]Ministry of Environment, Water, Climate, Zimbabwe; [5]Agricultural Research Council, South Africa; [6]University of the Free State, South Africa

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

INTRODUCTION

The climate change research community recognizes that climate data need to be translated into climate information useful and relevant for various users such as farmers and decision makers. They need context specific answers to increase their adaptive capacity and to allow effective planning. The most common challenge is to provide information on how climate variability and change will affect the current and future production of crops and livestock, and the entire agricultural systems.

MATERIALS AND METHODS

The Agricultural Model Inter-comparison and improvement Project (AgMIP) supports co-exploration of climate data analysis and climate information needs, with climate scientist and regional stakeholders, to produce useful climate products and services. Through dedicated and iterative engagement with local communities and regional stakeholders we propose dedicated analysis of current and future climate projections, delivered in formats that will help farmers and stakeholders to make better informed decisions.

RESULTS AND DISCUSSION

We present the results for Nkayi district in Zimbabwe and the larger Free State in South Africa. The climate is semi-arid, with dry moderately cold winter and variable low rainfalls during the hot summer, thus high risk for predominantly rain-fed agriculture. Future projections for both area show consistently increasing temperatures, but inconsistent rainfall changes. Local stakeholders are well aware of and mostly suffering those climate changes, but lack the relevant information to face them. Regional climate and crop research institutions, with Meteorological Services, Agricultural services started co-exploring and proposing new ways to respond to local needs for climate information. This will contribute to the Impact Explorer (IE), web-based tool dedicated to the dissemination of locally relevant climate information.

CONCLUSIONS

Co-exploration of climate data and the need for it, leads to the preproduction of more useful climate information. It has the potential to lead to more appropriate exploration of climate change adaptation options at local scale, hence improving adoption and translating into better drafted climate policies.

Keywords: crop modelling, climate change, climate adaptation, stakeholder engagement

THE EFFECT OF PLANT DENSITY ON THE YIELD OF DIFFERENT SOYBEAN (*Glycine max* L.) CULTIVARS

De Beer, A.S.[1], Thiebaut, N.M.[2] and Bronkhorst, L.[1]

[1]Agricultural research Council – Grain Crop Institute, Private Bag X1251, Potchefstroom, 2520, South Africa; [2]Agricultural Research Council - Biometry, P.O. Box 8783, Pretoria,0001, South Africa

Email: debeerannelie@arc.agric.za

INTRODUCTION

Soybean (*Glycine max* L.) production is currently the fastest growing grain commodity in South Africa. The soybean production area increased from 2013/14 planting season to the 2014/15 year from 502 900 ha to 687 300 ha, which resulted in a 26.8% expansion in production area. Planting date and plant population are important factors affecting soybean growth, development and subsequently grain yield. Soybean yield responses to plant population are being affected by environmental conditions, planting date and maturity grouping of the cultivar. Research conducted in Virginia (USA) showed that a maturity III cultivar required twice the plant population of a maturity group V cultivar to obtain maximum yield when planted on the same date. As the cost of seed can contribute as much as 15 - 25% of the total variable cost it is therefore important to determine the optimum required plant density to ensure maximum yield and profit.

MATERIAL AND METHODS

Cultivar evaluation trials have been conducted at localities representative of the main soybean production areas. Due to the photosensitivity of soybeans the production area has been grouped in cool, moderate and warm. Twenty four (24), 21 and 22 trials were conducted respectively during the 2012/13, 2013/14 and 2014/15 planting seasons with 27 entries during the 2012/13, 32 entries during 2013/14 and 30 entries during the 2014/15 seasons. Randomised Latinised row/column design with three replicates was used for the statistical layout. The plant density was also determined during harvesting and used to determine the correlation between plant density and yield. A quadratic regression analysis was the appropriate fitting and was used to get more info between the yield ha-1 and the plants ha-1 on the different factors in consideration.

RESULTS AND DISCUSSION

From the results it is clear that in the warm production area, under irrigation conditions, a plant density of 250 000/ha was sufficient for both the medium (maturity grouping (MG) 5 – 5.9) indeterminate and medium semi-determinate growers. However, under the same conditions the medium determinate growers requires a slightly higher plant density of 300 000/ha. Only 2 localities representing the moderate area are irrigated plots while non in the cool area is irrigated. The optimum plant density for a medium-long indeterminate (6-6.9 MG) cultivar in the moderate area is also in the proximity of 250 000/ha. The curve fittings, in general, are more accurate for the irrigation than for the dryland localities.

CONCLUSIONS

The recommended plant densities in South Africa is 350 000/ha for dryland conditions and 400 000/ha for irrigation. No distinction is being made between cultivars with different maturity groupings as well as growth habit. A Significant saving of 25% can be made on the seed costs if the seeding rate is reduced, as indicated by the results.

Keywords: grain yield, growth habit, maturity grouping, plant density, soybeans cultivars

HARVEST AND POST-HARVEST FACTORS INFLUENCING INTERNAL BROWNING AND FRUIT QUALITY OF 'ROSY GLOW' APPLES.

Doe W.J. and Crouch E.M.

Department of Horticultural Science, University of Stellenbosch, Private Bag X1, Matieland, 7602

E-mail: elke@sun.ac.za

INTRODUCTION

The Rosy Glow apple (*Malus domestica* Borkh.) is a mutant variety of the Cripps' Pink cultivar and highly, early colouring (Mason and Mason, 2003) in warmer winters and the main type of 'Cripps' Pink' planted in South Africa. 'Rosy Glow' may be prone to internal flesh browning (Dall, 2008). This study investigated tree age, harvest maturity, storage temperature, 1-methylcycolpropene (1-MCP) treatment, and storage duration in controlled atmosphere (CA) as factors influencing 'Rosy Glow' internal browning.

MATERIALS AND METHODS

Fruit were harvested <40% and >50% starch breakdown (SB) for the harvest maturity trial (Trial 1) and <40% SB for the storage duration, temperature, 1-MCP (Trial 2) and tree age trial (Trial 3) from Elgin (Trial 1, 2 and 3), Vyeboom (Trial 3) and Villiersdorp (Trial 3) in the Western Cape, South Africa. Trial 1 and 3 fruit were stored for 7 months in CA (1% CO_2 and 1.5% O_2) plus 6 weeks in air (RA) at -0.5 °C and 7 days at 20 °C and evaluated after each period. Trial 2 fruit treated with or without 1-MCP (SmartFresh™, AgroFresh, Inc., Dow AgroSciences, Philadelphia, PA, USA), were stored at -0.5 °C or 2.0 °C and evaluated after 3, 5 and 7 months in CA plus 6 weeks in RA and 7 days at 20 °C.

RESULTS AND DISCUSSION

Diffuse (DB), radial (RB) and combination (CB) browning were observed. Storage duration but not harvest maturity nor tree age, affected DB while none influenced RB. DB was the main type of browning which is similar to findings in 'Cripps' Pink' which is influenced by tree age, soil type, harvest maturity and storage temperature and duration (Butler, 2015; Crouch et al., 2015). RB in South African 'Cripps' Pink' is seasonal (Butler, 2015). 1-MCP treated 'Rosy Glow' fruit had a lower flesh browning incidence. DB and RB were first observed after 5 months in CA plus 6 weeks RA.

CONCLUSION

Diffuse browning was the main type of browning present. Neither harvest maturity, storage temperature nor tree age played a significant role in 'Rosy Glow' browning development. Differences in browning between farms, suggest that orchards factors play a significant role. Trials are being repeated in order to confirm that harvest maturity, storage temperature and tree age do not play a significant role in 'Rosy Glow' browning.

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Keywords: temperature, controlled atmosphere, harvest maturity, 1-MCP and Rosy Glow, internal browning

QUANTIFYING WATER USE OF HIGH YIELDING APPLE ORCHARDS

Doko, Q.[1], Taylor, N.J.[1], Annandale, J.G.[1], Lotze, E.[2] and Dzikiti, S.[3]

[1]University of Pretoria, Private Bag X20, Hatfield, 0028; [2]Stellenbosch University, Private Bag X1, Stellenbosch, 7602;[3]Council for Scientific and Industrial Research, Stellenbosch, P. O. Box 320, Stellenbosch, 7599

E-mail: qamanidoko@gmail.com

INTRODUCTION

High yielding apple orchards (>100 t ha^{-1}) are becoming the norm in South Africa and it is assumed that as yields increase, transpiration rates will also increase. This raises the need for improved knowledge on water use of these orchards in relation to water availability, given the increasing pressure on scarce water resources. Accurate estimates of transpiration are therefore necessary to assess the possible link between yield and water use. A project was therefore solicited, managed and funded by the Water Research Commission and the South African Apples and Pears Producers Association to quantify the water use and water relations of high yielding apple orchards.

MATERIALS AND METHODS

The heat pulse velocity sap flow technique was used to monitor transpiration rates in full bearing 'Golden Delicious' and 'Cripps' Pink' orchards in the Koue Bokkeveld. Measurements of water relations included stomatal conductance and leaf and stem water potential. Estimates of canopy size were obtained by measuring the interception of photosynthetically active radiation and leaf area index (LAI) of trees. Weather parameters were recorded by an automatic weather station and were used to calculate reference evapotranspiration.

RESULTS AND DISCUSSION

The transpiration rates for both 'Golden Delicious' and 'Cripps Pink' increased from spring to summer and decreased in autumn. The yield of the 'Golden Delicious' orchard was 98 t ha^{-1}, with a total of 786 mm transpired throughout the season. The yield in the 'Cripps Pink' orchard was 85 t ha^{-1} with a seasonal transpiration total of 594 mm. The higher seasonal transpiration in the 'Golden Delicious' orchard was likely a result of a higher LAI (3.43 $m^2.m^{-2}$) of these trees as compared to the 'Cripps Pink' trees (2.82 $m^2.m^{-2}$). Daily stomatal conductance varied with weather conditions, reaching a maximum at midday and minimum at sunrise and sunset.

CONCLUSIONS

The results show that tree water use varies according to climatic conditions and canopy size. There was no clear relationship between transpiration rates and yield in this current study. 'Golden Delicious' trees transpired more water than 'Cripps Pink' trees throughout the season; and this was a result of a bigger canopy size. These results can be used as a basis for future modeling exercises.

ACKNOWLEDGEMENTS

Funding is provided by the Water Research Commission and South African Apple and Pear Producers Association.

Keywords: apple orchards, high yielding, water use

A DECISION SUPPORT SYSTEM FOR DETERMINING THE SITE-SPECIFIC FITNESS-FOR-USE OF IRRIGATION WATER

Du Plessis. H.M.[1], Annandale, J.G.[1], van der Laan, M.[1], Benade, N.[1] and Jooste, S.H.J.[2]

[1]University of Pretoria, Private Bag X20, Hatfield 0028; [2]Directorate Resource Quality Information Services, DWS, Private Bag X313, Pretoria 0001

E-mail: meiringd@gmail.com

INTRODUCTION

Agriculturists often need to evaluate the fitness of a given water for irrigation purposes, while water resource managers require an answer to the question of what the water quality should be in order to maintain successful irrigation in a specific area. The further need of the Department of Water and Sanitation (DWS) for a risked based assessment of water quality, gave rise to the Water Research Commission (WRC) issuing a directed call for research to revise the current South African Water Quality Guidelines and develop a Decision Support System (DSS) with which to evaluate site specific irrigation water quality from a risk perspective.

MATERIALS AND METHODS

A review of the current South African and international irrigation water quality guidelines (IWQG) by a team of specialists identified the factors that determine general and site specific risks associated with water quality constituents, and collected information that can be used to quantify these risks. This knowledge was built into a Decision Support System (DSS) that calculates the effect and risk water constituents hold for soil quality, crop yield and quality and irrigation equipment.

RESULTS AND DISCUSSION

The DSS operates at three levels or tiers to provide a progressively more advanced evaluation of the effect that water quality constituents have on soil quality, crop yield and quality and irrigation equipment. In addition to quantifying the risk associated with a specific constituent concentration, user friendly displays convey the implications for irrigation with water of a specific composition. Tier 1 provides generic guidance that resembles the 1996 IWQG. It is the most conservative of the three tiers, assuming e.g. no dilution by rain, instant equilibrium between water constituents and soil and crops that are generally sensitive to water constituents. Tier 2 employs a scaled down version of the SWB model to dynamically simulate the interactions between irrigation water constituents and the soil-crop-atmosphere system over a period of thirty years. Site-specificity is introduced through the use of pre-defined data bases that allow the user to select an appropriate weather station, soil characteristics, crop to be irrigated and irrigation system. Tier 3 provides risk assessment guidelines for highly site-specific water quality assessments and use the climatic, soil, crop and other characteristics of a specific site.

CONCLUSIONS

A DSS was developed that provide an indication of the likelihood of specific consequences when water of a known quality is used for irrigation at a specific site. It can also provide guidance about what the water quality should be in order to maintain successful irrigation

ACKNOWLEDGEMENTS

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

Keywords: crop quality, crop yield, decision support system, soil quality, water constituent.

NITROGEN MANAGEMENT EFFECTS ON TUBER INITIATION OF SELECTED POTATO CULTIVARS

Du Raan, C. and Steyn, J.M.

Department of Plant Production and Soil Science, University of Pretoria, PO Box X20, Hatfield, 0028

E-mail: chantel.duraan@gmail.com

INTRODUCTION

Nitrogen (N) is an important plant nutrient that affects all aspects of potato growth, including tuber initiation. Tuber initiation (TI) is an important stage, as it affects crop growth and development, which can subsequently affect yield, size distribution and quality, and therefore also profitability. Potato producers are under immense input cost pressure and efficient nutrient management is therefore crucial. This study investigates the effect of N rate and timing on TI, final yield, size distribution and quality of selected potato cultivars.

MATERIALS AND METHODS

Field experiments (2013 and 2014) were conducted at the University of Pretoria's Hatfield Experimental farm on a sandy clay loam soil (15-20% clay). The factorial experiment was laid out as a split-plot RCBD with three replicates. Cultivars (BP1, Eos and Lanorma) were allocated to the main plots and three N levels (R1=160 kg/ha N, R2=240 kg/ha N and R3=360 kg/ha N), together with three N timing treatments (T1=30% at planting, 70% ±3 weeks after emergence; T2=50% at planting, 50% after emergence and T3=70% at planting, 30% after emergence), were allocated to the subplots. Weekly destructive harvests were conducted to monitor growth analyses and TI status. At final harvest tuber yield, size distribution and quality were determined.

RESULTS AND DISCUSSION

Eos and Lanorma tended to initiate most tubers early in the season whereas BP1 initiated tubers throughout the season. Timing also significantly affected TI early in the season, with treatments T2 and T3 initiating significantly more tubers than T1. Marketable yield (medium and large) was significantly influenced by cultivar, N timing and N rate. Final total and marketable yields significantly increased from rate R1 to R3 and when more N is applied at planting (T3). Timing of TI played a crucial role in Lanorma's higher proportion of marketable yield, since this cultivar initiated most of its tubers early extending the bulking period. R1 did not produce sufficient leaf canopy early in the season due to depleted N reserves, which resulted in insufficient bulking, whereas TI declined due to stolon die-off. Although R3 produced a large and efficient canopy early, lower harvest index suggest a stimulation of canopy growth at the expense of tuber development and bulking. The vegetative stage was also extended, delaying maturity and consequently reducing tuber quality. T3 ensured sufficient canopy cover throughout the season to ensure optimum growth, tuber bulking and final yield. On the contrary, T1 resulted in an initial inadequate canopy but, due to a large amount of N later in the season, vegetative growth was extended, delaying maturity.

CONCLUSIONS

Optimal N treatment combinations are R2 and T3 (recommended guidelines) for all three cultivars, ensuring high yields, optimal tuber size distribution and acceptable tuber quality.

ACKNOWLEDGEMENTS

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

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

DENSITY-DEPENDENT GROWTH PATTERNS OF NEMATODE EGRESS UNDER INCREASING CUCURBITACIN A AND CUCURBITACIN B CONCENTRATIONS: BIOACTIVE INGREDIENTS OF NEMARIOC-AL AND NEMAFRIC-BL PHYTONEMATICIDES

Dube, Z.P.[1], Mashela, P.W.[1], Ndhlala, A.R.[1, 2] and De Waele, D. [1, 3]

[1]University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa; [2]Agricultural Research Council - VOP, Private Bag X293, Pretoria, 0001, South Africa; [3]University of Leuven, Kasteelpark Arenberg 20, B-3001 Leuven, Belgium

Email: zakheleni_dube@yahoo.com

INTRODUCTION

Phytonematicides used through irrigation systems, that is, botinemagation, can be highly suppressive on population densities of the notorious root-knot (*Meloidogyne* species) nematodes. However, the mechanism through which these agents suppress nematode population densities is not documented. The objective of this study, therefore, was to investigate whether suppression of egg hatch constituted one of the mechanisms through which the active ingredients of Nemarioc-AL and Nemafric-BL phytonematicides suppressed nematode population densities of *M. incognita*.

MATERIALS AND METHODS

In vitro trials were carried out to establish the effects of a series of cucurbitacin A ($C_{32}H_{46}O_9$) and cucurbitacin B ($C_{32}H_{46}O_8$) concentrations on egress. Treatments, viz., 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25 and 2.50 µg/ ml purified cucurbitacin A and cucurbitacin B in 96-well plates, were arranged in a completely randomised design, with three replications. Distilled water and methanol were used as controls. Second stage juveniles were counted using stereomicroscope.

RESULTS AND DISCUSSION

Egg hatch over increasing cucurbitacin A and cucurbitacin B concentrations exhibited quadratic relations, which had an inhibition and slight stimulation of egress at low and high concentrations, respectively. During 24-, 48- and 72-h exposure periods, the model explained 67, 66 and 61%, respectively, to total treatment variation in egress for cucurbitacin A and 94, 90 and 87%, respectively, for cucurbitacin B. The density-dependent growth pattern observed in this study is in line with the hypothesis reported by Liu et al. (2003), that all biological entities will display a density-depended growth response when exposed to increasing concentrations of allelochemicals.

CONCLUSIONS

Suppression of *M. incognita* egress by both cucurbitacins suggested that, among other possible mechanisms, the two phytonematicides would reduce nematode population densities through enhancing egress, thereby exposing J2s to lethal active ingredient concentrations in the soil solution.

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ACKNOWLEDGEMENTS

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Keywords: allelopathy, chemotaxis*, Cucumis africanus*, future crops, liquid formulation

INTEGRATED ASSESSMENT OF PROJECTED CLIMATE CHANGE IMPACTS ON MAIZE PRODUCTION IN SOUTHERN AFRICA

Durand, W.[1]., Cammarano, D.[2]., Crespo, O.[3]., Nhemachena, C.[4]., Tesfuhuney, W.A.[5]., Teweldemdhin, M.Y.[6], Mpuisang, T.N.[7] and Bonolo, P.M.[6]

[1]Agricultural Research Council, Private Bag X1251, Potchefstroom, 2520, South Africa; [2]The James Hutton Institute, Invergowrie Dundee DD2 5DA, Scotland; [3]Environmental and Geographical Science Department, University of Cape Town, South Africa; [4]Human Sciences Research Council, Pretoria, South Africa; [5]University of the Free State, PO Box 339, Bloemfontein, 9300, South Africa; [6]Polytechnic of Namibia, Windhoek, Namibia; 7Botswana College of Agriculture, Gaborone, Botswana

Email: DurandW@arc.agric.za

INTRODUCTION

The Agricultural Model Inter-comparison Improvement Project (AgMIP) has developed a range of climate, crop, and economic modelling tools, protocols, and methodologies for integrating stakeholders' feedback for assessing the impacts of climate change on the agricultural systems at regional level (Rosenweig and Hillel, 2015). The impact of projected climate change on maize production and the mitigation using adaptations and policy interventions were evaluated at a site in three countries in Southern Africa.

MATERIALS AND METHODS

Two crop models, DSSAT and APSIM were calibrated for the local conditions using observed climate, soil and agronomic data from the region for maize. Past (1980-2010) and future (5 GCMs for the time period 2040-2070, with RCP8.5 and CO2 of 571 ppm) maize productivity was simulated. These results were then provided to an economist to characterize the economic impacts of climate change using the Trade of Analysis for multi-dimensional impact assessment model (TOA-MD).

RESULTS AND DISCUSSION

Projections of future changes in climate in Southern Africa showed an increase in temperature and variability in rainfall, increasing the risk of crop failure and food insecurity in the region. DSSAT and APSIM simulated 20% yield reduction if maize is managed with current practices into the future, causing an increase in poverty rates of 3%. When adaptations and positive policy interventions i.e., fertiliser subsidy, pricing are introduced to deal with future projected changes in climate, yield increased by 10% and poverty rates decreased.

CONCLUSIONS

This case study demonstrated that the integration between scientific skills in crop, climate, and economy can offer an interesting alternative in gaining information from integrated studies of climate change impacts. It also entails conducting detailed technical analysis along with stakeholder engagement, which provided "reality-checks" in terms of technology trends, agronomic practices, policy, etc.

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ACKNOWLEDGEMENTS

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Keywords: climate change, integrated regional assessment, maize response, economic impacts

NON-CHILLING POST-HARVEST PITTING OF VALENCIA ORANGE

Ehlers, J.[1], Alférez, F.[2], Theron, K.I.[1] and Cronje, P.J.R.[3]

[1]Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch, 7602, South Africa ; [2]3700 Experiment Station Rd, 33850 Lake Alfred, Fl, USA. Citrus Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida. ; [3]Citrus Research International (CRI), Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch, 7602, South Africa

E-mail: paulcronje@sun.ac.za

INTRODUCTION

Non-chilling post-harvest pitting is a physiological rind disorder that reduces external fruit quality, resulting in economic losses for producers. Originating in the transitional zone of the flavedo-albedo with epidermal cells of the flavedo, oil glands and deeper layers of the albedo are initially unaffected. As the disorder progresses affected areas turn bronze in colour, most likely due to the oil gland content being released into intercellular spaces resulting in enzymatic oxidation. The primary cause of the disorder is unknown, however, variation in relative humidity (RH) during pre and post-harvest handling and a change in the rind water status seems to aggravate this disorder in 'Navel' oranges. The objective of this study was to determine the pre-harvest factors that could contribute to the susceptibility of a fruit to post-harvest pitting. In addition various plant growth regulators (PGRs) were tested for their efficacy in reducing pitting of 'Valencia' oranges.

MATERIALS AND METHODS

This experiment was conducted in the Letsitele valley, Limpopo, on 'Benny' and 'Turkey Valencia' orange. Trials to determine the impact of postharvest water stress treatment involved dehydrating fruit at 25°C and 50% RH for three days, followed by one day at 20°C and 99% RH before cold storage of 21 days at 4.5°C. The influence of canopy position, fruit size and colour were also determined. In addition the impact of 2,4-D, GA3 and thiabendazole were tested for their efficacy to reduce pitting.

RESULTS

The stress treatment significantly increased both pitting and % weight loss 3 days after harvest of 'Benny' Valencia, while waxing fruit increased PPI, but not significantly at the 5% confidence level. Size and colour difference did not result in consistent differences between treatments whereas 2,4-D and thiabendazole reduced pitting incidence.

CONCLUSION

Non-chilling post-harvest pitting follows a similar mechanism of action to navel orange pitting indicating the importance of rind water balance. It is also evident that pitting can be induced preharvest to increase susceptibility postharvest, in the presence of a trigger.

ACKNOWLEDGEMENTS

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Keywords: citrus, physiological disorders

AN ANALYSIS OF THE POTENTIAL OF SUGARCANE AS A BIOETHANOL FEEDSTOCK IN SOUTH AFRICA

Eksteen, A.B.[1], Singels, A.[1, 2], Olivier, F.C.[1] and Zhou, M.[1]

[1]South African Sugarcane Research Institute, Mount Edgecombe, Durban, 4300; [2]Department of Plant Production and Soil Science, University of Pretoria, Pretoria, 0028

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

INTRODUCTION

High-fibre (HF) sugarcane could be an ideal feedstock for 1st and 2nd generation bio-ethanol production in marginal areas in South Africa. However, quantitative information regarding productivity, resource use and drought tolerance are lacking. The aim of this study was to review information from growth analysis experiments, plant breeding trials and the potential of growing HF sugarcane in marginal areas in South Africa, based on model simulations.

MATERIALS AND METHODS

Drought stress response of a HF and a high sucrose (HS) genotype were assessed in a controlled, rainshelter experiment at Mount Edgecombe and an irrigated, intermittent drought stress experiment at Komatipoort. Detailed measurements of transpiration rate (Mount Edgecombe only), growth, radiation and water use efficiency, and calculated theoretical ethanol yield (EY) were performed. Quantitative data from early stage plant breeding trials at Kearsney and Pongola were evaluated to identify potential HF cultivars that also yield high biomass. From the experimental data, derived model parameters were used in the DSSAT Canegro model to predict productivity and water use for four marginal dryland sites in KwaZulu-Natal.

RESULTS AND DISCUSSION

The HF genotype (04G0073) grown in the drought stress experiments developed a canopy quicker, captured more radiation and water, and produced more dry biomass yield (DBY) under mild drought stress conditions but did not cope as well with severe stress compared with the HS cultivar (N19) (Eksteen et al. 2014; Olivier et al. 2014). EY after 12 months growth was calculated as 26 and 19 kl/ha for N19 and 04G0073, which flowered at 8 months. Flowering acts a natural ripener in sugarcane and prevents further biomass accumulation. Results from the plant breeding trials show that some HF genotypes achieved DBY of 54 t/ha (EY = 18 l/ha) compared with DBY of 26 t/ha (EY = 10 kl/ha) for HS cultivars under dryland conditions. A wide adaptability for HF genotypes in marginal environments was found using Canegro model simulations, and the ET requirements to grow HF genotypes in dryland environments were less than the long-term mean rainfall for that region.

CONCLUSIONS

HF genotypes may have better tolerance to mild drought and higher biomass and bioethanol productivity than HS conventional cultivars, making them more suitable for cultivation in marginal dryland areas. Physiology research provided valuable data for parameterising models to predict dry biomass yields and resource use in target environments to assist decision-making regarding the production of sugarcane as a bioethanol feedstock in South Africa.

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Keywords: sugarcane, biomass, ethanol, cultivar, drought stress

THE EVALUATION OF CONTROLLED RELEASE UREA VERSUS CONVENTIONAL UREA ON SORGHUM IN A POT TRIAL

Esterhuizen, H.C. and Dreyer, J.G.

North-West University, Private Bag X6001, Potchefstroom 2520

E-mail: hendrico.est@gmail.com

INTRODUCTION

Nitrogen availability in soil is one of the most important plant growth factors. There is a strong correlation between the average amount of N fertiliser applied to crops and the yield per hectare. Careful consideration of application rates, application methods, and different sources of N in fertiliser and products of fertiliser is needed to produce optimum plant growth and maximum crop yield. As plant roots mainly absorb nitrogen in ammonium and nitrate forms, the rapid conversion of ammonium to nitrate through the process of nitrification, is of most concern. Because nitrate is negatively charged, and the soil colloids are mainly negatively charged, nitrate is easily leached form the soil. As a result, nitrogen leaching and nitrogen deficiency in soil is a common problem. By using new technologies such as Controlled Release Nitrogen Fertiliser, losses in plant available nitrogen due to leaching and the associated extra nitrogen fertiliser applications to compensate for the loss, can possibly be minimised.

MATERIALS AND METHODS

For the purposes of this study, controlled release urea fertiliser was tested against conventional urea fertilizer in pot trials to test the expected hypothesis that the controlled release urea fertilizer will prevent excessive nitrogen leaching and provide better plant growth compared to conventional urea fertilizer. The pots were planted with sorghum and fertilised with the respective fertilizers at levels of 40, 80 and 160 kg N per hectare. Three different soil depths of 30 cm, 15 cm and 5 cm were also simulated. The pots were watered manually and the leachate was analysed for nitrate ($NO3^-$) at 26, 56 and 88 days after planting. Plant height was measured at 26 and 88 days after planting. Dry biomass was weighed at 88 days after planting. Analysis of variance (ANOVA) was done on all the data.

RESULTS

Results show that the controlled release nitrogen fertilizer leached less nitrate and produced taller plants. Regarding the dry biomass results, in the 30 cm soil medium there was no difference between the controlled release and conventional fertilizer, but the thickness of the soil medium has a big impact. However, in the 5 cm soil medium the controlled release fertilizer showed statistically better results than the traditional fertilizer.

CONCLUSIONS

A conclusion can be made that controlled release nitrogen fertilizer does not prevent leaching but is more effective at supplying the plant with available nitrogen compared to conventional urea. Taller plants and a higher amount of biomass were also achieved with the controlled release fertilizer.

Keywords: nitrate, controlled release fertilizer, urea, leaching, sorghum, pot trial.

BIOREMEDIATION POTENTIAL OF FUNGI ISOLATED FROM DREDGED SEDIMENT OF ASA RIVER IN ILORIN, NORTH CENTRAL NIGERIA

Fawole, O.B., Affinih, K.O., Omoleye, W.S. and Oteniya, O.P.

Department of Agronomy, University of Ilorin, P.M.B.1515, Ilorin, Nigeria

E-mail: fawoleob@unilorin.edu.ng

INTRODUCTION

The Asa River runs across Ilorin city, Kwara State, Nigeria. Effluents are discharged into the river from a number of factories located along its course. Some local farmers carry out agronomic activities on dredged sediment along the river bank, producing healthy looking crops which may suggest a high nutrient status of the sediment. This study ascertains the level of contamination of the Asa River sediment with heavy metals and evaluates the bioremediation potential of various fungi indigenous to the sediment to prevent negative health impacts of the contaminants on consumers of produce from the site.

MATERIALS AND METHODS

Fungi were isolated from a composite sample of dredged sediment collected randomly from four different points along the river course. Isolations were grown on Potato Dextrose Agar medium using the soil dilution technique. Colony and microscopic morphology characteristics were used for identification. A bioremediation experiment was set up in triplicate glass jars per treatment using a completely randomized experimental design. Fungal inoculums prepared on agar plates were introduced at a rate of 3 10mm mycelial discs applied per 100g sterilized sediment. Deionized water was added to the jars every week to achieve sediment moisture content of approximately 60% of the water holding capacity. Inoculated sediments were incubated for 12 weeks. Heavy metals were extracted and concentrations present before inoculation and after the incubation period were determined with an Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The concentrations of heavy metals found in Asa river sediment were relatively high compared to the WHO standards. This could be attributed to effluents discharged into the river from Pharmaceutical and Chemical industries located along its course. Fungi isolated from the sediment were identified as *Aspergillus niger*, *A. terreus*, *A. ustus*, *A. sydowii*, *A. flavus*, *Trichoderma harzanium*, *Penicillium notatum* and *Fusarium solani*. These indigenous fungi all reduced concentrations of heavy metals in Asa river sediment after 12 weeks in bioremediation jars compared to the un-inoculated control. A significant reduction in heavy metals was observed particularly with *A. niger*.

CONCLUSIONS

It was concluded that Asa River sediment is highly contaminated with heavy metals and needs to be cleaned up before being used for agronomic activities. Fungi indigenous to the sediment have the potential for such remediation. The Aspergilli could be used for in situ studies to confirm laboratory findings.

ACKNOWLEDGEMENTS

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Keywords: bioremediation potentials, fungi, Asa River, sediment, heavy metal

DEVELOPMENT OF OPTIMUM FRUIT MATURITY AND SCIENTIFICALLY DEFINED QUALITY PARAMETERS OF POMEGRANATE FRUIT

Fawole, O.A. and Opara, U.L.

Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa

E-mail: olaniyi@sun.ac.za

INTRODUCTION

The goals of postharvest technology are to reduce losses, maintain quality, add value; and thereby, facilitate trade and market access of agricultural materials and other biomaterials. Although an ancient crop, global interest in commercial pomegranate production and consumption is very recent. In South Africa, export has grown by >20% during the past year, reaching about 4500 tonnes in 2015. The aim of our research in this area was to develop innovative postharvest solutions for the emerging South African pomegranate industry. This includes; predicting fruit readiness for harvest, cold chain technologies to extend storage and shelf life, and phytochemical basis of the health benefits of consuming pomegranate products.

MATERIALS AND METHODS

Fruit were harvested at three different maturities along days after full bloom (DAFB); Harvest 1 (H1) at 157 DAFB, H2 at 167 DAFB, and H3 at 175 DAFB. Fruit quality during a 6-week simulated shipping period at 5°C with 95% RH and subsequent 5 days of shelf life at 20°C with 75% RH were investigated. Instrumental evaluation of aril colour, juice content, juice absorbance (520 nm), total soluble solids (TSS), pH, titratable acids (TA), and phytochemical components including total phenolics, flavonoids, and anthocyanins were carried out. In addition, textural properties of arils which included hardness, toughness, bioyield point, and Young's modulus were also investigated. During the shelf life period, individual fruit were rated by a trained sensory panel based on appearance, taste, and texture. Relationships between the instrumental and descriptive sensory data were explored for harvest maturity determinants using discriminant analysis.

RESULTS AND DISCUSSION

Among the attributes evaluated, TSS, juice content, aril hardness and anthocyanin content were the most decisive attributes distinguishing the harvest maturities investigated. The results showed that to ensure acceptable quality of 'Bhagwa', harvest time should be between 167 - 175 DAFB (H2 and H3) when fruit had reached maximum TSS level (> 16°Brix; H3) and juice content (> 65 mL/100 g aril; H2). In addition, discriminant analysis (DA) showed the possibility of combining these decisive harvest parameters with aril red colour intensity. The harvest index proposed in this study could be used as a guide to establish a reliable harvest maturity index to assist in assuring fruit quality in consideration of long supply chains for the investigated cultivar.

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Keywords: arils, cold storage, discriminant analysis, maturity, quality

RYEGRASS GERMINATION IS INFLUENCED BY SEED AGE

MI Ferreira

Directorate Plant Science, Chief Directorate: Research and Technology Development Services, Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7607 South Africa

E-mail: mikefe@elsenburg.com

INTRODUCTION

A huge production constraint in the grain producing area of the Western Cape is the evolvement of herbicide resistant ryegrass. This raises the need for more information to develop appropriate weed control measures. Therefore, the aim of this six year study was to determine the effect of seed age on annual ryegrass germination.

MATERIALS AND METHODS

Ryegrass seeds were collected annually in October from 2009-2014 at Langgewens research farm. Experiments were conducted in an incubator annually in May from 2010-2015. The trial was laid out in a Randomised Block Design with ten replicates of 10 seeds each in Petri dishes and moistened with five ml of distilled water, and then placed in an incubator set at a 12hours/12hours day/night cycle with day/night temperature settings of 22 °C/14 °C, respectively. Germination was determined after seven and fourteen days of incubation, respectively, by counting and removing the number of germinated seeds with a protruding radicle.

RESULTS AND DISCUSSION

Germination results showed that ryegrass seeds collected in 2011 and 2013 had on average the highest germination of 66% and 55%, respectively. The lowest germination of 15% was obtained for seeds collected in 2014, confirming the strong effect of age on cumulative germination percentages of freshly harvested seeds and the need for an after ripening period of 2-4 years before optimum germination occurs. Nevertheless, 41% of seeds collected in 2009 were still viable after six years of storage.

CONCLUSIONS

Mature ryegrass seeds of 2-4 years old germinated more rapidly, probably due to dormancy release over time resulting in a higher germination rate than freshly harvested seeds. The strong influence of age on seed germination enables it to be persistent and ensures its survival irrespective of climatic conditions or weed control practices in field crops.

Keywords: after ripening, cumulative germination, incubation

THE EFFECT OF CHEMICAL- AND BIOFUMIGANTS ON NON-TARGET AND BENEFICIAL SOIL ORGANISMS

Fouché, T.C.[1], Maboeta, M.S.[2] and Claassens, S.[2]

[1]University of South Africa, Private Bag X6, Florida, 1710; [2]Unit for Environmental Sciences and Development, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom, 2520

E-mail: efouchtc@unisa.ac.za

INTRODUCTION

Biofumigation is an important crop protection practice for the commercial and emerging agricultural community because it can control agricultural crop pathogens and diseases with lower health and environmental risks than chemical fumigants. Glucosinolates are volatile compounds found in most Brassica species. When hydrolysed, it forms a range of natural toxins that act as biofumigants. Several studies have confirmed the effectiveness of glucosinolates against a series of plant pests. However, very little information is available on the effects of glucosinolates on non-target and beneficial soil organisms.

MATERIALS AND METHODS

Three biofumigants, broccoli, mustard and oilseed radish, and two chemical fumigants, metham sodium and cadusafos, were investigated for possible effects on non-target and essential soil organisms such as earthworms and the soil microbial community. The genotoxicity of the biologically active compounds towards earthworms was evaluated by means of the comet assay, as well as sub-lethal endpoints such as growth and reproductive success. Furthermore, the changes in the soil microbial community function and structure were evaluated by means of community level physiological profiling (CLPP) and phospholipid fatty acid (PLFA) analyses respectively. All exposures were done in artificial soil prepared according to the Organisation for Economic Co-operation and Development (OECD) standard guidelines.

RESULTS AND DISCUSSION

In the biofumigant treated soils, broccoli reduced earthworm reproduction while mustard induced more DNA strand breaks in earthworm cells compared to the control. All the biofumigants stimulated microbial growth, but broccoli and oilseed radish changed the microbial functional diversity. Mustard had no lasting effect on the functional diversity, but altered the microbial community structure. The chemical fumigants had a marked negative impact on the survival, growth, reproduction and the genotoxicity of the earthworms. The effects on the microbial community varied. Both chemicals had an inhibitory effect on the microbial growth in terms of the viable biomass, but no lasting effects were observed in the community structure.

CONCLUSION

Biofumigants had a less significant impact on non-target soil organisms and is a good alternative to chemical fumigants or as part of an integrated pest management (IPM) strategy for agricultural crops in South Africa.

Keywords: biofumigation, Biolog™, comet assay, earthworm biomarkers, microbial community, phospholipid fatty acid

CLIMATE CHANGE CAN IMPROVE YIELDS AND WATER USE EFFICIENCIES OF POTATO IN SOUTH AFRICA

Franke, A.C.[1], Steyn, M.J.[2], Muelelwa, L.N.[1], van der Waals, J.E.[2] and Haverkort, A.J.[3]

[1]University of the Free State, Bloemfontein, South Africa; [2]University of Pretoria, Pretoria, South Africa; [3]Wageningen University and Research Center, The Netherlands

E-mail: FrankeAC@ufs.ac.za

INTRODUCTION

In South Africa, potato is grown in both winter and summer in a wide range of climates. Climate change in potato production areas is expected to lead to higher temperatures, increasing the incidence of heat stress and dry spells, but lowering the risk of frosts in the mid- to high-altitude areas. Moreover, increased CO2 levels are likely to enhance photosynthetic rate and reduce water use in potato. The impact of these factors on potato yields and water use efficiency are non-linear and interact with each other. Moreover, the impacts and possibilities for adaptation are highly regional-specific. We assessed the impact of climate change on potential yields, water use efficiency and possibilities for adaptation for three production regions in South Africa (Haverkort *et al.*, 2013; Franke *et al*., 2013). Ongoing work evaluates the impact in 12 remaining production regions.

MATERIALS AND METHODS

Climate predictions between 1960 and 2050 were obtained by downscaling global circulation models. These were used as input for a crop simulation model (LINTUL-POTATO) calculating potential yield and evapotranspiration. Key is the relationship between photosynthetic rate, expressed as radiation use efficiency (RUE), water use and CO_2 levels. Various FACE studies reported strong responses of potato yield to increasing CO_2 levels, relative to other crops. We assumed a net yield increase resulting from CO_2 and O_3 increase of 28.5% between 1990 and 2050, with an expected CO_2 concentration increase of 190 ppm. In the same period, water use was assumed to decrease by 11% as a result of changing CO_2 levels if all other conditions remain the same.

RESULTS AND DISCUSSION

Potato in South Africa will benefit considerably from increased CO_2 levels through increased tuber yield and reduced water use by the crop if planting is shifted to appropriate times of the year. When the crop is grown in hot periods however, these benefits are counteracted by an increased incidence of heat stress and higher evapotranspiration, leading in some instances to considerably lower yields and water use efficiencies. When the crop is grown in a cool period, there is an additional benefit of a reduced incidence of cold stress and a more rapid canopy development in the early stages of crop growth. In many regions, potato growers are likely to respond to climate change by advancing planting.

CONCLUSIONS

Despite the fact that potato is a heat-sensitive crop grown under relatively warm conditions in South Africa, the impact of climate change on yield and water use efficiency is expected to be positive in most regions.

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Keywords: Solanum tuberosum, evapotranspiration, radiation use efficiency, crop model

MODELLING SMALLHOLDER CROPPING SYSTEMS

Franke, A.C.[1, 3], Van Wijk, M.T.[2], Descheemaeker, K.[3], Corbeels, M.[4] and Giller, K.E.[3]
[1]Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein, South Africa;
[2]International Livestock Research Institute, Nairobi, Kenya; [3]Plant Production Systems Group, Wageningen University, the Netherlands; [4]CIRAD, C/O Embrapa-Cerrados, Brazil

E-mail: FrankeAC@ufs.ac.za

INTRODUCTION

Crop simulation models can play an important role in agricultural research and development in the context of smallholder systems in sub-Saharan Africa. Detailed, process-based crop models tend to be relatively accurate at simulating yield, but possibilities for up-scaling the outputs of such models to farm level are limited. The model FIELD is a dynamic summary model of the soil and crop system that aims to capture all key processes determining crop productivity and long-term dynamics in soil fertility, while maintaining a degree of simplicity that facilitates parameterisation. FIELD is integrated in the NUANCES-FARMSIM framework allowing the simultaneous simulation of different fields varying in soil fertility, resource flows between seasons and fields, and interactions with livestock.

MATERIALS AND METHODS

In this study we present three novel model applications. (1) We assessed the ability of FIELD to simulate the impact of soybean on cereal yields and to differentiate the nutrient benefits of soybean from other rotational effects. (2) FIELD in combination with a livestock production model was applied to quantitatively explore trade-offs in the use of crop residues. (3) We explore the impacts of increased legume cultivation on yields and food self-sufficiency at farms differing in resource endowment.

RESULTS AND DISCUSSION

(1) Simulated yields of soybean and continuous maize were close to observed values. However, the simulated increase in yield of maize after soybean, relative to continuous maize, was only 67% of that observed, indicating that the remaining 33% increase was due to other rotational benefits of growing soybean such as a reduction in biotic stresses. (2) In the second application, allocation of crop residues to livestock had strong long-term consequences for soil C. To maintain soil C, at least 50% of the aboveground crop residues should be returned to the soil. Conservation agriculture can help in improving crop productivity but has negative consequences for livestock productivity if residue use is not carefully balanced. (3) In the final case, rotating maize with legumes improved maize yields, relative to continuous maize, but a decline in maize yield and soil fertility was only halted when legumes received improved management. While legumes achieved lower grain yields than maize, the yield-enhancing effect of legumes on maize resulted in increased food availability. The improvements were nevertheless modest on the resource-poor farm where the small farm size (0.4 ha) is a binding constraint to any major improvement in farm productivity.

CONCLUSIONS

Daily time-step models are well suited to evaluate tactical and operational management decisions requiring subtleties in simulation that cannot be provided by summary models. For strategic management decisions at smallholder farms, an approach using FIELD provides a balanced representation of processes at different scales, yet with relatively modest requirements for input parameters.

Keywords: crop modelling, legumes, maize, resource allocation, soil carbon, sub-Saharan Africa

DEVELOPING A HYDRO-SALINITY IRRIGATION MODEL FOR FOREST TREES PLANTED IN THE UNITED ARAB EMIRATES WHEN USING HYPER-SALINE WATER

Gouws, J.A.[1] and Van Rensburg, L.[2]

[1]Barari Forest Management, P O Box 113260, Abu Dhabi. UAE; [2]University of the Free State, P O Box 339, Bloemfontein, 9300;

E-mail: andries@barari.ae

INTRODUCTION

There is still much confusion about the water requirement of trees planted in forests and in gardens of the UAE. The present guideline is to 18 litres per day, which does not make provision for tree size, tree species, and water quality, nor for leaching requirements or the effect of mulching. More than 28 of the 250 forests in the UAE receive irrigation water with a salinity level above 27 mS/m (TDS > 20 000ppm).This prompted research to develop irrigation guidelines for forestry when using saline water.

MATERIALS AND METHODS

Transpiration for three tree species was measured with a Sapflow meter and evaporation by calculating water lost from a container during every irrigation cycle. Daily ET0 was calculated from weather stations located in proximity of the research plots.

RESULTS AND DISCUSSION

The daily transpiration rate was predicted very accurately (R2=0.93):
Transpiration = ET_o x TF x SF
Where: ET_o = Average monthly evapotranspiration (as per Penman Monteith), TF = Tree factor and SF = (1.467 x Tree volume-28.04)/30.65

CONCLUSIONS

This research tried to quantify the transpiration by measuring the sap flow and the evaporation by measuring the actual water loss from bare soil and when mulched. The research found that both transpiration and evaporation can successfully be calculated in order to predict the inputs to the water balance model.

Keywords: Acacia tortilis, hydro-salinity irrigation model, *Prosopis cineraria*, reference tree factor, sap flow meter, tree size factor

WATER USE OF SORGHUM IN RESPONSE TO VARYING PLANTING DATES

Hadebe, S.T., Modi A.T. and Mabhaudhi, T.

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

E-mail: hadebesta@gmail.com

INTRODUCTION

It is vital to understand how rainfall onset, amount and distribution between planting dates affect sorghum (*Sorghum bicolor* L. Moench) yield and water use in order to aid planting date and cultivar selection. This study investigated morphological, physiological, phenological, yield and water use characteristics of different sorghum genotypes in response to different planting dates**.**

MATERIALS AND METHODS

Field trials were conducted during 2014/15 at Ukulinga Research farm, Pietermaritzburg, South Africa. The experimental design was split–plot design. Planting dates were the major factor with cultivars allocated to sub–plots arranged in randomised complete blocks replicated three times. The planting dates were 03 November 2014, 17 November 2014, and 26 January 2015 represented early, optimal and late planting dates respectively. Four sorghum genotypes – PAN8816 (hybrid), Macia (open–pollinated variety, OPV), Ujiba and IsiZulu (both landraces) – were evaluated. Climate, soil physical, morphological, physiological, phenological, yield and water use data were collected during the trials.

RESULTS AND DISCUSSION

Low soil water at the optimal planting date was associated with delayed crop establishment and low final emergence. Sorghum genotypes adapted to low and irregular rainfall at the late planting date through significantly ($P<0.05$) low leaf number, canopy cover, chlorophyll content index and stomatal conductance, and hastening phenological development. This resulted in markedly ($P<0.05$) low biomass and yield. Landraces exhibited panicle yield stability across planting dates, whilst OPV and hybrid genotypes significantly reduced panicle yield in response to low water availability when planted late. Biomass and yield water use efficiency (WUE) were highest at optimal planting (30.5 and 12.2 $kg.ha^{-1}.mm^{-1}$), relative to late (23.1 and 11.8 $kg.ha^{-1}.mm^{-1}$), and early planting dates (25.2 and 10.9 $kg.ha^{-1}.mm^{-1}$).

CONCLUSIONS

Biomass and WUE of the hybrid and OPV were low under water limited conditions. For the landraces, biomass and WUE improved with decreasing water availability. Cultivation of hybrids and OPVs is recommended under optimal conditions. Landraces are recommended for areas with low and highly variable rainfall.

ACKNOWLEDGEMENTS

The Water Research Commission of South Africa is acknowledged for initiating, funding, managing and directing this research through WRC Project No. K5/2274//4 ‘Determining water use of indigenous grain and legume food crops’.

Keywords: cultivar selection, rainfall variability, water use, water use efficiency

FACTORS AFFECTING SURVIVAL OF WILD POPULATIONS OF *Warburgia salutaris*: STRATEGIES FOR PROPAGATION AND CONSERVATION.

Hannweg, K.[1], Grove, T.[1], Hofmeyr, M.[2], Froneman, W.[3] and Neary, T.[4]

[1]ARC-ITSC, Private Bag X11208, Nelspruit, 1200; 2SANPARKS Conservation Services, Private Bag X402, Skukuza, 1350;3SANBI-LNBG, PO Box 1024, Nelspruit, 1200; 4SAPPI Pty Ltd, PO Box 31560 Braamfontein, 2017

E-mail: karin@arc.agric.za

INTRODUCTION

Pepperbark, *Warburgia salutaris* (Family: Canellaceae), is one of the most highly sought after tree species in South Africa due to its high medicinal value. SANPARKS established "The Pepperbark Initiative", a project aimed at focusing on conservation of this species by addressing various issues, including scientific and social aspects. Being a multi-use species, it has become highly endangered, particularly in the Kruger National Park where illegal bark harvesting is practiced. Known stands of trees are protected by patrolling field rangers who also identify new populations while on patrol. Bark is harvested unsustainably and trees are effectively ring-barked, causing death of the trees several months after harvest. Furthermore, flower and fruit set are exceptionally low, and when fruits are set they are parasitized by fruit flies resulting in low seed survival rates. Various strategies for propagation were investigated.

METHODS AND MATERIALS

Both *in vitro* and *ex vitro* propagation methods were investigated, including methods which could be readily adopted by neighbouring communities to propagate and establish their own trees at their homesteads. In this study, the use of micro-cuttings was investigated. Aspects investigated included: season of harvest, type and size of micro-cutting, rooting medium, rooting hormones and rooting microclimate. In vitro investigations included a study of explant type at initiation, treatments to prevent phenolic browning and contamination at culture initiation as well as type of culture and growth regulator composition in culture media. Further, an investigation of which fruit fly species uses *W. salutaris* as a host was conducted and a seed storage trial, whereby seeds were stored at room temperature and at 4 °C for up to 5 months, was also carried out to determine storage conditions required to maintain viability.

RESULTS AND DISCUSSION

The best conditions for micro-cutting establishment included the use of summer harvested shoots rooted using Seradix® or Dip 'N Grow rooting hormones, using a well-drained potting medium. While challenging, in vitro explants could be established and research is continuing. High infestations by Marula fruit fly were identified in fruit, resulting in failure of fruit and seed development. The seed storage trial revealed that viability was significantly higher when seeds were stored at 4 °C.

CONCLUSIONS

This collaborative effort between SANPARKS, the Agricultural Research Council's Institute for Tropical and Subtropical Crops and SANBI-Lowveld National Botanical Garden has resulted in significant progress in generating new knowledge on the propagation of this species, as well as other horticultural and botanical aspects. This research provides a template for the conservation of other species with a high conservation mandate. The contribution of the ARC-ITSC and SAPPI Southern Africa (Pty) Ltd towards funding of the project is also acknowledged.

Keywords: pepper bark, propagate, fruit fly, seed storage, conservation

BIORESOURCE (BR) PROGRAM AS A CROP PRODUCTION EXTENSION TOOL IN THE NQUTHU COMMUNAL FARMING AREA, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Hlatshwayo, P.P.K[1] and Worth, S.H.[2]

[1]KwaZulu-Natal Department of Agriculture and Rural Development, Nquthu Agricultural Office, Private Bag X5501 Nquthu 3135; [2]Department of Agricultural Extension and Rural Resource Management, University of KwaZulu-Natal, Private Bag X01 Scottsville 3209

Email: Phendukani.Hlatshwayo@kzndard.gov.za

INTRODUCTION

Bioresource (BR) program is a computerised, rainfall x altitude interaction program, developed to guide extension service and farmers to scientifically choose sites for crop production. Camp (1999) defined Bioresource Unit (BRU), (which is the most important level of BR program), as a class of land within which the environmental factors such as soil type, climate, terrain form and vegetation display a sufficient degree of homogeneity such that uniform land use practices and production techniques can be defined. This study determined the theoretical understanding and the practical usage of BR program by state extension officers (EO's) advising on crop production.

MATERIALS AND METHODS

For theoretical understanding by extension officers, the self-administered closed ended questionnaire was conducted amongst EO's (n=16) in 2014. Sampling procedure was purposive sampling (Schumacher & McMillan, 2001). For practical utilization of BR, samples were randomly harvested in three sites per field for maize and dry beans to determine yield against 16 BRU's, under rainfed conditions during 2013 season. The data was analysed with IBM SPSS Statistics, version 19.0 (2010).

RESULTS AND DISCUSSION

Results indicated that all EO's (100%) have heard about BR program but only 38.5% had attended the short course, which was in 2008. 38.5% indicated they know BRU's of their extension ward. The majority (37%) responded that they looked for climatic data compared to 30% for crop potential, 20% for soil information and 13% for maps in BR program. These figures indicate that agricultural advisors have this tool to help them advice properly at their disposal, but do not use it effectively. On practical utilization on both mostly grown crops (maize n=89 and dry beans n=10) in Nquthu area, results showed that there were significant ($p>0.05$) differences in yields between BRU's (those with higher rainfall x higher altitude compared to those with lower rainfall x lower altitude).

CONCLUSION

Use of BR tool should be encouraged or made compulsory to all EO's on state funded interventions so that BRU with higher rainfall x higher altitude can be selected for cropping and potentially to improve crop production in resource poor communal areas.

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Keywords: agricultural extension, communal farming, natural resource management, rural livelihood

THE INFLUENCE OF PACLOBUTRAZOLE ON SWEET POTATO GROWTH AND YIELD

Hlerema, I.N[1], Laurie, S.[1] and Eiasu, B.[1]

[1]ARC-VOPI, Private Bag X293, Roodeplaat; [2]University of Fort Hare, Private Bag X1413, Alice

E-mail: HleremaI@arc.agric.za

INTRODUCTION

Vegetative growth reduction in fruit trees has been shown to reduce competition between vegetative and reproductive sinks (storage organ). Manipulation of sink capacity may enhance sweet potato yield through assimilates repartitioning. Paclobutrazole (PBZ) is a plant growth retardant. It is a known antagonist of the plant hormone gibberellin. It acts by inhibiting gibberellin biosynthesis, reducing internodal growth to give stouter stems, increasing root growth, causing early fruit set and increasing seed set in plants. PBZ might therefore be useful for sweet potato growers to achieve higher plant populations per hectare since it will reduce the plant canopy. The objective of this study was to determine the effect of PBZ on sweet potato growth and storage root yield.

MATERIALS AND METHODS

The experiment was done at University of Fort Hare. It was a split plot experiment. The main plots (paclobutrazol levels) was laid out as a Randomized Complete Block Design. The two cultivars (Bophelo and Blesbok) and two plants spacings (20cm and 30cm) were randomly allocated into the subplots. The paclobutrazol levels used included 0 mg, 100 mg, 200 mg and 300 mg of active ingredient per 1L (water), applied forth nightly, 4 weeks after planting. Basal fertilizer (2:3:4) was added at 800kg/ha. Top dressing (LAN) at 150kg/ha was applied twice. Root yield and biomass accumulation was recorded. Harvesting was done in May 2015.

RESULTS AND DISSCUSSION

The results show that there was significant difference ($p<0.001$) between the two cultivars used in the trial, with Blesbok having the highest average root yield. There was significant difference ($p<0.01$) in marketable yield of each cultivar at the two spacings tested. The 20cm spacing had the highest average yield. PBZ had a significant ($p<0.05$) effect on the cultivar Blesbok with 100mg/1 L having the highest average marketable yield and also significantly ($p<0.05$) reduced the vine length.

CONCLUSIONS

A narrower in-row plant spacing of 20 cm resulted in higher average marketable yield. Data from this study suggested that it may be possible to use PBZ to manipulate the source-sink relationship for higher storage root yield in sweet potato.

Keywords: Blesbok, Bophelo, Paclobrutrazol, sweet potato vines

PHENOTYPING SUGARCANE GENOTYPES FOR RADIATION USE EFFICIENCY

Hoffman, N., Singels, A., Eksteen, A. and Jones, M.

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

E-mail: Natalie.Hoffman@sugar.org.za

INTRODUCTION

Radiation use efficiency (RUEo - gross photosynthate produced per unit of photosynthetically active radiation under reference conditions), is a key driver of biomass yields and a key parameter in crop models (Sinclair and Muchow, 1999). RUEo values can be estimated from concurrent biomass yield and intercepted radiation data, or from leaf-level gas exchange measurements. The objective of this study was to develop a phenotyping method for estimating sugarcane RUEo from leaf-level gas exchange measurements.

MATERIALS AND METHODS

A well-watered pot trial was established at Mount Edgecombe, KwaZulu-Natal as a complete randomised block design consisting of five replications of 14 genotypes. Leaf level photosynthesis rate (A) and stomatal conductance were measured in two data sets using the LiCor-6400 infrared gas analyser (g_{sLicor}) and SC-1 Decagon steady-state porometer (g_{sporo}). For each replicate, three hourly datasets were collected between 10:00 and 13:00 on a given day, and values expressed relative to NCo376.

RESULTS AND DISCUSSION

Relative values of A and g_{sporo} could be combined, while g_{sLicor} showed significant genotype X hour interaction in data set II (p= 0.008). There was a significant correlation between genotype average A and gs values (R2=0.62), as well as in genotype rankings (R2=0.48) for these parameters. Canopy level RUEo values were derived by multiplying relative gsporo values with a field calibrated value for NCo376 (Table 1).

Table 1. Average relative values (%) of stomatal conductance measured with a poromoter (g_{sporo}) and radiation use efficiency (RUEo, g MJ-1) for 14 genotypes. Superscripts with common letter denote no significant differences (p>0.05).

Genotypes	N12	ZN6	N51	N25	N31	R570	N14	N19	N36	N48	N42	NCo376	N41	04G0073
g_{sporo}	54^{a}	60^{ab}	65^{abc}	72^{bcd}	75^{cde}	75^{cde}	81^{de}	82^{def}	83^{def}	87^{efg}	95^{fgh}	100^{gh}	101^{gh}	109^{h}
RUEo	3.1^{a}	3.4^{ab}	3.8^{abc}	4.2^{bcd}	4.3^{cde}	4.3^{cde}	4.6^{de}	4.7^{def}	4.8^{def}	5.0^{efg}	5.5^{fgh}	5.7^{gh}	5.8^{gh}	6.2^{h}

CONCLUSIONS

A method was developed to estimate leaf-level photosynthetic efficiency from porometer measurements of g_s. Canopy level RUEo values can be estimated from this information. The phenotyping method developed here may be implemented as a possible screening procedure for selecting high yielding sugarcane genotypes in breeding programs.

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Keywords: breeding, phenotyping, photosynthetic rate, radiation use efficiency, stomatal co

RESPIRATION RATE DYNAMICS OF APPLE BUDS EXPOSED TO CHEMICAL REST BREAKING AGENTS AND INSUFFICIENT WINTER CHILL

Inamahoro, M.[1], Steyn, W.J.[1, 2], Schmeisser, M.[1], Jacobs, G.[1] and *Louw, E.D[1]

[1] Dept. Horticultural Science, University of Stellenbosch, Private bag X1, Matieland 7602
[2] HORTGRO Science, P.O. Box 12789, Die Boord 7613

E-mail: esmelouw@sun.ac.za

INTRODUCTION

Apple trees that do not receive adequate chill during winter do not fully release endodormancy, resulting in decreased bud break and uneven and delayed blooming that impacts negatively on tree formation and yield. To overcome this, chemical rest breaking agents (i.e. Dormex® (Hydrogen cyanamide) and oil) are used to artificially release the buds from dormancy and synchronize bud break. This study aims to investigate the effects of insufficient winter chill as well as Dormex® and oil on the total respiration rate and the rate of four respiratory pathways (Tri-Citric Acid cycle (TCA), Pentose Phosphate Pathway (PPP), Alternative Oxidase (AOX) and Cytochrome C (CytC) in apple terminal buds) .

MATERIALS AND METHODS

Terminal buds from mature 'Cripps' Pink' trees were collected from May to September 2015. Samples exposed to insufficient winter chill were collected from three orchards in the Elgin area (±700 chill units (CU)) and compared to samples from orchards in the Koue Bokkeveld area (±1400 CU). In the Elgin area, sampling continued after the commercial application of Dormex® and oil. Control shoots were covered with plastic bags during the treatment. The respiration rate was determined by using a Clark-type oxygen electrode fitted to a liquid filled chamber containing the buds. The rates of the pathways were measured using inhibitors targeting each pathway. Means (min 12 reps) were compared using a two-way ANOVA.

RESULTS AND DISCUSSION

The results showed that the total respiration rate of the buds from both areas declined over the first part of the winter, with the buds from the warmer area having a higher respiration rate. For the latter part of the winter, the respiration from both areas increased but the buds from the warmer area responded significantly slower and failed to reach a level equal to what was achieved before the winter. The TCA and Cyt C pathways from the warmer area mimicked this pattern whereas the PPP and AOX pathways indicated significantly higher levels for the latter part of the winter. Dormex® and oil treatment caused an increase in the respiration rate of the TCA and Cyt C pathways, reaching a level similar to what was measured for the buds exposed to cold winter conditions. The untreated buds continued to show a crippled respiration rate with an increasing use of the PPP and AOX pathways.

CONCLUSION

Buds exposed to insufficient winter chill have a respiration pattern different to that of buds that received sufficient winter chill. The TCA and Cyt C pathways are negatively affected towards the latter part of the winter, resulting in the plant having to increase its use of the PPP and AOX pathways to accommodate the loss in energy. If the buds are treated with Dormex® and oil prior to budbreak, the rates of the TCA and Cyt C pathways are re-established and the PPP and AOX rates decrease correspondingly, resulting in a respiration pattern similar to that of buds grown in the Koue Bokkeveld.

Keywords: apple, buds, respiration, chemical rest breaking, chill units dormancy

FIELD SCREENING OF LESOTHO AND SOUTH AFRICAN WHEAT CULTIVARS FOR RUSSIAN WHEAT APHID RESISTANCE

Jankielsohn, A.[1] and Masupha, B.[2]

[1]ARC-Small Grain Institute, Private Bag X29, Bethlehem, 9700, South Africa; [2]National University of Lesotho, Roma, Lesotho

Email: jankielsohna@arc.agric.za

INTRODUCTION

Russian wheat aphid (*Diuraphis noxia*) is an international wheat pest and was first recorded in South Africa in 1978 in the Bethlehem area in the Eastern Free State. The aphid rapidly spread to all the wheat production areas in South Africa and Lesotho and became a significant threat to the wheat industry in South Africa. With the release and adoption by farmers of Russian wheat aphid resistant cultivars from 1996 this threat was successfully mitigated. The occurrence of new Russian wheat aphid biotypes since 2005, however posed a new threat to the wheat industry in South Africa. Lesotho lies adjacent to one of the largest wheat producing areas in South Africa, the Eastern Free State, where winter wheat and facultative types are cultivated under dry land conditions. Wheat (*Triticum aestivum* L.) is an important crop adapted to all agro-ecological zones of Lesotho. Wheat is planted in the lowlands of Lesotho during May and in the highlands of Lesotho during October. Russian wheat aphid may have a significant impact on wheat yield. No monitoring or pest control is being done in Lesotho and at this stage there is very little information on the Russian wheat aphid resistance of wheat cultivars cultivated in Lesotho. In view of this it is important to monitor the distribution of Russian wheat aphid biotypes in Lesotho and determine level of Russian wheat aphid resistance in local Lesotho wheat cultivars.

MATERIAL AND METHODS

Two local Lesotho wheat cultivars, Bolane and Makalaote was screened together with South African cultivars Elands, Matlabas, Senqu, PAN3379, PAN3118 and SST387 with known Russian wheat aphid resistance in the glasshouse against all four known biotypes in South Africa. All these cultivars were also planted in 5m plots in the field at two localities Leribe and Roma in the lowlands of Lesotho. These cultivars were screened in the field for Russian wheat aphid resistance. The predominant Russian wheat aphid biotype in these areas was also determined.

RESULTS AND DISCUSSION

The two Lesotho cultivars, Bolane and Makalaote did not have any Russian wheat aphid resistance in either the glasshouse or field screenings.

CONCLUSIONS

To contribute to food security an increasing wheat yield potential is a high priority. Russian wheat aphid has been included in the list of important international cereal pests. Russian wheat aphid adapts to changing environments and taking their ecology, distribution, virulence patterns, and variability into account is important in minimizing the gap between actual and attainable yields. Current management practices for winter wheat include the use of resistant cultivars, which is the most economical management strategy for Russian wheat aphid. Introducing Russian wheat aphid resistant cultivars in Lesotho will improve overall yield and as a result food security. This will also result in lower Russian wheat aphid pest pressure in the adjacent wheat production areas in the Eastern Free State, South Africa.

Keywords: field screening, Lesotho, resistance, Russian wheat aphid, wheat cultivars

EFFECTS OF SOIL AMENDMENT WITH BIOCHAR ON SPHYSIOLOGICAL PROPERTIES AND YIELD OF SPINACH GROWN IN NUTRIENT-DEPLETED SOIL

Jifon, J.L.[1], Sivakumar, D.[2], Crosby, K.[3], Soundy, P.[2] and Leskovar, D.[4]

[1]Texas A&M AgriLife Research, Weslaco, TX, USA; [2]Tshwane University of Technology, Pretoria, South Africa; [3]Texas A&M University, College Station, TX, USA; [4]Texas A&M AgriLife Research, Uvalde, TX, USA

E-mail: jifon@tamu.edu

INTRODUCTION

Continuous cropping and soil fertility depletion are among the key factors contributing to low crop productivity that threaten global food security and agricultural sustainability (Winterbottom, et al., 2013). Integrated soil fertility management (ISFM) practices such as soil amendments can mitigate these effects and increase long-term agricultural productivity and resilience to climate change. However, benefits of soil amendment seem to depend on many factors including antecedent soil properties and crop selection. The goal of this study was to evaluate effects of soil amendment with biochar on yield and nutrient content of leafy vegetables.

MATERIALS AND METHODS

Greenhouse investigations with spinach (Spinacia oleracea L. var 'PV 9263') were carried out using a nutrient-depleted soil, amended with biochar at 0, 15, and 30% soil incorporation. Yield, leaf area, leaf chlorophyll (CHLL), relative water content, stomatal conductance, photosynthesis and mineral contents were measured during or at the end of the crop growth cycle.

RESULTS AND DISCUSSION

Leaf relative water content (RWC), leaf area, leaf chlorophyll content and leaf fresh mass were greater at the 30% biochar incorporation rate ($P<0.006$, $P<0.021$, $P<0.038$ and $P<0.046$ respectively) compared to the 0 and 15% rates. Leaf stomatal conductance and photosynthesis rates did not differ among biochar incorporation rates presumably due to measurement time and overall adequate water supply in all treatments. Leaf nitrogen contents ranged from 3.2 to 4.5% but did not differ among biochar incorporation rates.

CONCLUSIONS

Biochar incorporation at 30% had beneficial effects on leaf physiological properties and yield. These benefits likely resulted from improvements in soil chemical and physical properties that allowed for better water and nutrient retention.

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Keywords: Biochar, leafy vegetables, soil amendment, food security

EFFECT OF ACID MINE WATER AND *Bacillus subtilis* ON GROWTH AND YIELD OF POTATO

Kanu, S.A. and Ntushelo, K.

Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa, Private Bag X6 FLORIDA 1710, South Africa

E-mail: kanusa@unisa.ac.za

INTRODUCTION

Potato (*Solanum tuberosum* L.) is cultivated for food, starch and tuber production and is ranked as the fourth most important food crop after rice, maize and wheat. Cultivation of this crop is a big economic activity but requires adequate clean irrigation water supply. In South Africa, most surface waters are being polluted due to mining activities. Therefore, acid mine drainage is prevalent in most urban and rural mining precincts where it poses threats to agriculture - a major source of livelihood for the local communities. The ubiquitous *Bacillus subtilis* is known to promote plant growth through secretion of metabolites. The objective of this study was to test the ameliorating effect of *Bacillus subtilis* on growth and yield of potato cv. 'BP1' treated with proportions of acid mine water (AMW).

MATERIALS AND METHODS

Certified potato seed tubers cv. 'BP1' were planted in 4 L plastic bags filled with sterile potting soil. Three different proportions of AMW (0%, 25% and 75%) were each mixed with sterile potting soil as treatments. A pure strain of *Bacillus subtilis* was cultured in LB broth at 32^{o}C and the growth medium divided into two equal volumes after incubation. The plate count method was used to determine the cell populations of *B. subtilis* in each growth medium. The *B. subtilis* population in one medium was killed by autoclaving and the other maintained alive. During planting, potato seed tubers in the three treatments were each inoculated with either "killed" *Bacillus*, or "live" *Bacillus* or "no" *Bacillus*. The study entailed 3 experiments with 3 treatments each replicated four times in a glasshouse. Growth parameters were recorded at four-day intervals from day 30 through 66 days after planting (DAP). Thereafter, the plants were allowed to grow until tuber formation and maturity at 90 DAP. The tuber number and weight per plant were determined at harvest, 90 DAP.

RESULTS AND DISCUSSION

AMW proportions significantly ($p<0.05$) affected growth parameters such as plant height and stem diameter. Plants grown on 75% AMW soils either with "killed" or "live" or "no" *Bacillus* were taller, had the largest stem diameter than those of the 25% and 0% treatments. The AMW proportion and inoculum interaction was significant with 75% x "killed" *Bacillus* treatment resulting in better seedling growth. AMW proportions also affected potato yield as 75% treated soils resulted in plants with the highest number and weight of tubers relative to other treatments. Plants raised on tap water (0% AMW) mixed with soil and inoculated with "live" *Bacillus* had the lowest number of tubers and weight of biggest tuber per plant.

CONCLUSIONS

Inoculation with *Bacillus subtilis* showed no significant effect on growth and yield of potato cv. 'BP1' treated with acid mine water proportions according to findings of this ongoing study.

ACKNOWLEDGEMENTS

Authors acknowledge University of South Africa for funds.

Keywords: acid mine water, *Bacillus subtilis*, potato

SYMBIOTIC PERFORMANCE OF *Psoralea pinnata* (L.) GROWN UNDER TWO CONTRASTING HABITATS IN THE CAPE FYNBOS OF SOUTH AFRICA

Kanu, S.A.[1] and Dakora, F.D.[2]

[1]Department of Agriculture and Animal Health, University of South Africa, Private Bag X6 FLORIDA 1710, South Africa; [2]Department of Environmental, Water and Earth Sciences, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa.

E-mail: kanusa@unisa.ac.za

INTRODUCTION

Legume nodules formed in different artificially supplied pO_2 revealed both anatomical and physiological adaptations to effectively fix N_2. In nature, some legumes are known to grow in habitats that experience low pO_2, often leading to adaptations that support nodule functioning. This study evaluated the symbiotic performance of *Psoralea pinnata* (L.) grown naturally under upland or wetland conditions in the Cape Fynbos of South Africa.

MATERIALS AND METHODS

P. pinnata plants growing naturally in wetland and well-drained upland conditions in the Cape Fynbos of South Africa were used for this study. To determine symbiotic functioning using the natural abundance technique, stems plus leaves of the eight nodulated plants from each habitat were used to measure N_2 fixation. Branches with leaves were similarly harvested from non-legume species for use as reference plants. Mass spectrometry was used for ^{15}N analysis and the percent N derived from fixation (%Ndfa) was calculated using the ^{15}N natural abundance technique as described by Unkovich et al. (2008).

RESULTS AND DISCUSSION

Nitrogen concentration in branches was similar for *P. pinnata* plants growing in wetland and upland conditions. The $\delta^{15}N$ values of plant samples were also not different between the two habitats. As a result, the %Ndfa values were similar for *P. pinnata* from wetland and upland conditions. Interestingly, plants from both habitats derived over 75% of their N nutrition from symbiotic fixation. This clearly indicates that, despite the potentially low pO_2 conditions in the wetland, *P. pinnata* plants were still highly dependent on N_2 fixation for their N nutrition.

CONCLUSIONS

The lack of differences in symbiotic parameters such as N concentration, $\partial^{15}N$ and %Ndfa between wetland and upland *P. pinnata* plants could suggest major anatomical changes in root nodules of the former, which increased O_2 supply to N_2-fixing bacteroids.

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ACKNOWLEDGEMENTS

Authors acknowledge Tshwane University of Technology and the National Research Foundation for funds.

Keywords: Psoralea pinnata, symbiotic performance, upland, wetland.

INFLUENCE OF SEASONAL VARIATION IN NUTRITIONAL STATUS, ROOTING AND ROOT DEVELOPMENT OF HONEYBUSH (*Cyclopia genistoides*)

Karsen, P.A.[1], Valentine, A.[2] and Hoffman, L.[3]

[1]Directorate Plant Sciences, Department of Agriculture Western Cape; [2]Department of Botany and Zoology, Stellenbosch University ; [3]Department of Horticultural Science, Stellenbosch University;

E-mail: pippak@elsenburg.com

INTRODUCTION

Currently there are ±200 ha of C*. genistoides* ("kustee") and *C. subternata* ("vleitee") under cultivation in South Africa. *C intermedia* ("bergtee") is the predominate species harvested from the wild. Cultivation of honeybush is promoted as it provides greater control over tea quality and increased yields, whilst wild populations are conserved. Rooting and root development is remarkably sensitive to the variation, supply and distribution of available nutrients in the plant. The seasonal availability of nutrient levels in cuttings such as N, P, K and Fe influences rooting and root development directly or indirectly through changing the internal nutrient status. The aim of this study was to compare cutting nutritional levels with the seasonal variation of rooting ability and development.

MATERIALS AND METHODS

Two clones (GK 3 and GK 5) of C*. genistoides* were selected from stock plants in Bredasdorp, Western Cape, with cuttings were taken in July and October 2013 as well as in January, April and July 2014. Cuttings were made per industry recommendations and assessed for nutrient levels before striking. Rooting percentage, number of primary and secondary roots, total root length and dry mass were assessed three months after striking.

RESULTS AND DISCUSSION

Both clones showed significantly higher rooting percentages respectively in the January (59%; 75%), April (100%; 40%) and July 2014 (53%; 90%) cuttings compared to those collected in October 2013 (12%; 23%). Low rooting, number of primary roots and total number of roots in October 2013 were correlated with low N, K levels and high Ca, Fe, B and Al levels in the cutting. The inverse was true when higher rooting percentages were achieved. No significant differences were seen in the P, Mg, Cu and Zn levels in the cuttings at all four sampling dates. High available N levels influence the root morphology and increase root branching and root growth. High K increases root growth whilst low iron increases root formation and elongation.

CONCLUSION

Cuttings made when the mother plant is flowering or directly after consistently lead to a significantly lower rooting percentage. The mother plant nutritional status plays a significant role in the rooting and root development of cuttings.

ACKNOWLEDGEMENTS

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Keywords: honeybush, rooting, seasonal nutritional levels, cuttings

MECHANICAL THINNING OF APPLES (*Malus domestica* Borkh.)

Kirstein, D.L.[1], Steyn, W.J.[1, 2] and Theron, K.I.[1, 2]

[1]Dept. of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602; [2]HORTGRO Science, PO Box 12789, Die Boord 7600

E-mail: kit@sun.ac.za

INTRODUCTION

Fruit thinning is one of the most important orchard management practices in apple cultivation. Thinning is performed to enhance fruit size, improve yield and to ensure adequate return bloom. Mechanical thinning is relatively new in South Africa and currently only used commercially on stone fruit. Various machines are available and we evaluated the potential of the tractor-driven BAUM and Darwin 300™, as well as the Bloom Bandit™ hand-held thinner for apple thinning.

MATERIALS AND METHODS

The BAUM was tested on 'Cripps' Pink' in two trials; four treatments were applied in the first trial in the 2013/2014 season at 30% petal drop, with tractor speeds of 3.0 and 4.0 km·h^{-1}, and rotation rates of 350 and 400 rpm. A late (18 mm fruit diameter) chemical application of 6-BA (150 µl·L^{-1}) and an unthinned control was included. The second trial received four mechanical treatments at full bloom in the 2014/2015 season, with tractor speeds of 2.7 and 3.3 km·h^{-1} with 300 rpm rotation rate, and 3.0 km·h^{-1} with 400 rpm rotation rate, and the Bloom Bandit™ for 1 min tree^{-1}. An untreated control was included and commercial hand thinning was done on all treatments. The Darwin 300™ was evaluated in the 2013/2014 season on 'Cripps Pink' at 4 mm fruit diameter with three treatments; a tractor speed of 3.0 km·h^{-1} and rotation rates of 200 and 220 rpm, and at 4.0 km·h^{-1} with 240 rpm. A late (15 mm fruit diameter) chemical application of 6-BA (100 µl·L^{-1}) and an unthinned control was included. The Bloom Bandit™ was tested in two trials in the 2014/2015 season on 'Fuji' and 'Cripps' Red', and used for 1 or 2 min tree^{-1}. A standard farm chemical application of carbaryl (700 mg·L^{-1}) and NAA (5 µl·L^{-1}) was applied at 6 - 7 mm fruit diameter. The control was untreated, and was hand-thinned commercially with all other treatments.

RESULTS AND DISCUSSION

Mechanical thinning with the BAUM and Darwin 300™ did not consistently reduce set and the hand thinning requirement. The unreliable results are probably due to the general unsuitability of orchards for mechanical thinning. The Bloom Bandit™ effectively thinned apples and improved fruit size and quality without major losses in yield at both 1 and 2 min tree^{-1} with better results at the more intense 2 min level.

CONCLUSIONS

Mechanical thinning with the BAUM or Darwin 300™ did not reliably reduce fruit set and hand thinning requirements, but generally increased fruit size and quality. The unreliability of thinning was probably due to apple orchards in South Africa not being designed for mechanization and therefore not adapted to the machines. Orchards first need to be adapted for these machines before further evaluation can take place. The Bloom Bandit™ showed promise for thinning apples due to its more selective nature, but extra time spent in the orchard should be carefully evaluated to fully understand its economic feasibility.

Keywords: BAUM, Darwin 300™, Bloom Bandit™, chemical thinning, fruit set, fruit quality, return bloom

CROSS-ABILITY AMONG *Lachenalia* SPECIES AND HOW IT INFLUENCES FUTURE BREEDING STRATEGIES

Kleynhans, R.[1] and Spies, J.J.[2]

[1]Tshwane University of Technology, Private Bag X680, Pretoria, 0001; [2]University of the Free State, PO Box 339, Bloemfontein, 9300

E-mail: kleynhansr@tut.ac.za

INTRODUCTION

Lachenalia is a diverse genus, consisting of more than 130 species and subspecies. Species in the genus have been used in a breeding program, for the development of new cultivars for the international flowering pot plant market. The diverse nature of the genus has, however, created various breeding challenges. The cross-ability within the genus was thus investigated to enable breeders to propose strategies for the continuous development of new cultivars to satisfy the market.

MATERIALS AND METHODS

Fifteen of the *Lachenalia* species were crossed in all possible combinations to obtain detailed cross-ability results. Data were recorded on amongst others: number of flowers with normal seed, number of flowers with abnormal seed and % flower set. The data were subjected to statistical analysis using XLSTAT. Agglomerative hierarchical clustering analysis was performed, followed by a discriminant analysis to determine which of the variables contributed as drivers to cluster the data into three groups. Results were linked to actual chromosome numbers, the presence of polyploidy and cross direction.

RESULTS AND DISCUSSION

The cross-ability can be linked to the evolutionary relationships among species. The different basic chromosome numbers within the genus, as well as the existence of polyploidy influence the cross-ability. The existence of unilateral cross-ability was evident from the data and different accessions of the same species often gave different success results if crossed with another species. The basic chromosome number of the species used influenced the success rate of crosses and it was clear that the basic chromosome numbers remain the best way to predict cross-ability. Results also indicate that specific basic chromosome number combinations are more successful than others and confirm the importance of continued genetic variation studies.

CONCLUSIONS

Based on the results from the study, specific strategies important for future breeding include: maintenance of multiple accessions of the same species; essential importance of good germplasm characterization and evaluation; multi-disciplinary approach to clarify the genetic relationships among species; investigation of crossing barriers; pre-breeding to assess the compatibility and cross-ability; followed by actual crosses and quality hybrid evaluation processes.

Keywords: basic chromosome number, cross-ability*, Lachenalia*

A COMPARATIVE STUDY OF LASER DIFFRACTION VS. CONVENTIONAL SEDIMENTATION AND SIEVE ANALYSES FOR PARTICLE SIZE MEASUREMENT USING A VARIETY OF SOUTH AFRICAN SOILS

Koch, J., Schmidhuber, B.E. and Pretorius, C.

North-West University, Private Bag X6001, Potchefstroom, 2520

Email: jacokoch01@gmail.com

INTRODUCTION

Particle size analyses is considered a fundamental analytical method in most pedologicaly associated fields of study as well as geotechnical applications. The conventional methods used to determine particle size are time consuming, labour intensive and the sizes measured are limited to a specified number or readings depending on the method used. Laser diffraction as an alternative is a rapid method that analyses particle sizes far below clay fraction in as little as a minute at an accuracy that cannot be achieved by conventional methods.

MATERIALS AND METHODS

For this study two methods were used based on standard particle sizing procedures which were then compared. The first method used is the standard sieve and sedimentation method as described in ASTM D 421/422. The second method used laser diffraction using a Mastersizer 2000 with a HydroSM attachment (ISO 13320, 1999). For both methods samples were dispersed using only a 40 g/dm3 sodium hexa-meta-phosphate solution.

RESULTS AND DISCUSSION

Laser diffraction tends to overestimate larger particles (> 100µm) and as a result under estimate smaller particles. Sedimentation tends to overestimate fine particles as the settling effect deviates from the calculated settling rates based on particle charge and surface interaction with instruments as well as particle shape effects. Laser diffraction increases data density as well as repeatability allowing sample statistics to calculate reliability of results which is usually not indicated in conventional analyses.

CONCLUSIONS

Both methods have limitations which skews results in some way. Sieve and sedimentation analyses are extremely time consuming and labour intensive whilst laser diffraction is rapid and results allow sampling statistics to be incorporated as a standard. Time and labour saved as well as the accuracy of the method at particle sizes significantly smaller than clay particles makes the method an attractive alternative.

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Keywords: particle size analyses, laser diffraction, sedimentation and sieve analyses

PHYSICOCHEMICAL AND STRUCTURAL CHARACTERIZATION OF PYROGENIC BIOCHARS FROM HUMAN FAECAL WASTE

Koetlisi, K.A and Muchaonyerwa, P.

Soil Science Discipline, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01 Scottsville 3209, South Africa

Email: koetlisika@gmail.com

INTRODUCTION

Production of biochar from organic wastes, and its use on agricultural land could be viable and beneficial. Biochar properties are known to depend on feedstock and carbonization processes Human faecal waste is known to vary from region to region and there is little to no information on biochars produced from human waste from sub-Saharan Africa. The objective of this study was to determine the effects of pyrolysis temperature on physicochemical properties of biochars from latrine dehydration and pasteurisation (LaDePa) pellets and sewage sludge relative to pine-bark.

MATERIALS AND METHODS

The biochars were produced by slow pyrolysis at 350°C, 550°C and 650°C, and were analysed for yield, ash content, fixed C, pH, EC, exchangeable bases and CEC, total C, N, and H content, chemical functional groups, and surface characteristics.

RESULTS AND DISCUSSION

Biochar pH, C:N ratio, and aromatic functional groups increased, while yield decreased, with increase in pyrolysis temperature. Values of EC were low across all the biochars and pyrolysis temperature. CEC decreased with increase in pyrolysis temperature on pine-bark and sewage sludge and increased on LaDePa biochar. Biochar from pine-bark showed a more porous structure, with fissures, than those from LaDePa and sewage sludge biochars. Higher pyrolysis temperatures resulted in greater porosity. Faecal waste biochar had lower fixed C and C:N than that from pine bark.

CONCLUSIONS

The findings suggested that faecal waste biochar is unlikely to sequester large quantities of C, may degrade faster, and increase ash and exchangeable bases than that from pine bark especially if pyrolysed at 650°C. So if the intension is to maximize the benefits of nutrients from faecal waste through a better waste disposal management, sewage sludge biochar still deserve making despite their low C:N ration comparative to pine bark. High pyrolysis temperature (650°C) is preferable to obtain highly porous and alkaline biochars with higher C:N ratio.

ACKNOWLEDGEMENTS

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Keywords: ash, biochar, carbon, human faecal waste, pine-bark, pyrolysis temperature

THE FATE OF SOIL HUMIC SUBSTANCES AS AFFECTED BY LAND USE CHANGE IN THE SEMI-ARID FREE STATE

Kotzé, E., Loke, P.F., Akhosi-Setaka, M.C. and Du Preez, C.C.

Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein, 9300

Email: kotzee@ufs.ac.za

INTRODUCTION

Productivity of cropland soils, especially in semi-arid to arid zones, is declining due to increasing losses of stable organic matter. The aim of this study was therefore to quantify the influence of land use change on soil humic substances of the semi-arid Plinthustalfs in the Free State Province, South Africa.

MATERIALS AND METHODS

Topsoil samples from spesific agro-ecosystems at Harrismith, Tweespruit and Kroonstad in the virgin, cultivated and restored Plinthustalfs were analysed for C and N in crude humic substances (Cs and Ns), extractable humic substances (Ce and Ne), humic acids (Ch and Nh) and fulvic acids (Cf and Nf). Contribution of mean annual rainfall (MAR), aridity index (AI) and mean annual temperature (MAT) on loss or accumulation rates of these soil humic substances, were also evaluated.

RESULTS AND DISCUSSION

Results indicated that cultivation depleted the virgin soils of crude humic substances, extractable humic substances and humic acids across the three agro-ecosystems. Fulvic acids were also depleted by cultivation, with the exception of Kroonstad, where cultivated soils had more fulvic acid than virgin soils. Restored soils had substantial amounts of these humic fractions, except fulvic acids that behaved differently in the Kroonstad agro-ecosystem. Some correlations were observed between climate variables and soil humic fractions. Although no trends were observed for the C/N ratios of the examined soil humic fractions, most were within a range of 10-12, suggesting that SOM was approaching equilibrium state. In general, mean annual rainfall (MAR) and aridity index (AI) contributed to the loss of crude humic substances, extractable humic substances, humic acids and fulvic acids, while mean annual temperature (MAT) did not. More specifically, the most rapid loss and recovery of soil humic fractions in response to cultivation and restoration, occurred in the cool, moist region, whereas the least depletion and gain of these fractions occurred in the warm, arid region.

CONCLUSIONS

These results have important implications for understanding the CO2 mitigation potential of agricultural lands and how climate change could alter this potential. It is known that humic substances are recalcitrant in nature, while our results revealed that management practices that prohibit soil disturbance are needed to reduce biological oxidation of humic substances, and hence reduce C and N losses into the atmosphere.

Keywords: fulvic acid; humic acid; organic carbon; organic nitrogen; soil organic matter

PHOSPHORUS MINERALISATION, AVAILABILITY AND DYNAMICS OF DIFFERENT FRACTIONS DURING PHOSPHO-COMPOST PRODUCTION

Kutu, F.R.[1] and Mokase, T.J.[2]

[1]Department of Crop Science, Faculty of Agriculture, Science and Technology, North West University (Mafikeng Campus), P/Bag X2046, Mmabatho 2735; [2]Department of Plant Production, Soil Science and Agricultural Engineering, University of Limpopo, P/Bag X1107, Sovenga

E-mail: Funso.Kutu@nwu.ac.za

INTRODUCTION

Phosphorus (P) deficiency is a widespread problem on most croplands due to inherent soil properties and high crop demand. Successful crop production is largely dependent on application of high doses of inorganic P fertiliser to guarantee high yields. However, the use of inorganic P fertiliser is limited by high cost and restricted access (World Bank 2004; Lynch 2007). Consequently, farmers have often relied on the use of low input technology such as manures and/or composts, that are also inherently low in plant available P, to address the low soil-P problem. A simple and cost-saving initiative to improve the P content of composts for use as fertiliser includes the introduction of phospho-composting technology. This paper attempts to quantify the various P fractions released at critical phases during the co-composting process of non-reactive ground Phalaborwa phosphate rock (GPR) with biodegradable wastes such as poultry and cattle manures.

MATERIALS AND METHODS

Four phospho-compost piles were prepared by mixing different ratios (5:5, 7:3, 8:2, 9:1) of poultry and cattle with GPR on dry mass basis and subjected to aerobic-thermophilic co-composting. Compost pile without GPR addition to each of the two manures was included as control. During the co-composting process, representative samples were taken at mesophilic, thermophilic, compost cooling and cured phases. Collected compost samples were used for the quantification of organic, water extractable, Bray and inorganic P fractions of Ca- and Fe-bound P. Data generated were analysed as factorial experiment using Statistix 10 package. Treatments and interaction effects were evaluated using Fisher protected least significant difference at probability level of 5%.

RESULTS AND DISCUSSION

The chemical composition of the different composts including the C/N and C/P ratios are fairly similar and comparable. Variation in phospho-compost types, sampling phase and their interaction exerted significant effects on the measured P fractions. The measured P concentrations differed significantly ($P<0.001$) across the various mix ratios and manure types; and were of the order organic P<Bray P1<Ca-P<water extractable P<Fe-P. Significant correlation between Bray P1 and water extractable-P ($r = 0.475^{***}$) as well as Fe-P ($r = 0.659^{***}$) were obtained. Similarly, the content of Ca-P measured in the different composts showed significant correlation with water soluble-P ($r = 0.632^{***}$) and Fe-P ($r = 0.754^{***}$). Quantitatively higher P contents were measured in the poultry than cattle manure-based phospho-composts at the four different sampling phases; and generally highest in the 8:2 mix ratio.

CONCLUSIONS

Our findings revealed that aerobic-thermophilic co-composting increased the amount of plant available P released from non-reactive GPR. The various P forms measured varied significantly depending on the amount of GPR added, types of manure utilised and composting phase.

Keywords: composting, compost quality, nutrient cycling, P availability indices, P transformation, ground phosphate rock, phospho-composts

EVALUATION OF MAIZE (*Zea mays* L) GENOTYPES FOR RESISTANCE TO WITCHWEED (*Striga asiatica* L. Kutze) INFECTION IN MAIZE

Kwashie, F.N, Mabasa, S., Rugare, J.T. and Gasura, E.

University of Zimbabwe, Crop Science Department, Box MP 167, Mount Pleasant, Harare

E-mail: rugarejoy@yahoo.co.uk

INTRODUCTION

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

MATERIALS AND METHODS

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

RESULTS AND DISCUSSION

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

CONCLUSION

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

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Keywords: resistance*, Striga asiatica*, witchweed

EFFECT OF ONCE- OFF TILLAGE ON SOIL QUALITY AND WHEAT PERFORMANCE IN A LUCERNE/CASH CROP SYSTEM

Labuschagne, J.[1], Smith, J.D.V.[2] and Langenhoven, W.[1]

[1]Directorate Plant Sciences Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607; [2]Yara Cape Ltd, PO Box 59, Hugenoot, 7645

E-mail: johanl@elsenburg.com

INTRODUCTION

Scientifically tested information on the effects of different tillage management strategies before planting no-till cash crops following long-term permanent pastures is not available. Applying a once-off tillage operation should "break up" typical stratification but the long-term consequences regarding its effect on soil quality is rather controversial. The aim of this study was to investigate if significant short-term effects of once-off tillage on soil quality and wheat performance.

MATERIALS AND METHODS

This study was conducted at the Tygerhoek Research Farm (Riviersonderend). Three tillage treatments were investigated on a loamy sand Klapmuts soil form: no-tillage (AusPlow-seeder) (NT); non-inversion tillage (deep tine ~ 400 mm) (DT) and inversion tillage (mouldboard plough ~ 250 mm) (MP). Tillage was done early May before wheat was planted after a 12-year lucerne stand. Cumulative CO_2 respiration (28 days) was estimated twice during the season. First trial was carried out 4 weeks after tillage treatments (June/July) and the second trial followed in September/October. Before tillage, total SOC and nutrient content were determined in 5 depth increments (0-5; 5-10; 10-20; 20-30; 30-40 cm). Active carbon content, mineral N content during the growing season, light interception, leaf chlorophyll content and grain yield were recorded.

RESULTS AND DISCUSSION

Cumulative CO_2 emissions in the June/July period were significantly higher for DT while for NT and MP it was similar. Deep tine, not inverting the high SOC surface layer, further enhanced CO_2 emissions as it aerates the surface soil extensively. With MP, similar emissions compared to NT were recorded although soil was most likely more aerated. In the September/October period, CO_2 emission increased for NT and MP but decreased for DT. This means SOC that was inverted with MP is probably later more utilized by microbes. The increase observed for NT and MP is expected to be mainly of biological nature while the decrease observed for DT is attributed to a more "steady" physical state of the soil. This results in similar emissions during October/September period. Active carbon was not influenced by the tillage treatments tested. Chlorophyll content (SPAD) were 42.53 (NT), 44.77 (DT) and 45.35 (MP). Grain yield was not influenced by the tillage treatments.

CONCLUSIONS

Preliminary results show that tillage can be a management option when wheat is seeded after lucerne in a lucerne/cash crop system in the Rûens without long-term detrimental effects on the soil quality parameters studied. Natural stratification of macronutrients and SOC in long-term pasture systems can be successfully amended through a one-time MP operation. Short-term losses of SOC with the MP were similar to NT, indicating no significant short-term loss in soil quality. Higher C losses can be expected with DT. The fact that the development and yield of wheat was not influenced, could be instrumental in deciding on cultivation practices after the lucerne phase.

Keywords: active carbon, aggregate stability, chlorophyll content, C stratification, CO_2 emission

SENSITIVITY OF SOIL QUALITY INDICATORS AND CROP PERFORMANCE TO SOIL DISTURBANCE AND CROP ROTATION IN THE SWARTLAND AND RUENS SUB-REGIONS OF THE WESTERN CAPE

Labuschagne, J., Langenhoven, W., Zyl, H. and Mokwele, A.

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

Email: johanl@elsenburg.com

INTRODUCTION

Soil and crop management practices usually influence soil quality as well as crop performance. It is however anticipated that the magnitude might differ between ecosystems. The aim of this presentation is to evaluate and compare the effect of soil disturbance and crop rotation on soil quality and crop performance in the Swartland and Rûens sub-regions of the Western Cape.

MATERIALS AND METHODS

Long-term trials were initiated in 2007 at the Langgewens (Moorreesburg, Swartland) and Tygerhoek (Riviersonderend, Rûens) Research Farms to evaluate the effect of soil disturbance and crop rotation in combination with maximum stubble retention on soil quality and crop performance. Three crop rotations namely: continuous wheat (WWWW), medic-clover/wheat/medic-clover/wheat (McWMcW) and lupin/wheat/canola/wheat (LWCW) were allocated to main plots and replicated four times. 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. Only a few important parameters like active carbon, aggregate stability and C:N will be highlighted and discussed in this presentation.

RESULTS AND DISCUSSION

A comparison between the effects of various soil quality indicators on soil quality at Langgewens and Tygerhoek proved that the soil at Langgewens site is more sensitive to soil disturbance than Tygerhoek. The higher organic carbon content at Tygerhoek (± 1% higher than Langgewens) is believed to buffer the detrimental effects of soil disturbance. The focus of this presentation will be on how to secure high carbon content of good quality and the positive effect on aggregate stability, one of the building blocks of improved soil quality and the resultant effect on crop performance.

CONCLUSIONS

The data captured during the first 9 years of this study shows that there is definite ecosystem influence and that the rate of improving/destructing soil quality/health most certainly differ between ecosystems.

Keywords: active C, aggregate stability, C:N

ON-FARM PERFORMANCE OF ARC SWEET POTATO CULTIVARS RELEASED FOR THE INFORMAL MARKET

Laurie, S.M., Mtileni, M.M., Mphela, W.M., Ramathavhana, T., Sediane, L., Ndou, P. and Du Plooy, C.P.

ARC-Vegetable and Ornamental Plants

E-mail: slaurie@arc.agric.za

INTRODUCTION

Sweet potato is a starchy staple, easy to grow and hardy, thus promoted by ARC programs for addressing food security, and contributing to income generation and enterprise development. In addition, orange-fleshed cultivars are important for the crop-based approach program to address the national health problem related to vitamin A deficiency (Laurie *et al*. 2015 a). Several new sweet potato cultivars have been released by ARC during 2004 till 2011 aimed at the informal market (Laurie *et al*. 2015 b,c). The present study reports on the on-farm performance of these cultivars.

MATERIALS AND METHODS

On-farm trials were conducted in nine sites in KwaZulu-Natal, and one each in Eastern Cape, Northern Cape and Mpumalanga over the past three planting seasons. Cultivars Ndou, Monate and Mvuvhelo (cream-fleshed), Bophelo, Impilo and 199062.1 (orange-fleshed) and commercial control Blesbok were included. Data collection included root yield, unmarketable root yield classes, dry-matter content, and taste acceptability. Furthermore data was collected from commercial production at small-holder farms in Limpopo and Gauteng. A combined analysis of variance was performed and the Additive Main Effects and Multiplicative Interaction (AMMI) model was used to analyze genotype by environment interaction using Genstat.

RESULTS AND DISCUSSION

The cultivars developed for the informal market produced significantly better yield than the commercial cream-fleshed variety Blesbok, generally due to their ability to adapt to low input. Mean marketable yield was in the range of 15-20 t/ha for the various cultivars. Taste tests with small groups of farmers indicated good taste acceptance scores for orange-fleshed sweet potatoes. Vine dissemination during 2014/15 raised to 3363 bags, enough to grow 75 ha of which 66% were orange-fleshed sweet potatoes. Bophelo was the dominant orange-fleshed cultivar, while Ndou topped the cream-fleshed informal market cultivars. The new cultivars produce sustainable yields and have been sold with success on local informal markets.

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Keywords: adaptability, marketable yield, on-farm trials

THE PEDOGENESIS OF BLEACHED TOPSOILS OVERLYING WEAKLY STRUCTURED SUBSOILS AND THEIR SIGNIFICANCE TO CLASSIFICATION

Le Roux, J.L., Lambrechts, J.J.N., Ellis, F., de Clercq, W.P. and Clarke, C.E.

University of Stellenbosch, Private Bag X1, Matieland, 7602, South Africa

Email: luan@agrimotion.net

INTRODUCTION

A lack of knowledge of bleached topsoil horizons as part of weakly structured soil profiles in South Africa regarding genesis, impact on land use and environmental functions, exists. This study aimed to investigate the catenal, chemical and physical processes governing the occurrence of these bleached topsoils in the Western Cape and Mpumalanga Highveld, in order to make inferences on the mechanisms involved in topsoil bleaching under these circumstances. In addition, this information was also used to make recommendations on the classification of such soil profiles.

MATERIALS AND METHODS

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

RESULTS AND DISCUSSION

Most of the determined soil parameters expressed no relation to topsoil bleaching. The Fe_{CBD} content did not significantly differ between bleached and non-bleached topsoils, which is regarded to be the result of the nature of the data set. The Fe_{AAO}/Fe_{CBD} ratio tended to be higher in bleached compared to non-bleached soils, particularly in the Highveld samples. Proportionally more Fe_{AAO} was deemed to be indicative of a wetter soil moisture regime and alternating cycles of Fe reduction and oxidative precipitation.

The WC and Highveld profiles expressed significant differences in terms of the WDC phases of the soils. In the WC, profiles tended to be more dispersive than on the Highveld, with the bleached WC profiles proving to be even more unstable than the non-bleached variants. This suggests that clay eluviation is a central process in the WC soils. The data did not provide a clear explanation for how clay eluviation results in bleached soil colours and no certainty regarding the role of Fe reduction and clay eluviation as independent or complementary processes responsible for bleaching in the WC soils exists.

CONCLUSION

Evidence for Fe reduction as bleaching mechanism on the Highveld suggest that bleached orthic A horizons should be included as family criteria in wetter variants of the yellow-brown apedal profiles (Cv, Av, Gc). Bleaching in the weakly structured WC profiles are indicative of a more dispersive clay phase and therefore should direct subsoil classification towards the recognition of neocutanic B horizons.

Keywords: bleaching, reduction, clay eluviation

USING WATER FOOTPRINTING TO IMPROVE AGRICULTURAL WATER USE MANAGEMENT ON A WATER STRESSED AQUIFER

Le Roux, C.E., van der Laan, M., Annandale, J.G. and Bristow, K.L.

University of Pretoria, Private Bag X20, Hatfield, Pretoria, 0028

Email: betsielr@gmail.com

INTRODUCTION

Water footprint accounting is an emerging approach to quantify impacts on freshwater and guide improved management. Hoekstra et al. (2011) distinguish between blue, green and grey water footprints. Blue water is surface and groundwater resources, available to multiple users. Green water originates from rainfall and is stored in the soil, and is only available to crop growth. Grey water is a way of measuring water quality impacts. This study aimed to better understand how water footprint accounting can improve water resource management on the water-stressed Steenkoppies Aquifer west of Tarlton.

MATERIALS AND METHODS

Blue and green water footprints were calculated for the main crops cultivated on the Steenkoppies Aquifer, including maize, wheat, beetroot, broccoli, carrots and cabbage. Cropping areas for 1998 was obtained from Vahrmeijer (2005) and were used to up-scale water footprints to the catchment level. Total evapotranspiration (ET) of the catchment, i.e. ET from natural vegetation and agriculture, was subtracted from rainfall to estimate outflows. Recorded outflows from the Maloney's Eye, which is the only natural outlet, were used to verify estimated outflows.

RESULTS AND DISCUSSION

Water footprinting provided a way to quantify water used by agriculture on the Steenkoppies Aquifer. Average outflows from Maloney's Eye were successfully estimated by the difference between averages of ET and precipitation. Annual variation between estimated and actual outflow was, however, different, which indicates the buffering capacity of the aquifer. The catchment water balance was used to propose an alternative approach to assess the sustainability of water used on the catchment.

CONCLUSIONS

Water footprinting can improve water resource management of a water stressed catchment by quantifying agricultural water use. It provides the required data to quantify the water balance of the catchment, which can be used to assess the sustainability of water use.

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ACKNOWLEDGEMENT

We would like to acknowledge the WRC and the NRF for funding this project and for general guidance from the WRC.

Keywords: agriculture, steenkoppies aquifer, water footprinting

YIELD, QUALITY AND WATER USE EFFICIENCY OF LEAFY GREENS IN RESPONSE TO HYDROPONICS AND OPEN FIELD PRODUCTION

Leskovar, D.I., Solis-Perez, A., Xu, C., Cerven, V. and Palma, M.

Texas A&M AgriLife Research, 1619 Garner Field Road, Uvalde, TX 78801, USA

E-mail: d-leskovar@tamu.edu

INTRODUCTION

Since the last decade, the Wintergarden region of southwest Texas is experiencing an increasing scarcity of water resources and more frequent heat and drought stresses. At the same time, consumer demand for high-quality, tasty and locally produced leafy vegetables is rapidly increasing, particularly in San Antonio, Houston and Dallas. More recently, growers are exploring the possibility of commercially-grown leafy greens in hydroponic culture using the nutrient film technique (NFT). A study was conducted to evaluate water use efficiency (WUE), yield and product quality of leafy vegetables grown with three irrigation technologies. Follow up experiments were conducted to screen and select best lettuce cultivars among Bibb, loose leaf and Romaine types grown in the NFT system.

MATERIALS AND METHODS

Experiments were conducted at the Texas A&M AgriLife Research Center, Uvalde using three irrigation systems: linear sprinkler (LEPA*), s*ubsurface drip irrigation (SDI), and the NFT. In open fields two irrigation levels were applied, 70%ETc as deficit and 100%ETc as the well-watered control. Crops evaluated were spinach, kale, collards and lettuce. The second study in the NFT system evaluated WUE, growth components and overall product quality of lettuce cultivars belonging to Bibb, loose leaf and Romaine types.

RESULTS AND DISCUSSION

In spinach, yield and WUE were reduced at 70% ETc under LEPA, while in lettuce the overall WUE slightly increased at 70% ETc under LEPA, being cultivar dependent under the SDI. In kale and collards, 70% ETc caused a slight reduction in yield under SDI. WUE for lettuce grown under the NFT system was 8-fold higher and the growth cycle 40% shorter than those grown in the open field. Similar trends were measured for kale and collards under the NFT system. In lettuce, after three growth cycles in the NFT, the best cultivars based on growth and WUE were Buttercrunch (Bibb), Sunbelt (Romaine) and Caipira and Kremlin (Loose leaf).

CONCLUSION

This study suggests that deficit irrigation is an important strategy to conserve water in open field systems. WUE and the overall water savings (90%) were maximized under the hydroponic culture as compared to open field. Expanded screening and selection of best lettuce cultivars based on reduced leaf tip burn, high WUE and leaf quality in hydroponic culture is important to conserve water, extend the production season, and improve the final product quality.

ACKNOWLEDGEMENTS

This study was funded by the Texas Department of Agriculture and in part by the Howard Buffet Foundation

Keywords: bibb, leafy greens, loose leaf, NFT, Romaine, subsurface drip, *Lactuca sativa*

EFFECT OF ONCE-OFF TILLAGE ON SELECTED SOIL PROPERTIES UNDER NO-TILL IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

Leygonie, I.R.[1], Labuschagne, J.[2], Hoffman, J.E.[1] and Van Zyl, H.[2]

[1]Department Soil Science, University of Stellenbosch, Private Bag X1, Matieland, 7602 [2]Institute for Plant Production, Department of Agriculture Western Cape, Private Bag X1, Elsenburg, 7607

Email: johanl@elsenburg.com

INTRODUCTION

Minimum soil disturbance is an important aspect of conservation agriculture (CA). No disturbance of soil may result in nutrient stratification, increased bulk density and increased crop residue cover that might create a habitat for pests and diseases or interfere with the planting proses. These effects may be addressed through, amongst others, the cultivation of soil. The objective of this study was to determine the effect once-off tillage of no-till land has on selected soil physical and chemical properties.

MATERIALS AND METHODS

The study was conducted during 2014 to 2015 at the Langgewens Research Farm, managed by the Western Cape Department of Agriculture near Moorreesburg. The experimental design was a randomised complete block with a split-plot treatment design. Five cropping sequences, namely: medic-clover/wheat/medic-clover/wheat (McWMcW), wheat/lupin/wheat/canola (WLWC) and lupin/wheat/canola/wheat (LWCW), canola/wheat/lupin/wheat (CWLW) and wheat/medic-clover/wheat/medic-clover (WMcWMc) were allocated to main plots and replicated four times. The last letter in the sequence represents the crop on the field at the time of data collection. Main plots were sub-divided into three sub-plots and allocated to tillage treatments, namely: continuous no-till (NT), soil left undisturbed until planting and then planted with a tined no-till planter, non-inversion tillage (DT), deep tine to a depth of ~400 mm and inversion tillage (MP), soil inverted using mouldboard plough to a depth of ~250 mm. Coarse fragment %, bulk density, aggregate stability, conductivity (EC), pH and soil organic carbon (SOC) content were determined for the 0 - 100, 100 - 200, 200 - 300 and 300 - 400 mm soil layers during May 2015. Infiltration rates were measured before and after tillage using a Mini Disk Infiltrometer. Active carbon content was determined for the 0 - 100 and 100 - 200 mm soil depths before-, after- and 1 year after tillage.

RESULTS AND DISCUSSION

Tillage had no significant effect on coarse fragment %, aggregate stability, pH, SOC and active C content ($P = 0.05$). A significant higher EC under DT compared to NT was recorded in the 100 - 200 mm layer in McWMcW. Although not significant ($P > 0.05$) bulk density tended to be higher for DT in the 200 - 300 mm depth (LWCW) compared to NT. Significant lower infiltration rates were measured for NT compared to MP and DT in the WLWC sequence. In McWMcW significantly higher infiltration rates for DT compared to NT and MP were recorded. Significantly lower infiltration rates for MP compared to NT and DT were recorded for LWCW.

CONCLUSION

Preliminary results shows that potential negative effects of soil disturbance as single strategic tillage action on the soil properties tested are negligible.

Keywords: aggregate stability, EC, infiltration rate, pH, strategic tillage

ETHNO PHARMACOLOGICAL PROPERTIES OF *Lobostemon fruticosus* (L.) UNDER CULTIVATION

Lodama, K.[1], Du Toit, E.S.[1], Steyn, J.M.[1], Araya, H.T.[2], Prinsloo, G.[3] and Du Plooy, C.P[2]

[1]Department of Plant Production and Soil Science, University of Pretoria, Pretoria, Private Bag X20, Hatfield, 0028.; [2]ARC- Roodeplaat, Vegetable and Ornamental Plant Institute, Private Bag X 293, Pretoria, 0001. ; [3]Department of Agriculture and Animal Health, University of South Africa, Florida, 0170

E-mail: lodamakm@arc.agric.za

INTRODUCTION

In South Africa, *Lobostemon fruticosus* L. (Baraginaceae) is a medicinal plant commonly used by rural communities of the Western Cape Province. Traditionally, leaves of the plant are used for treating wounds, blood poisoning, ringworms, skin diseases and syphilis (Van Wyk et al., 1997). Currently, the plant is harvested from the wild and this can lead to a decline in natural populations or extinction from its natural habitats. To date, according to our knowledge no scientific report regarding the cultivation as well as ethno pharmacological properties *of L. fruticosus* have been reported. The objective of the study was to investigate the effect of nitrogen fertilizer on secondary metabolites and ethno pharmacological activities of *L. fruticosus*.

MATERIALS AND METHODS

The treatments consisted of two spacing's (1 m x 90 cm and 1 m x 120 cm) and four nitrogen application levels (0, 70, 140, and 210 kg/ha). Methanolic extracts were evaluated for biological activity against Gram-positive (Bacillus subtilis and Staphylococcus aureus), and Gram-negative (*Escherichia coli, Klebsiella pneumonia, Pseudomonas aerguinosa* and *Salmonella typhi*) bacteria using micro dilution assay to obtain minimum inhibitory concentration (MIC). The extracts were also evaluated for their ability to inhibit HIV-1 reverse transcriptase (RT) enzyme. Thin layer chromatography (TLC) was used to investigate the chemical profiles of each treatment in comparison to wild material.

RESULTS AND DISCUSSION

The interaction between N levels and combination treatments revealed a maximum plant height of 92.5 and 47.5 cm was recorded in control. The results obtained on chlorophyll A, B, and total chlorophyll as well as phenolic and flavonoids content significantly ($p<0.05$) varied according to nitrogen treatments and plant parts. Minimum inhibition concentration (MIC) of methanolic extract against *E. coli*; *S. typhi*; *S. aureus*; *B. subtilis*; *P. aerguinosa*; and *K. pneumonia* showed moderated activity with high MIC values ranging from (3.12.to 12.5 mg/ml). Highest inhibition activity of 75.6% against HIV-1 RT was observed.

CONCLUSION

Nitrogen fertilization levels may be an effective method to increase the biomass production and expression of secondary metabolite compounds in *Lobostemon fruticosus*.

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ACKNOWLEDGEMENTS

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Keywords: medicinal plant, plant spacing, nitrogen levels, chlorophyll a and b, phenolics, flavonoids

DROUGHT TOLERANCE OF SELECTED NEGLECTED AND UNDERUTILISED CROPS FROM SOUTH AFRICA

Mabhaudhi, T. and Modi, A.T.

Crop Science, School of Agricultural, Earth and Environmental Science, University of KwaZulu-Natal, PO Box X01, Scottsville, Pietermaritzburg 3209

E-mail: mabhaudhi@ukzn.ac.za

INTRODUCTION

The combination of increasing population, malnutrition and climate change as well as land degradation suggests a gloomy picture for future food and nutrition security in South Africa. The country already has scarce water resources. Such concerns have led to renewed interest in neglected and underutilised crop species (NUS). Decades of 'neglect' by researchers in favour of major crops have led to limited robust and comparable empirical information describing NUS. This study hypothesised that local NUS may have acquired drought tolerance over years of natural and farmer selection often under harsh conditions.

MATERIALS AND METHODS

To test this hypothesis, conventional (controlled and field trials) and modelling approaches were adopted in experiments spanning a period from 2008/09 to 2014/15 seasons. These included experiments evaluating agronomy, drought tolerance mechanisms, alternative cropping systems and modelling yield responses of selected local NUS. Crops studied included maize landraces, wild mustard, wild water melon, bambara groundnut and taro. Conventional experiments were based on replicated (x3) randomised complete block designs and data were used to parameterise and test the FAO's AquaCrop model.

RESULTS AND DISCUSSION

Maize landraces exhibited drought tolerance during the establishment stage. Although wild watermelon is reported to be very drought tolerant, water stress occurring during the late vegetative stages when vines that will bear flowers and fruits develop can be detrimental to yield attainment. Wild mustard landraces were shown to be drought tolerant. Bambara groundnut demonstrated drought avoidance and escape mechanisms. An upland taro landrace was shown to possess drought tolerance traits. Application of the AquaCrop model for bambara groundnut and the taro landrace confirmed their adaptation to low water availability.

CONCLUSIONS

Several NUS possess traits that confer drought tolerance. The degree of such drought tolerance, however, varies among these species. The use of conventional and modelling approaches can assist in generating data over a short period of time, thus saving cost and time. Local NUS are an important germplasm resource. Their potential to contribute to food and nutritional security in marginal agricultural production areas requires further investigation.

ACKNOWLEDGEMENTS

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Keywords: AquaCrop, landraces, water stress

CROP RESPONSE TO IRRIGATION WITH ACIDIC AND NEUTRALIZED, SALINE GOLD-MINE WATER

Madiseng, L.E., Annandale, J.G., Van Der Laan, M. and De Jager, P.C.

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

E-mail: u28424868@tuks.co.za

INTRODUCTION

Two irrigation options have recently been presented as part of a possible management strategy for mine water from the Witwatersrand Goldfield's Western Basin. The first option is to irrigate directly with "raw" acid mine water, and the other is to irrigate with neutralized mine water. The quality of the "raw" and neutralized mine water does not comply with the thresholds indicated by the South African Water Quality Guidelines for irrigation purposes (Department of Water Affairs, 1996). However, literature has shown that there are crops that can tolerate irrigation with such waters. The aim of this study is to observe the response of selected crops on buffered and unbuffered soils to surface irrigation and leaf wetting with synthetic acidic and neutralized saline Witwatersrand Goldfield Western Basin mine water.

MATERIALS AND METHODS

A greenhouse pot trial was undertaken in 2016, in which several crops were planted and irrigated with fresh water as well as with synthesized acidic and neutralized mine waters. A sandy soil with a low acid buffering capacity and a clay soil with a high buffering capacity were used as growth media. Summer and winter crops were selected for their relative tolerance/sensitivity to acidity and salinity i.e. grain sorghum and rye as salt and acid tolerant crops, barley as salt tolerant and acid sensitive crop, maize and broad beans as salt sensitive and acid tolerant crops, and lucerne and peas as salt and acid sensitive crops. The crops were grown in 12.7L pots until they reached maturity. Each treatment had three replicates and the trial was set up in a completely randomized design on a rotating table. Data was analyzed using ANOVA.

RESULTS AND DISCUSSION

Analyses show that the simulated mine waters closely resembled actual mine waters. Leaf wetting with the synthetic mine waters did not cause scorching of foliage. Crops grown on the unbuffered sandy soil with acid mine water grew poorly, whilst those grown on buffered soil grew satisfactorily but started to show symptoms of stress later in their growth cycles. Crops grown with neutralized mine water irrigation grew satisfactorily on both the sandy and clay soils.

CONCLUSION

Synthesized mine water can be used to represent actual mine water for use in pot trials. There are crops that can grow, at least in the short term, under irrigation with water that is considered unfit for use according to local water quality guidelines. The buffering capacity of soils plays an important role in the performance of crops grown under irrigation with poor quality water.

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Keywords: irrigation, mine water, acidic, saline, crops, tolerance

EX VITRO DORMANCY ELIMINATION AND IN VITRO PROPAGATION OF *Cucumis myriocarpus* INDIGENOUS TO SOUTH AFRICA

Maila, M.Y., Mashela, P.W., Nzanza, B. and Mphosi, M.S.

University of Limpopo

E-mail: mmatshelo@webmail.co.za

INTRODUCTION

Wild cucumber (Cucumis myriocarpus), indigenous to South Africa, has fruit that contain high concentrations of cucurbitacin A, which induces auto-allelopathy (Kristkova *et a*l. 2003). Additionally, the hard testa contains impermeable layers which restrict unaided seed germination (Singh and Dathan 2001). The objective of this study was to determine whether inhibited germination and poor performance of seedlings in *C. myriocarpus* could be attributed to both chemical and physical dormancies.

MATERIALS AND METHODS

Forty seeds each, grouped as untreated, leached and leached-scarified batches were arranged in a completely randomised design, with 5 replicates. One seed batch was leached in running tapwater for 0, 2, 4, 6, 8, 10 and 12 h, whereas another batch was leached and scarified at the chalaza end. After appropriate sterilisation, seeds were incubated in vitro for seven weeks in Murashige & Skoog (1962) medium at 25ºC and 50-60% RH in complete darkness. The calculated data were expressed as germination percentage (GP), mean germination time (MGT), germination index (GI) and germination rate (GR) prior to analysis through SAS software.

RESULTS AND DISCUSSION

Untreated and leached seeds did not germinate, whereas leached-scarified seeds germinated. The optimum leaching time and GP of leached-scarified seeds were 6.7 h and 93%, respectively, whereas for seedling performance variables optimum values were 6.3 h and 41 days for MGT, 9.5 h and 0.90 seedling/day for GI and 9.0 h and 0.20 seedling/day for GR. Comparing performance of untreated and leached-scarified seeds suggested that cucurbitacin A was localised endogenous to the testa.

CONCLUSIONS

Leaching and scarification eliminated both chemical and physical dormancies, thereby improving germination and performance of seedlings in *C. myriocarpus.*

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ACKNOWLEDGEMENTS

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Keywords: allelochemicals, ethnomedicinal plants, secondary metabolites, water gap structures

THE EFFECT OF TEMPERATURE ON SEED GERMINATION AND EMERGENCE OF THREE *Eucomis* SPECIES

Makena, I.M., Matsiliza-Mlathi, B. and Kleynhans, R.

Tshwane University of Technology

E-mail: imasefako@yahoo.com

INTRODUCTION

Eucomis is one of the most commonly used medicinal plants in Southern Africa, used to treat a variety of ailments due to its anti-inflammatory and antimicrobial properties (Cheeseman, Fannie & van Staden, 2010; Masondo et al., 2014). The development of rapid, large scale propagation system for *Eucomis* species has become a necessity in order to ensure sustainable supply of plant material and to meet the demand in both the formal and informal markets. Seed propagation appears to be more promising and cost effective for mass production of seedlings. However; the main challenge with *Eucomis* is failure to germinate and slow propagation. The main objective of this study was to determine the effect of temperature on seed germination and emergence of three *Eucomis* species.

MATERIALS AND METHODS

Fresh seeds of *Eucomis autumnalis*, *E comosa* and two year old seeds of *E. zambesiaca* were used. Seed germination and emergence were tested over a wide range of temperatures, from 10°C to 30°C using 5°C increments, under continuous darkness in laboratory. Youden square experimental design was used with 25 seeds per treatment replicated three times. For the seed germination trial, seeds were placed in 90 mm PetriTM dishes on top of two layers of WhatmanTM filter paper moistened with 0.5 ml distilled water. Seed germination was monitored daily. Seeds were considered germinated once radical had protruded at least 2 mm from the testa. For the seedling emergence trial, seed were sown in containers (280 mm x 190 mm) filled with moistened sand. Data was recorded daily and seeds were considered emerged once cotyledons were visible above surface of the sand.

RESULTS AND DISCUSSION

Preliminary results showed a higher germination percentage in *E. comosa* (87%) at 20°C and the lowest germination percentage in E. zambesiaca (1%) at 30°C. *Eucomis autumnalis* (75%) showed higher germination percentage at 25°C, while *E. zambesiaca* (19%) responded well to 15°C. *Eucomis zambesiaca* seeds initiated germination first, but had the lowest germination percentage compared with other species. Seeds germination and emergence was inhibited at 10°C for all species.

CONCLUSIONS

The study revealed that the highest germination and emergence of the three *Eucomis* species could be achieved at temperatures between 20°C and 25°C. The seeds are unable to germinate at lower temperatures 10°C and below.

Keywords: Eucomis, seed germination, seedling emergence.

PLANT WATER STATUS AND SUNBURN IN JAPANESE PLUMS

Makeredza, B.[1], Jooste, M.[2], Lötze, E.[1], Schmeisser, M.[1] and Steyn, W.J.[2]

[1]Department of Horticulture, Stellenbosch University, , Private Bag X1, Matieland 7602; [2]HORTGRO Science, P.O. Box 12789, Die Boord 7613

E-mail: makaredza@sun.ac.za

INTRODUCTION

Adverse environmental conditions such as high irradiance and temperatures decrease Japanese plum (*Prunus salicina* Lindl.) quality by causing sunburn. Fruit with sunburn are downgraded, thus decreasing the profitability of orchards. Sunburn incidence in apple was found to increase under drought stress (Makeredza et al., 2013). The mechanism by which drought stress increases sunburn is unknown, but may include a photoinhibitory component since photoinhibition has been reported to be aggravated by moisture stress (Düring, 1999). We investigated the effect of plant water status on sunburn in Japanese plums and also studied the effect of drought stress on photochemistry.

MATERIALS AND METHODS

Irrigation was manipulated at Sandrivier Estate (Welllington) and Welgevallen farm (Stellenbosch) in the 2013/14 season. A control (farm practice), half irrigation and double irrigation treatments were used at Sandrivier throughout the season on 'African Delight' plums. At Welgevallen farm, full irrigation (control), half irrigation and no irrigation treatments were applied for 15 days in the early and again in the late season on different trees of 'Laetitia' plums. Plant water status, photochemistry, anti-oxidant concentration, fruit surface temperature (FST) and sunburn were assessed.

RESULTS AND DISCUSSION

Stem water potential decreased and antioxidant concentration, FST, and sunburn increased linearly with a decrease in irrigation, particularly late in the season. Irrigation in excess of plant requirements did not decrease sunburn. Photosynthesis and maximum quantum yields of photosynthesis (Fv/Fm) of leaves progressively decreased with a decrease in irrigation. However, Fv/Fm of fruit peel seemed insensitive to irrigation. As fruit peel was more sensitive to light stress when compared with leaves (Hetherington, 1997), it could mean that moisture stress does not directly affect or was not prolonged enough to affect fruit peel photochemistry. The increase in sunburn at lower plant water status may relate to reduced vegetative growth, decreased evaporational cooling of fruit, increased oxidative stress or a combination of these factors.

CONCLUSIONS

Water stress, particularly late in the fruit development stage, aggravates sunburn. However, excessive irrigation cannot be used to control sunburn in Japanese plums.

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Keywords: irradiance, moisture stress, photoinhibition, plum, sunburn, temperature

COMBINING ABILITY OF ARC, CIMMYT AND IITA MAIZE (*Zea mays* L.) INBRED LINES FOR GRAIN YIELD UNDER LOW NITROGEN STRESS

Makhumbila, P.[1], Mashingaidze, K.[1], Gwata, E.T.[2] and Sere, L.J.[1]

[1]ARC-Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520; [2]University of Venda, Private Bag X5050, Thohoyandou, 0950

E-mail: makhumbilap@arc.agric.za

INTRODUCTION

Nitrogen is an important nutrient in the productivity of maize. Maize production in the smallholder sector in South Africa is limited by lack of access to mineral nitrogenous fertilisers. The main objective of the study was to evaluate maize inbred lines for combining ability for grain yield under low nitrogen stress conditions.

MATERIALS AND METHODS

Fourty-eight inbred lines were obtained from the International Maize and Wheat improvement Center (CIMMYT), Agricultural Research Council (ARC) and International Institute of Tropical Agriculture (IITA). These were crossed to develop 103 single-cross hybrids using North Carolina-II mating design. The 103 hybrids plus three local checks were evaluated in North West (Potchefstroom and Taung) and KwaZulu-Natal (Cedara) provinces under low nitrogen stress and optimum fertiliser conditions during the 2014/15 summer season. An (0.1) alpha lattice design replicated twice was used. Low nitrogen stress trials were planted in Potchefstroom and Taung while optimum nitrogen fertiliser trials were planted in Cedara and Potchefstroom. Recommended agronomic practices were carried out at all sites. Low nitrogen stress trials were planted without nitrogenous fertiliser in nitrogen depleted fields. Grain yield data were subjected to analysis of variance (ANOVA) using GENSTAT software programme. Parental lines were classed into female and male to estimate specific and general combining abilities (SCA and GCA) using AGD-R software.

RESULTS AND DISCUSSION

There were significant differences among environments, sites, SCA and GCA estimates of genotypes for grain yield. Hybrids with highest SCA for grain yield under low nitrogen stress were TZEI 13 (IITA line) x CB388 (ARC line) in Potchefstroom and CB232 (ARC line) x FO215W (ARC line) in Taung. Under optimum conditions, CML489 (CIMMYT line) x I-42 (ARC line) ranked first followed by PHB30Y38 (local check). T1162W (ARC line) and TZEI 56 (IITA line) had high GCA estimates as females under low nitrogen stress, while CML489 and TZEI 56 had high GCA effects as males under low nitrogen stress conditions. CML489 and TZEI 63 (IITA line) had high GCA effects across optimum sites as males. Inbred lines with high GCA can be used as testers and/or sources of genes for low nitrogen tolerance. Heritability under both low nitrogen stress and optimum was 0.46 and 0.41. This indicates that there can be further genetic advances of these genotypes under low nitrogen stress and optimum conditions.

CONCLUSIONS

Single-cross hybrids with high SCA for low nitrogen tolerance were TZEI 13 x CB388 and CB232 x FO215W. Inbred lines with high GCA that can be used as testers or sources of genes for low nitrogen tolerance are T1162W, TZEI 56, CML489 and TZEI 56.

Keywords: general combining ability, heritability, specific combining ability

ENHANCING MICROCLIMATE AND PRODUCTIVITY OF SUBTROPICAL AVOCADO 'CARMEN®-HASS' IN PROTECTED CULTIVATION

Malapana, C.K.[1], Savage, M.J.[1] and Blakey, R.J.[2]

[1]School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, P/Bag X01, 3209 Scottsville [2]Westfalia Technological Services, Tzaneen

E-mail: savage@ukzn.ac.za

INTRODUCTION

Agricultural production is affected by changes in microclimate factors. South Africa is a water-scarce country, with high variability in annual rainfall. Hence the use of a shadenet over an orchard may improve the microclimate, making the environment more conducive for fruit production. The South African avocado industry is export oriented with about 60% of total production classified as export grade. Sun and wind damage and small fruit size as a result of water stress are factors limiting the production of export grade avocados in the industry. Hence the current study aims to address these challenges faced within the industry.

MATERIAL AND METHODS

The experiment was conducted at one of Westfalia's Fruit Farms, in an avocado (Carmen®-Hass) orchard at Mooketsi in Limpopo Province (23°40'54.59"S, 30°01'50.67"E). White shade net (20%) was used on 1.0 ha of this commercial orchard. Hourly measurements of air and canopy temperature, and wind speed were measured at 2 m. Solar irradiance and leaf wetness duration (LWD) were measured above and below tree canopy, respectively. Soil matrix water potential was monitored weekly using tensiometers at depths of 300 and 600 mm. Leaf area was measured on 50 leaves per treatment fortnightly. Fruit water content was measured gravimetrically on ten fruit weekly or fortnightly.

RESULTS AND DISCUSSION

Temperature (air and canopy) and relative humidity were slightly reduced within the shadenet structure. Air flow was restricted to a certain degree, and canopy temperature depended on tree density and the incoming solar irradiance received on the sun-exposed leaves. Calm conditions were experienced inside the structure and 80% of the incoming solar irradiance was transmitted, increasing the LWD by 12. Leaf roller pests were observed on fruit as a result of the increased LWD inside. Evapotranspiration (ET) was reduced by 14%, and 29% less water was applied inside the shadenet. Fruit reached maturity two weeks earlier. The fruit size distribution was greater inside the shadenet but, yield was affected due to pollination difficulties inside the shadenet.

CONCLUSIONS

The shadenet resulted in improved fruit quality due to reduced wind damage and reduced sunburn. There were difficulties in the 2014 bee activity and pollination but slight improvements were observed in the 2015 season. Pollination may be improved but this can only be confirmed in the 2016 harvest season.

ACKNOWLEDGEMENTS

Thanks to SAAGA, Westfalia Fruit Estates, UKZN, Hans Merensky Foundation and DAFF for funding the research and infrastructural support. Thanks to Mr J. van Eyk for assistance on the farm.

Keywords: microclimate, evapotranspiration, fruit quality, 20% shadenet, leaf wetness

EFFICACY OF DIFFERENT PLANT EXTRACTS AGAINST ROOT-KNOT NEMATODES (*M. javanica*)

Malatji, K.P. and Novela, P.

ZZ2, Bertie van Zyl, P.O. Box 19, Mooketsi, 0825

E-mail: kgashane200@gmail.com

INTRODUCTION

There are thousands of genera and species of plant parasitic nematodes (PPN) which cause damage in quality and quantity of yields in various crops (Khalil, 2013). The most destructive genus around the world is the root-knot nematode (RKN) genus *Meloidogyne* due to its wide host range, which includes more than 2000 hosts such as vegetables, fruit trees, oil, fibre and grain crops. In 2009, the South African Plant Parasitic Nematode Survey (SAPPNS) database recorded *Meloidogyne javanica* as the most prevalent *Meloidogyne* species in South Africa. The aim of this study was to evaluate the efficacy of different plant extracts as root-knot nematode (*M. javanica*) suppressants in tomato plants.

MATERIALS AND METHODS

The study was conducted at ZZ2 Natuurboerdery research centre. A pot trial was conducted under growing room with ambient day and night average temperature of 28°C with relative humidity of 78%. The trial consisted of fourteen treatments, laid out as completely randomised design with ten replicates. Fresh plant materials were slashed fine, followed by addition of water, molasses and effective microorganisms. After 14 days of anaerobic fermentation, the top aqueous layer was removed and used as the extract. Uniform six-week-old tomato seedlings (cultivar 'Money Maker') were transplanted into 18 cm diameter pots filled with pasteurized medium (sand mixed with hygromix (3:1) w/w). Seven days after transplanting the seedlings were inoculated with 2000 eggs and juveniles. At 56 days after inoculation the following parameters were recorded: root weight, gall index, no. of eggs, no. of nematodes (juveniles and females). Data was subjected to analysis of variance using statistix version 10.0 and means were separated using Tukey HSD at a probability level of 5%.

RESULTS AND DISCUSSION

Results revealed that plant extracts did not have a significant effect on root weight and galling index ($p=0.05$). Gall formation did not have an influence on final root weight. The lowest count of juveniles was observed in plants treated with crop guard while the highest was in plants treated with carbo and control. EM fermented wild garlic, EM fermented lantana + garlic and crop guard significantly affected nematode reproduction, this was observed through the calculation of nematode reproduction factor.

CONCLUSIONS

The results of this study showed that EM fermented lantana + garlic and EM fermented wild garlic have the potential to reduce nematode populations. Further studies will be conducted using EM fermented lantana + garlic and EM fermented wild garlic at different application rates and intervals to confirm their efficacy against RKN.

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Keywords: fermented plant extracts, tomato plants, root-knot nematode

VEGETATIVE PROPAGATION OF BULBINE *Latifolia* var. *latifolia*

Malele, J., Kleynhans, R. and Matsiliza-Mlathi, B.

Tshwane University of Technology, Private Bag X680, 0001

E-mail: malelej@tut.ac.za

INTRODUCTION

Bulbine latifolia var. *latifolia,* commonly known as rooiwortel, ibhucu and ingcelwane, is endemic to South Africa and widely distributed in Gauteng, Kwazulu-Natal, Mpumalanga, Eastern Cape and Western Cape Provinces. The leaf sap is used as a skin remedy, while a stem powder and root decoctions are used for various ailments including male dysfunction, diarrhea, diabetes, venereal disease, convulsions and as an aphrodisiac. *Bulbine latifolia* var. *latifolia* was amongst other plants identified by the Muthi Futhi Trust for commercial production and this community based project needed information on the propagation of the plant to ensure sustainable production. Three vegetative propagation methods, namely vertical, horizontal and divisional root cuttings were investigated.

MATERIALS AND METHODS

Six roots of *B. latifolia* var. *latifolia* were used as an experimental unit. Roots were either divided or cut horizontally or vertically in halves, and then planted in moist vermiculite in plastic bags and placed in incubators under five different temperatures (10°C, 15°C, 20°C, 25°C and 30°C). The experimental design was conducted as a latinised row/column with three replicates. Data was collected once a week for a period of a month on the number of roots and shoots produced per piece. Data was subjected to a split plot ANOVA using SAS and the Shapiro-Wilk test was performed to test for normality. The GLM procedure and t-test at a 5% and 10% level of significance was used to separate treatment means.

RESULTS AND DISCUSSION

No significant differences were obtained for temperature and cutting treatment at a 5% level of confidence. Temperature significantly influenced the number of sprouts and shoots per root at a 10% level of confidence with 20 and 15°C giving significantly more sprouts and shoots than 10 and 30°C. Cutting treatment on the other hand significantly influenced the shoot and root length, with the horizontal cut method producing significantly longer shoots and roots than the other two treatments. No significant interactions between cutting method and temperature were observed.

CONCLUSIONS

Vegetative propagation of *B. latifolia* var. *latifolia* is a viable propagation method and it can be concluded that root cuttings of *B. latifolia* var. *latifolia* can be used as an alternative method to seed germination, especially in seasons when seed set is problematic.

Keywords: Bulbine latifolia var. *latifolia*, vegetative propagation

THE INFLUENCE OF CLIMATE VARIABILITY ON TOMATO YIELD IN THE LIMPOPO PROVINCE (SOUTH AFRICA)

Malherbe, S.[1] and Marais, D.[2]

[1]ZZ2, PO Box 19, Mooketsi, 0825; [2]Department of Plant Production and Soil Science, UP, Pretoria, 0001

E-mail: diana.marais@up.ac.za

INTRODUCTION

South Africa is the leading tomato producer in the Southern African region. A clear tomato yield gap exists within the region even though climate conditions are suitable for tomato production in several neighbouring states. Understanding the reasons behind tomato crop failures and successes in South Africa could increase tomato production in the fast-growing tomato markets of the region. The objective was to study climatic variation within three climatically distinct planting windows and interactions with tomato yield and quality.

MATERIALS AND METHODS

The leading commercial tomato producer in the Lowveld bioregion of the Limpopo province supplied climate, yield, and tomato quality data for 2,138 production events for the period 2003-2010. Climate data was summarized according to five-week growth stage-specific phases for every production event: before planting (P0), seedling establishment (P1), initial flowering and fruit set (P2), and three consecutive five-week harvest periods (P3-P5). Interactions between climate variables and tomato yield were explored with Classification and Regression Tree (CART) analysis.

RESULTS AND DISCUSSION

Temperature-related variation in the P5, P3, and P1 development phases influenced total yield in the early (from summer to winter), optimum (winter to spring) and late (spring to summer) planting times respectively. Temperature, wind speed, and relative humidity were the main drivers of quality variation throughout the year

CONCLUSIONS

Different sets of climate variables influenced the final yield and quality outcomes for every planting window. Relative humidity played a significant role in occurrence of diseases and thus played a significant role in tomato quality, while temperature was the more dominant role player in yield.

Keywords: CART analysis, Interactions, planting times, quality

EFFICACY OF NEMARIOC-AL, NEMAFRIC-BL AND *Penicillium simplicissimum* ON *Phytophthora cinnamomi*

Mamphiswana, N.D., Kena, M.A. Mashela, P.W. and Shadung, K.G.

University of Limpopo, Private Bag x1106, Sovenga, 0727

Email: ndivhuwo.mamphiswana@ul.ac.za

INTRODUCTION

Worldwide, *Phytophthora cinnamomi* remains the major soil-borne pathogen which causes significant losses in avocado production. In an attempt to manage and improve productivity, in vitro efficacy of fermented *Cucumis* fruit extracts (nemarioc-AL and nemafric-BL) and a bio-agent (*Penicillium simplicissimum*) was investigated.

MATERIALS AND METHODS

In vitro bio assays were used to determine the efficacy of nemarioc-AL, nemafric-BL and P. *simplicissimum* against *P. cinnamomi*. Food poisoning assay (Das et al., 2010) had six treatment concentrations, viz., 0, 2, 4, 8, 16, 32 and 64 % arranged in a completely randomised design with three replicates. Dual culture bio-assay (Hajieghrari *et al*., 2008) had two treatments, with and without the bio-agent, replicated three times. Analysis of variance was generated and means compared for food poisoning assay. A two sample t- test was used for the dual culture assay.

RESULTS AND DISCUSSION

Relative to control, nemarioc-AL, nemafric-BL and *P. simplicissimum* all inhibited *P. cinnamomi* mycelia growth. Nemarioc-AL and nemafric-BL completely inhibited *P. cinnamomi* mycelia growth at treatment concentrations of 16, 32 and 64 %. However, at treatment concentrations lower than 16 % (2, 4 and 8 %), P. cinnamomi mycelia growth inhibition ranged from 24 to 39 %. Dual culture of P. cinnamomi and P. simplicissimum resulted in 60 % inhibition of P. cinnamomi mycelia growth at the end of seven days and 100 % suppression at 16 days.

CONCLUSION

All three tested bio-controls managed to suppress pathogen growth. Further studies are underway to determine their efficacy under greenhouse conditions.

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ACKNOWLEDGEMENT

University of Limpopo and Flemish Inter University Council are acknowledged for financial support.

Keywords: acid-loving fungus, crown rot disease, *Persea americana*, root rot disease

ALLELOPATHIC EFFECTS OF LANTANA (*Lantana camara* L.) ON TOMATOES (*Lycopersicon esculentus* L.) AND LETTUCE (*Lactuca sativa* L.)

Manyenga, N., Rugare, J.T. and Mabasa, S.

Crop Science Department, University of Zimbabwe, Box MP 167, Mount Pleasant, Harare

E-mail: rugarejoy@yahoo.co.uk

INTRODUCTION

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

MATERIALS AND METHODS

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

RESULTS AND DISCUSSION

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

CONCLUSIONS

It can be concluded that *L. camara* leaf extracts suppress the germination of lettuce and tomato but incorporating their biomass in red soils had no inhibitory effect on the emergence of tomato and lettuce at the biomass levels that were used.

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Keywords: allelopathy, lantana, tomato, lettuce

EFFECT OF SEED COLOUR VARIATION ON CHICORY (*Chicorium intybus* L. var. *sativum* Bischoff) SEED QUALITY WITH RESPECT TO GERMINATION AND VIGOUR

Manyoni, N.N., Bertling, I. and Odindo, A.

University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, 3291

E-mail: nnmanyoni@gmail.com

INTRODUCTION

Chicory (*Cichorium intybus* L. var. *sativum* Bischoff) is a perennial tap-rooted herb mainly cultivated in South Africa for the production of coffee powder substitute. Chicory farmers in South Africa rely on imported seed, often of poor quality, since no local seed is available due to unfavourable agro-climatic conditions for seed production. Therefore, the availability of low quality seed is one of the major obstacles to chicory growing in South Africa, often resulting in poor crop establishment and low yields. Seed colour has been associated with chicory seed quality however results were not conclusive and colour separation was carried out visually. The objectives of the study were to evaluate the use of image analysis as a method to objectively determine seed coat colour differences in chicory as well as to investigate the possible association between seed quality and seed coat colour with respect to germination and vigour.

MATERIALS AND METHODS

Seeds of chicory (cv. Orchies) were separated visually into eight seed colour categories: cream, cream with light brown speckles, cream with dark brown speckles, roasted, brown with yellow speckles, cream and brown, light brown and dark brown. Seeds were then separated and assigned to a certain group using an image analysis system AnalySIS® PRO.Version 3.2 manufactured by Soft Imaging System, GmbH, Germany. This measures colour in terms of hue, intensity and saturation. Seed quality was determined using standard germination (SG), accelerated aging (AA), imbibition and electrolyte leakage (EC) tests.

RESULTS AND DISCUSSION

Image analysis indicated that two colour categories could be separated with respect to hue. These groups were categorized as light and dark coloured seeds. Results also showed significant interactions ($P < 0.05$) between seed colour and seed quality test results with respect to germination percentage and mean germination time. There were highly significant differences ($P < 0.001$) between seed colour and seed quality as detected by the germination velocity index (GVI) and between seed colour and imbibition time. Electrolyte leakage from the seeds was not significantly different ($P > 0.05$) between seed colour groups.

CONCLUSIONS

Seed colour is likely to be aligned with seed performance in chicory; however, results suggest a need to evaluate seed performance of chicory seeds varying in seed colour using different seed vigour tests such as mean emergence time and seedling growth rates.

ACKNOWLEDGEMENTS

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Keywords: chicory, seed colour, image analysis, seed quality

EX VITRO ELIMINATION OF PHYSIOLOGICAL DORMANCY IN SEEDS OF YELLOW KIWIFRUIT, *Actinidia chinensis*

Maseko, N.T, Maila, M.Y. and Mashela, P.W.

University of Limpopo

E-mail: mmatshelo@webmail.co.za

INTRODUCTION

Kiwifruit, native to China, belongs to the Actinidiaceae Family. The fruit is considered as a late-comer in the international fruit market. The South African kiwifruit industry is relatively small, with an estimated 200 ha of the green-fleshed variety (*Actinidia deliciosa*) being produced (DAFF, 2014). The new yellow-fleshed kiwifruit (*Actinidia chinensis*), also comprises various important features, namely, nutritional, medicinal, insecticidal, but it tastes better than the common *A. deliciosa* fruit (Ward and Courtney, 2013). However, physiological dormancy has been a serious challenge in the successful establishment of *A. chinensis* seeds for commercial expansion in South Africa. The objective of this study was to investigate whether various concentrations of gibberellic acid (GA3) would have an effect on germination of *A. chinensis* seeds.

MATERIALS AND METHODS

Ten seeds per treatment were soaked for 24 h in 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mg/l GA3 concentrations. The untreated (0.0) seeds were soaked in tap water and represented the control. Seeds were germinated in seedling trays containing steam-pasteurised sand and Hygromix at 3:1 (v/v) ex vitro. Treatments were arranged in a randomised complete block design, with 10 replicates. The number of germinated seeds were recorded daily for 56 days and expressed as emergence percentage (E%) and seedling performance variables, namely, mean emergence time (MET), emergence rate (ER) and emergence index (EI). Data were subjected to ANOVA using SAS software and then subjected to lines of the best fit.

RESULTS AND DISCUSSION

Both untreated and treated seeds with GA3 emerged. Emergence percentage and seedling performance variables responded linearly to all GA3 treatments, which suggested additional work to determine the optimum GA3 concentration for eliminating the inhibitory germination substances contained in seeds *of A. chinensis*.

CONCLUSIONS

In conclusion, GA3 treatment linearly improved *A. chinensis* seed emergence as well as seedling performance variables.

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Keywords: physiological dormancy, emergence indices, plant growth regulator, temperate fruit

DOSAGE MODEL: MANAGING PHYTOTOXICITY IN PHYTONEMATICIDES

Mashela, P.W.[1], Pofu, K.M.[2], Dube, Z.P.[1] and Mamphiswana, N.D.[1]

[1]University of Limpopo, Private Bag X1106, Sovenga, 0727; [2]Agricultural Research Council-VOP, Private Bag X293, Pretoria, 0001

Email: phatu.mashela@ul.ac.za

INTRODUCTION

Most trials on phytonematicides do not go beyond the *in vitro* testing stage, due to international zero tolerance limits on phytotoxicity. The objective of this study was to develop the dosage model as an empirically-based procedure to avoid phytotoxicity in managing soil-borne pathogens, using nematodes as a pest model.

MATERIALS AND METHODS

The dosage model is a two-phase model, comprising (1) development of mean concentration stimulation range (MCSR) and (2) application frequency (T_{ca}), constituting sequential experiments. In order to derive MSCR, nematode-inoculated tomato plants were subjected to a series of phytonematicide concentrations at weekly interval for 56 days, with significantly affected plant variables at harvest being subjected to the Curve-fitting Allelochemical Response Dosage computer-based model (Liu *et al*., 2003) to generate seven biological indices. D_m and R_h biological indices were used to compute MCSR. The application interval (T) for the derived MCSR value was established using the concept of a "30-day-week-period" for *Meloidogyne* species, which translated to 0, 1, 2, 3 and 4 application interval units. Significantly affected plant variables were further subjected to lines of the best fit, where quadratic curves ($bx2 + bx + c$) were optimised using $–b/2b2$ to generate T, which was used with the crop cycle (T_{cc}) to derive the application frequency (($T_{ca} = T_{cc}/T$).

RESULTS AND DISCUSSION

MCSR was equal to 2.63%, while T was equal to 17 days. Using the derived MCSR and T, which are phytonematicide- and crop-specific, phytotoxicity would be avoided. MCSR and T allowed for the computation of dosage ($D = MCSR \times Tca = 2.63 \times 3.29 = 8.65\%$). The model had been validated under diverse environments to manage *Meloidogyne* species without causing phytotoxicity on tomato crops, while consistently suppressing nematode numbers.

CONCLUSION

Properly researched and developed, inherent phytotoxicity challenges on phytonematicides can empirically, be ameliorated. This enhances the potential commercialisation of these materials as alternatives to synthetic chemical nematicides.

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Keywords: botanicals, environment-friendly, phyto-pestidices, root-knot nematodes

NON-PHYTOTOXICITY OF NEMARIOC-AL AND NEMAFRIC-BL PHYTONEMATICIDES ON VOLKAMERIANA CITRUS ROOTSTOCK

Mathabatha, R.V., Mashela, P.W., Mokgalong, M.N.

University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa

E-mail: raesibevivyat@gmail.com

INTRODUCTION

Nemafric-BL and nemarioc-AL phytonematicides are being researched and developed for managing the citrus nematode (*Tylenchulus semipenetrans*). The major drawback of phytonematicides is their phytotoxicity to crops. The objective of this study was to determine the non-phytotoxic concentrations of nemarioc-AL and nemafric-BL phytonematicides for the volkameriana citrus rootstock using the curve-fitting allelochemical response dosage (CARD) model.

MATERIALS AND METHODS

Two separate greenhouse experiments were conducted at the Green Technologies Research Centre (GTRC), University of Limpopo. Nemarioc-AL and nemafric-BL phytonematicides were prepared (Pelinganga *et al*., 2012). The seven concentrations (0, 3, 6, 9, 12, 15 and 18%) were arranged in a randomised complete block design, with nine replications. In both trials, five month-old seedlings were inoculated with 64 000 eggs and juveniles of *T. semipenetrans*. Twenty cm-diameter (7 l) plastic pots were filled with 6.5 l steam-pasteurised (300°C for 1 h) river sand and Hygromix. Seven days after transplanting, both phytonematicides were applied weekly using 300 ml diluted solution. At 42 days after initiating the treatments, plant variables and nematodes were collected and analysed using SAS software, prior to subjecting the treatment means to CARD model.

RESULTS AND DISCUSSION

From CARD results, the threshold stimulation point (D_m) and saturation point (R_h) indices were used to calculate the mean concentration stimulation range (MCSR) = $D_m + (R_h/2)$. This is the concentration that will stimulate plant growth with the density-dependent growth patterns (Pelinganga *et al*., 2012). MCSR for nemafric-BL on volkameriana was 7%, whereas that for nemarioc-AL was 10%. The overall sensitivities ($\sum k$) of volkameriana to the two phytonematicides was 1 and 0, respectively, suggesting high sensitivities to both products.

CONCLUSION

MCSR values were rather high and since nematodes are reduced at considerably lower concentrations, the values could still be reduced, suggesting the need for validation.

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ACKNOWLEDGEMENTS

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Keywords: cucurbitacins, crude extracts, effective microorganisms, fruit extracts, nematicide

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

Mathe, S.[1], Tesfay, S.Z.[1], Mathaba, N.[2], Mlimi, T.J.[2] and Blakey, R.J.[3]

[1]University of KwaZulu-Natal, Private Bag X01, Scottville 3209, Pietermaritzburg; [2]ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200; [3]Westfalia Technological Services, Tzaneen, South Africa

E-mail: sakhilemathe@yahoo.com

INTRODUCTION

The South African avocado industry is export orientated (Voster, 2001) and dominated by 'Hass type' avocado. Currently export markets for South African 'Hass' avocado fruits are dissatisfied with 'Hass' avocado skin color synchronization during ripening. Skin color change of 'Hass' avocado fruit from green to purple black after harvest is the main indicator of ripening, and is therefore important to both consumers and industry.The aim of this research was to investigate pre- and postharvest factors leading to 'Hass' skin color being de-synchronized with softening during ripening.

METHODS AND MATERIALS

Avocado fruits 'c.v. Hass' were harvested at early, mid and late-season from two locations (Kiepersol, Mpumalanga and Tzaneen, Limpopo), at an orchard block with a slope (upper and lower slope), both from inside and outside the tree canopy. Fruit were immediately transported to the ARC – ITSC postharvest laboratory for storage and analysis. At the laboratory, fruits were sorted and graded manually, and then stored at 5.5°C for 28 days. After withdrawal from cold storage, fruits were ripened at 16, 21 or 25°C. During ripening, the avocado fruits were evaluated for firmness, skin color (L, C and hue), and pathological, physiological and mechanical damage. Evaluations were done at 48 hour time intervals until ripened.

RESULTS AND DISCUSSION

Avocado fruit 'c.v. Hass' harvested early season showed higher colour de-synchronization compared with fruits harvested mid and late season. Orchard slope did not have a significant effect on fruit ripening and colour development. However, late season fruits harvested from the upper slope outside tree canopy from Tzaneen showed higher synchronization at higher temperatures (21 and 25°C), while fruits from Kiepersol harvested from lower slopes outside canopy showed higher synchronization at higher temperatures (21 and 25°C). In general, colour synchronization improved with harvest time, irrespective of ripening temperature, orchard block, slope and locations (Mpumalanga and Tzaneen). In addition, colour de-synchronization, was associated with higher internal and external cold damage, especially for fruits harvested early, inside the tree canopy, and ripened at lower temperature (16°C).

CONCLUSIONS

Late season fruits ripened at high temperatures (25°C), harvested from outside the tree canopy showed better synchronization of colour with softening during ripening.

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Keywords: avocado fruit (*Persea americana*); firmness, cold damage, lightness, chroma and hue

EFFECT OF 1-MCP AND HARVEST TIME ON 'HASS' AVOCADO FRUIT SKIN COLOUR CHANGE

Mathe, S.[1], Tesfay, S.Z.[1], Mathaba, N.[2], Mlini, T.J.[2], and Blakey, R.J.[3]

[1]University of KwaZulu-Natal, Private Bag X01, Scottville 3209, Pietermaritzburg; [2]ARC-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200; [3]Westfalia Technological Services, Tzaneen, South Africa

E-mail: sakhilemathe@yahoo.com

INTRODUCTION

'Hass' avocado fruits are characterized by a skin colour change from green to purple black after harvesting as an indicator of ripening.1-Methylcyclopropene (1-MCP), commercially registered as Smart freshTM, is used to regulate ripening of climacteric fruit by inhibiting ethylene activity. According to Woolf et al. (2005), 1-MCP application reduces internal and external cold damage, while delaying colour change. However maturity also plays a role in improved quality. Recently, markets importing South African 'Hass' avocado fruits have being complaining about skin colour synchronization during ripening. The aim of this research was to investigate the effect of 1-MCP and harvest time on the skin colour change of 'Hass' avocado fruit during ripening.

METHODS AND MATERIALS

'Hass' avocado fruits were harvested at early, mid and late-season from the Tzaneen (Limpopo) area. After harvest hey were sorted, graded and treated with 1-MCP for 18 hours at 6°C. Fruits were then transported to the ARC–ITSC postharvest laboratory for storage and analysis. At the laboratory, fruits were stored at 5.5°C for 28 days. After withdrawal from storage, fruits were ripened at 21°C (commercial ripening temperature). During ripening fruits were evaluated for firmness, skin colour (L, C, and hue), and pathological, physiological and mechanical damages at 48 hour time intervals until fully ripened.

RESULTS AND DISCUSSION

'Hass' Avocado fruits treated with 1-MCP generally took longer to ripen, when compared to non-1-MCP treated fruits. However, application of 1-MCP had no effect on ripening time and skin colour change of early season fruits. The early season fruits had higher de-synchronized colour change during ripening compared with mid and late season fruits. Furthermore, mid and late season fruits treated 1-MCP took longer to ripen and there were no significant differences in external and internal quality between treated and untreated fruits. Early season fruits had a higher incidence of external cold damage compared with mid and late season fruits. Skin colour change improved with harvest season (time), regardless of 1-MCP treatment. Moreover, late harvest fruits treated with 1-MCP showed mixed ripening.

CONCLUSION

The use of 1-MCP was effective in delaying ripening for mid and late season fruit, but had no effect on skin colour change.

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Keywords: avocado fruit *(Persea americana*); firmness, lightness, chroma, hue and cold damage

INFUSION OF SEVEN CARBON SUGARS TO ENHANCE POST-HARVEST QUALITY OF AVOCADO (*Persea americanan* Mill.) FRUIT

Mathe, S.[1], Bertling, I.[2] and Tesfay, S.Z.[2]

[1]P.O Box 182, Mtubatuba, 3935; [2]University of KwaZulu-Natal Private Bag X01, Scottville 3209, Pietermaritzburg

E-mail: 215081941@stu.ukzn.ac.za

INTRODUCTION

Avocado (*Persea americana* Mill.) is known to contain rarely occurring seven carbon sugars (heptoses). Sedoheptuloses occur in most plants, but avocado contains the rare sugar aldose D-mannoheptulose and its reduced polyol form perseitol (Liu *et al*., 1999; Tesfay et al., 2012). These two uncommon heptoses have been found to be abundant in various avocado tissues and also seem to play a vital role in fruit ripening (Liu *et al*., 1999). Tesfay (2010) has reported mannoheptulose to act as an antioxidant agent that plays a major role in postharvest quality of avocado fruit. The high concentration of C7 sugars in avocado has led to the assumption that these compounds are associated with fruit quality (Bertling and Bower, 2005).

MATERIALS AND METHODS

This study was conducted to investigate the effects of fruit water loss and the infusion of various sugars on the postharvest fruit ripening pattern of physiologically mature 'Fuerte' and 'Hass' avocados. *D*-mannoheptulose, perseitol, sucrose and water were continuously infused through the pedicel into harvested fruit for three weeks. Fruit without pedicel, with pedicel and water-infused fruit were used as control. Mesocarp samples were taken at 10 day intervals along the equatorial region of each fruit for oil and sugar determination.

RESULTS AND DISCUSSION

It was found that continuous *D*-mannoheptulose, perseitol, and sucrose infusion resulted in the highest mesocarp *D*-mannoheptulose, perseitol, and sucrose concentration in fruit infused with these sugars, followed by water-infused fruit. *D*-mannoheptulose-infused fruit showed the lowest weight loss, followed by water-infused fruits. Fruit without pedicels had the highest weight loss followed by sucrose-infused fruits. *D*-mannoheptulose-infused fruit were characterized by a greater firmness followed by water-infused fruit, whereas perseitol-and sucrose-infused fruit were softer than the former two. Perseitol infusion had a slight effect on reducing fruit softening.

CONCLUSIONS

In conclusion, *D*-mannoheptulose infusion can increase the concentration of this sugar postharvest and can possibly conserve avocado fruit quality. Therefore, means to increase the mannoheptulose concentration present at the time of harvest need to be sought.

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Keywords: C7 sugars, avocado, D-mannoheptulose, perseitol

DOES SHADE NETTING INCREASE OR DECREASE WATER USE IN AVOCADOS?

Mazhawu, E.[1], Savage M.J.[1] and Blakey, R.J.[2]

[1]School of Agricultural, Earth and Environmental Sciences; [2]Westfalia Technological Services, Tzaneen

E-mail: savage@ukzn.ac.za

INTRODUCTION

Efficient water use in the fruit industry is important because of its dependence on irrigation. Hence the management of available water resources whilst maintaining fruit yield and quality is of utmost importance. In horticulture, water is the main factor limiting production, directly affecting the quality and quantity of yield. In the face of limited water resource in South Africa, there is a need to use the available resources sparingly. Shade netting is thought to play a role in improving water use efficiency. However, there is little information on the role played by shade nets on the water use of avocado trees. The objective of the study was to determine if 'GEM' avocado trees under shade nets require less water for growth as compared to trees in the open field using the thermal dissipation probe (TDP) sap flow method.

MATERIALS AND METHODS

The study was conducted at Everdon Estate, Karkloof area in KwaZulu-Natal, South Africa (29° 26'37.95"S, 30°16'22.29"E, 1250 m altitude) on '3-29-5' (marketed under the trademark Gem®). Sap flow was measured from March 6 to November 2015 using TDP method (Dynamax Inc., Houston, USA). Automatic weather systems were set up in the open and under 30% crystal shade net to measure meteorological variables including rainfall, wind speed and solar radiation. Relative humidity and air temperature were monitored every five minutes using U23-002 Hobo data logger (Onset Computer Corporation, Massachusetts, USA) from which vapour pressure deficit (VPD) was calculated. Leaf area index (LAI) measurements were recorded with the LI-COR LAI2200 plant canopy analyser (LI-COR, Lincoln, Nebraska, USA) regularly throughout the duration of sap flow measurements.

RESULTS AND DISCUSSION

Preliminary results show higher sap flow rates in the open field compared to those under shade netting. Even though the study is ongoing there are clear indications of a higher water use in the open field.

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Keywords: sap flow, thermal dissipation probe

IMPROVING IRRIGATION WATER AND SOLUTE MANAGEMENT USING SIMPLE TOOLS AND ADAPTIVE LEARNING

Mbakwe, I.[1], Stirzaker, R.J.[2] and Annandale, J.G.[1]

[1]Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield, 0028, Pretoria, South Africa; [2]CSIRO Land and Water, P.O. Box 1666 Canberra, ACT 2601, Australia

Email: mbakweikenna@gmail.com

INTRODUCTION

In sub-Saharan Africa, crop yields from smallholder irrigation farms have been markedly low partly due to low skill levels in water and nutrient management. Technologies that guide irrigation management have been poorly adopted because farmers generally favour experiential knowledge over use of objective tools, many of which are difficult to understand. The solution to improving soil water management in sub-Saharan Africa as a precursor to increasing agricultural productivity can therefore be found in simple tools that build on farmers' existing knowledge, stimulate local experimentation and creativity, and help with pattern recognition and intuitive decision-making. We present findings from the use of such tools (the FullStop wetting front detector and the Chameleon – a new soil moisture sensor that gives output in the form of colours: blue = wet, green = moist, red = dry) by farmers in irrigation schemes in Southern Africa.

MATERIALS AND METHODS

One hundred farmers were selected from 5 irrigation schemes in 3 countries (Mozambique, Tanzania and Zimbabwe). FullStop wetting front detectors and Chameleon soil moisture sensors were installed in their plots and farmers were guided to collect, interpret and discuss soil water and solute data. Information on water use and change in irrigation practices were captured in biophysical data, interviews and surveys.

RESULTS AND DISCUSSION

Results indicate that farmers using the tools have reduced irrigation frequency, and report higher crop yields. Results also show that farmers are using information from leachate tests to guide type and timing of fertilizer application. This change in irrigation practice and nutrient management is attributed to the link the farmers made with over-irrigation (Chameleon showing blue at all depths most of the time) and nutrient leaching (high nitrate from deep wetting front detector), accompanied by their prior experiential knowledge of crop performance.

CONCLUSIONS

This study provides evidence that improvement in irrigation water and solute management can be achieved when simple tools that build on farmers' experiential knowledge are used in an environment of adaptive learning.

ACKNOWLEDGMENTS

This work forms part of a project funded by the Australian Centre for International Agricultural Research (ACIAR).

Keywords: irrigation, smallholder farmers, soil water monitoring

GENETIC DIVERSITY AND HERBICIDE TOLERANCE IN *Conyza bonariensis*

Mbedzi, P.P. and Vorster, B.J.

University of Pretoria, Private bag X20, Hatfield, 0028, South Africa

E-mail: princeey4822@gmail.com

INTRODUCTION

Conyza bonariensis is an annual weed of the family Asteraceae, commonly known as hairy leaf fleabane. *Conyza* can be found growing along roadsides, gardens and cultivated areas. *Conyza* is also an alternate host of the tomato wilt virus which infects tobacco, tomatoes and potatoes. In the past 15 years; there has been cases of herbicide resistance in *C. bonariensisin* South Africa and other countries and this continues to be a problem. In South Africa herbicide resistance in this weed has only been recorded in the Western Cape regions but not in other regions; understanding the genetic diversity of *C. bonariensis* could help to predict the evolution of resistance and the management thereof.

MATERIALS AND METHODS

Thirty populations collected across South Africa and that were previously screened for glyphosate sensitivity were used in the study. DNA was extracted from one plant per population using an optimised CTAB method and genetic diversity were evaluated using the RubisCO large subunit (*rbcL*) and Maturase K (*matK*) DNA barcoding markers. PCR amplification of therbcL and matK DNA barcode markers with their respective primers was done followed by bi-directional DNA sequencing using the Sanger sequencing method. DNA sequences were evaluated for similarity using the following bioinformatics programmes (CLC main workbench 6.9, Mesquite 3.01, Prank-ClastalW2 alignment). The genetic relationships among the three groups were evaluated by constructing a phylogenetic tree using maximum-likelihood on the CIPRES database program and FigTree software.

RESULTS AND DISCUSSION

The amplification of *rbcL* and *matK* using a polymerase chain reaction allowed for evaluation of the gene size of the respective DNA barcoding markers and this was found to be approximately 700bp and 1000bp respectively. Preliminary sequence analysis shows very little sequence differences between the different cultivars for the respective markers. Evaluation of the genetic relationships among the different populations with the construction of a phylogenetic tree showed no clear clustering of resistant or sensitive traits, indicating that resistance have probably evolved and been selected for multiple times across different populations rather than a single event that spread across the country. Comparison of the sequences to that of *C. canadensis* has also given some evidence of possible hybridization.

CONCLUSION

The genetic similarity observed among some of the populations from resistant, tolerant and sensitive groups indicates that resistance is highly likely to develop in populations where it has not yet been observed and herbicide resistance in *C. bonariensis* is going to be a problem for farmers in regions of South Africa other than the Western Cape region.

Keywords: Conyza, herbicide, resistant, *matK*, *rbcL*

MAIZE SEED QUALITY IN RESPONSE TO HAIL DAMAGE AND PLANT DENSITY

Miya, S.P., Modi, A.T., Mabhaudhi, T. and Tesfay, S.Z

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

E-mail: slindilemiya@gmail.com

INTRODUCTION

Hail damage has been identified as a major factor in climate change that may detrimentally affect maize production. Hail damage can cause severe losses in maize yield and quality. One of the major success factors in agriculture is climatic adaptability of the production system. The objective of this study was to determine the effect of simulated hail damage and plant density on subsequent seed quality of three maize cultivars (SC701, MMP and ZS) at two significantly different bioresource groups (BRG) of KwaZulu-Natal (Baynesfield and Swayimane).

MATERIALS AND METHODS

A randomised complete block design replicated three times was used to evaluate the effect of plant population density [High (65 000), Moderate (46 000) and Low (28 000)] and simulated hail damage at V7 (7th leaf stage) and VT (Tasseling) on subsequent seed quality. After harvest, the maize cob was separated into two halves (proximal and distal) for evaluation of seed position factor. Seed quality (viability and vigour) was then determined using a completely randomised design replicated four times for Tetrazolium (TZ) and standard germination (SG) tests. Measured vigour indices were germination vigour index, mean germination time, seedling length (shoot, root and total) and seedling mass (fresh and dry) as well as root to shoot ratio.

RESULTS AND DISCUSSION

For the SG test, there were significant effects ($P<0.05$) of plant density, seed position and BRG. Proximal seeds had high seed quality with Baynesfield being the superior environment. Seeds from high plant density had superior quality with the best cultivar being SC701. Occurrence of hail damage at V7 or no hail damage (Control) showed no negative effect as expressed by standard germination and germination vigour. The TZ test showed that seed from Swayimane and subjected to hail damage at VT were more viable.

CONCLUSIONS

Stress caused by hail damage can influence seed quality. Farmers should consider variety selection, plant population density, environment and seed position on the cob when selecting seeds. Farmers from hail prone areas can cultivate SC701 at high plant density as this combination showed resilience to hail damage. Further research is still needed to explore the sugar profile of seeds.

ACKNOWLEDGEMENTS

The National Research Foundation of South Africa and the South African Society of Crop Production are acknowledged for financial support.

Keywords: seed selection; seed position; hail damage; cultivar; plant density

CROP-LIVESTOCK INTEGRATION IN SMALLHOLDER FARMING SYSTEMS: A CASE STUDY FROM SUB-HUMID ZIMBABWE

Mkuhlani, S.[1], Nyagumbo I.[1], Mupangwa W.[1], Manyawu, G.[2] and, Crespo, O.[3]

[1]CIMMYT, P. O Box MP163, Mt. Pleasant, Harare, Zimbabwe; [2]ILRI, C/O CIMMYT, P. O Box MP163, Mt. Pleasant, Harare, Zimbabwe; [3]UCT, CSAG-ESG, P. Bag X3, Rondebosch 7701, Cape Town, South Africa

E-mail: siyabusa@gmail.com

INTRODUCTION

Poor productivity in mixed smallholder farming systems has increased demand for crop and livestock products. The potential of crop-livestock integration to improve productivity warrants the need for further research. The complexity of on-farm crop-livestock integration research necessitates the use of computer models. The farm typology approach increases the applicability of the outputs. This study sought to identify options to improve crop-livestock integration among farmers through scenario modelling of crop and livestock productivity improvement strategies and increased interaction between component outputs (Tshoni, 2015).

MATERIALS AND METHODS

This study was undertaken in sub-humid Murehwa and Goromonzi districts, Zimbabwe. A household survey was undertaken and farmers were classified using PCA (principal component analysis) into: old resource endowed (OR); part time (PT) and young, resource constrained and enthusiastic (YE) farmers. Crop-livestock integration scenarios were developed for each farmer type. APSIM (Holzworth *et a*l., 2014) and IAT (Lisson *et al*., 2001) models were calibrated for each farmer typology based on the biophysical and socio-economic characteristics (2013-15). Crop-livestock integration was conducted through assessing the economic value of the contribution of crops to livestock (grain and stover) and vice versa (manure and draught power).

RESULTS AND DISCUSSION

Results showed that OR farmers had the highest initial crop-livestock integration of $3,981. In contrast, PT and YE farmers had relatively lower crop-livestock integration of $1,487 and $2,872 respectively. Contribution of crops to livestock was higher than that of livestock to crops, in OR with $2,976 compared to $857 and $1,832 among the PT and YE farmers, respectively. In contrast OR farmers had the lowest manure use of $384 yr-1(4800 kg) compared to PT and YE farmers with $480 yr-1 (6000 kg) and $800 yr-1 (10000 kg) respectively due to labour shortages. This inefficiency led to low legume yields of 800 kgha-1 compared to 3525 kgha-1 from groundnut for YE farmers. OR farmers had the highest net profits of $5,550 yr-1 compared to about $1,500 yr-1 from both PT and YE farmers due to many crop and livestock enterprises. Crop and livestock improvement scenarios across all farmer types increased grain yields to $1206 yr-1, $3232 yr-1 and $3095 yr-1 for mucuna, cowpea and groundnut in OR, PT and YE farmers, respectively. Crop-livestock integration ultimately increased by 135, 132 and 101% to $9,880, $2,963 and $6,284 yr-1 in OR, PT and YE farmers respectively.

CONCLUSIONS

This study shows that current crop-livestock integration levels are low due to poor crop and livestock productivity, and manure and crop residue use. Improved crop agronomy and livestock husbandry leads to increased manure and stover use in the fields and as livestock feed respectively. This ultimately increases crop-livestock integration.

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Keywords: farm typology, manure, models, productivity, scenario, stover

COLD STERILIZATION OF NEW MANDARIN SELECTIONS DEVELOPED BY THE ARC-ITSC

Mmako, K.[1], Mafeo, T.P.[1], Mathaba, N.[2] and Mlimi, J.[2]

[1]University of Limpopo, Department of Plant Production, Soil Science and Agricultural Engineering, Private Bag X1106, Sovenga 0727; [2]Agricultural Research Council-Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200

E-mail: mathaban@arc.agric.za

INTRODUCTION

In many citrus exporting countries, early season mandarin citrus fruits are de-greened to improve peel colour and disinfested against fruit flies by cold storage. Although these treatments are generally effective, some importing countries require that the effectiveness of the treatments must be tested on new mandarin selections before they could be considered for import approval. Hence, this study aims to investigate the effect of ethylene de-greening and low temperature storage (-0.5, 2 and 4.5°C) on internal and external quality variables of new mandarins (Sonet, I22, B24, M37, Nova ARC and Nova) developed by the ARC-ITSC.

METHOD AND MATERIALS

'Mandarin' fruits were collected from the ARC-ITSC in Addo (Eastern Cape) during the 2014 and 2015 season. After harvesting, some fruits were de-greened while others were not de-greened, packed and transported to the Postharvest Laboratory at ARC-ITSC in Nelspruit. Fruits were re-packed into smaller boxes, which contained 15 fruits per box with three replicates per treatment and subjected to cold storage temperatures (-0.5, 2.0 and 4.5°C) for 28 days. After 28 days of cold storage fruits were evaluated for weight loss, firmness, colour (Lightness, Chroma and Hue), total soluble solids (TSS), titratable acidity (TA), electrical conductivity (EC) and chilling injury (CI). Data analysis was by means of an ANOVA using GENSTAT.

RESULTS AND DISCUSSION

Amongst the studied selections, only selection "M37" showed significantly higher external chilling injury at -0.5°C when compared with 2.0 and 4.5°C. After cold storage, both de-greened and non-de-greened mandarin fruit showed an improvement in colour as measured by Lightness (L), Chroma (C) and Hue angle (h°). There was significant increase in weight loss and electrical conductivity (EC) observed after 28 days of cold storage. Subsequently, fruits lost firmness during storage. An increase in TSS and a reduction in TA were noted in all the selections, which resulted in an increase in Brix. This observation was more pronounced in M37 and I22.

CONCLUSIONS

All studied selections maintained their good external and internal qualities during cold disinfestation with the exception of M37 and I22. Furthermore, an improved peel colour without negative effect on any measured internal variables was observed on all selections in response to de-greening treatment.

Keywords: brix, chilling injury, colour, titratable acids, total soluble solids

EFFECT OF N AND P NUTRITION ON FRESH MARKETABLE YIELD OF COWPEA (*Vigna unguiculata* (L.) Walp) INTERCROPPED WITH AMARANTH (*Amaranthus cruentus* L.)

Mndzebele, B.M.P[1], Modi, A.T.[2], Fessehazion, M.K.[1], Mabhaudhi, T.[2] and Du Plooy, C.P.[2]

[1]Agricultural Research Council, Vegetable and Ornamental Plants Private Bag X293, Pretoria, South Africa, 0001; [2]University of KwaZulu Natal, School of Agricultural, Earth & Environmental Sciences, Private Bag X01, Scottsville, Pietermaritzburg, South Africa, 3209

E-mail: mndzebeleb@arc.agric.za

INTRODUCTION

Nitrogen and Phosphorus constitute primary nutrients necessary for vegetable production systems because of their role in increasing yield and improving quality (Graham *et al*., 2001). To supply the crop requirement, inorganic sources are commonly utilized, even though their costs are high. The incorporation of N2-fixing legume crops to intercropping farming systems provide an affordable option for smallholder farmers who cannot purchase or have access to inorganic commercial fertilizers. Therefore, the aim of the study was to test the effect of N and P in an intercrop system using cowpea and amaranth as test crops.

MATERIALS AND METHODS

This experiment was conducted at the Agricultural Research Council-Vegetables and Ornamental Plants, Pretoria, in the summer of 2014/2015. Amaranth (A) and cowpea (C) were row-intercropped. Amaranth monocrop spacing was 0.3 x 0.3 m (111 111 plants/ha), which was similar to the cowpea-amaranth intercropped plots. The cowpea sole cropping spacing was 0.3 by 0.6 m (55 555 plants/ha). Factorial design including three row-intercropping arrangements ($100\%_{Amaranth}$; $50\%_{Amaranth}$: $50\%_{Cowpea}$; $100\%_{Cowpea}$) and four N and P fertilizer (0, 25, 50 and 100%) of the recommended rates treatment combinations were assigned in a completely randomized block design, with four replications. Harvesting for amaranth was done by cutting the plants and separating leaves from stems. Cowpea was harvested by tipping. Thereafter fresh marketable seasonal yield were determined.

RESULTS AND DISCUSSION

Yield of both crops increased as a function of the amount N and P fertilizer applied. The highest fertiliser rate (100%), based on the recommendation resulted in increased yield of monoculture of amaranth. Seasonal yield totals revealed that cowpea-amaranth intercropping was highest (48 t/ha) as compared to the each monoculture, i.e., amaranth (46 t/ha) and cowpea (31 t/ha). However at 50% of the recommended rate, sole cowpea as well as intercropped cowpea were highest, though not significantly different from the 100% optimum rate. Results in terms of land equivalent ratio showed that intercropping was beneficial (LER ranged from 1.3-1.5), which was above 1.

CONCLUSIONS

In conclusion, N and P application increased yield of amaranth and cowpea in an intercrop and as sole crops. Amaranth/cowpea intercropping was beneficial (in terms of LER) as it performed better than the sole of each crop. The project has impact on small holder farmers, so that through intercropping they can increase productivity as well as use land efficiently.

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Keywords: Amaranth, cowpea, intercropping, nitrogen, phosphorus

WHEAT SEED QUALITY- DOES POSITION ON THE HEAD MATTER?

Modi, A.T.

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

E-mail: modiat@ukzn.ac.za

INTRODUCTION

Fundamentals of seed production require careful consideration of agronomic, handling and marketing aspects to make sure that the seed certification and law enforcement requirements are met. Seed quality is tested using different internationally recognised methods to produce a wide range of results that can be interpreted separately or in combination. Seed germination is the most reliable seed quality test in that it can be easily used together with other tests to produce a detailed seed quality measure such as seed vigour. Seed germination has also been shown to closely correlate with seedling establishment, which can be used to predict crop stand. In maize, studies have shown that seed size and shape are significant for seed quality and conditioning. Hence, these are used in maize seed marketing. The objective of this study was to determine the effect of position on the plant with respect to wheat seed quality.

MATERIALS AND METHODS

Wheat (*Triticum aestivum* L) cultivar Duzi was grown under dryland conditions and mature heads of different lengths were randomly harvested. The heads were cut into two equal halves, proximal and distal, respectively. From the head parts, seeds were removed to create two seed lots. For each lot, seed moisture content, water activity, 1000 grain mass, seed viability, germination and seedling establishment were determined according to the International Seed Testing Association rules. The study design for all variables was based on seed position as a factor and it was replicated four times to allow statistical analysis using Genstat®.

RESULTS AND DISCUSSION

There was a significant difference between seed lots in harvest seed moisture content, which correlated with water activity, where the distal seeds showed greater amounts. Seeds from the distal part of the head also showed a significantly greater 1000 seed mass compared with those from the proximal part. Although there was no significant difference between seed lots with respect to viability and total seed germination, the distal seeds showed a significantly better germination rate and vigour. The seedling vigour difference was linked to seedling establishment. Distal seeds produced larger seedlings compared with proximal seedlings. Water activity of harvested seeds may have connotations for seed longevity. Hence, it would be interesting to determine whether seeds with high water activity and seed quality properties at harvest could maintain that during long-term storage.

CONCLUSIONS

Wheat seeds differ in size and other seed quality measures depending on position on the head. Distal seeds are better in seed quality. However, seed viability is not affected by position on the head. A future study should investigate seed conditioning to enhance the quality of proximal seeds.

ACKNOWLEDGEMENTS

The author thanks the AGPS 714 Class of 2015 and Mr. Khulekani Mkhonza.

Keywords: distal, germination, proximal, vigour

ASSESSMENT OF GENETIC DIVERSITY AMONG SELECTED SOUTH AFRICAN SORGHUM GENOTYPES FOR PROTEIN CONTENT AND AMINO ACID COMPOSITION

Mofokeng, M.A.[1], Shargie, N.[1,] Shimelis, H.[2] and Laing, M.D.[2]

[1]Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520; [2]African Centre for Crop Improvement, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209

Email: MofokengA@arc.agric.za

INTRODUCTION

Sorghum is an important food security crop in sub-Saharan Africa providing food and feed. However, sorghum has inadequate and variable protein content and levels of essential amino acids required for balanced human and animal diets. The objectives of the study were to determine genetic diversity present among selected South African sorghum genotypes for protein and amino acid content and to select candidate lines for breeding.

MATERIALS AND METHODS

Fifty nine selected South African sorghum genotypes grown at two localities, Makhathini and Ukulinga, were analysed for crude protein content using near-infrared spectroscopy (NIR). Nineteen genotypes with high crude protein content from each locality were selected and analysed for amino acid profiles using protein hydrolysates. The spectral data was entered into VISION software and further analysed using Unscrambler v. 3.0. The model used was adapted from Brauteseth (2009). The protein content and amino acid profiles were compared using analysis of variance in GenStat 14th edition.

RESULTS AND DISCUSSION

The crude protein content of the genotypes varied from 7.7 to 16.8% across the two sites with a mean of 13.1%. The genotypes that had high crude protein content at both sites were Mammopane (16.2%), AS16 M1 (15.6%), Macia-SA (15.3%), AS19 (15.2%), Maseka-a-swere (15.1%) and AS4 (15.1%). The genotypes identified with superior leucine content were LP 1948 at 14.3%, FS 4905 (14.3%), MP 4154 (14.3%) and LP 1481 (14.3%). High lysine content was detected in the genotypes KZ 5246 at 2.3%, AS17 (2.3%), Manthate (2.2%) and LP 1481 (2.1%). The genotype AS16cyc was the best candidate for high phenylalanine content at 6.0%. The results concur with grain sorghum protein content reported by Shegro et al. (2012) and other authors who found that there is genetic variation observed among high lysine sorghum genotypes from India based on protein and amino acids.

CONCLUSIONS

The studied lines had great variability in their protein and amino acid profiles. The presence of genetic diversity is essential for quality improvement to achieve balanced protein and amino acid levels in sorghum.

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ACKNOWLEDGEMENT

Alliance for Green Revolution in Africa (AGRA) is appreciated for funding.

Keywords: amino acids, genetic diversity, near-infrared spectroscopy, protein content, sorghum

EVALUATION OF LETTUCE CULTIVARS FOR OFF-SEASON PRODUCTION IN THE LIMPOPO REGION OF SOUTH AFRICA

Mogaila, M.M.R[1], Crosby, K.M.[2], Jifon, J.L.[3], Leskovar, D.I.[4] and Soundy, P.[1]

[1]Department of Crop Sciences, Tshwane University of Technology, Pretoria 0001; [2]Texas A&M University, VFIC, 1500 Research Pkwy Ste 120, College Station, TX 77845 USA; [3]Texas AgriLife Research, 2415 E, Hwy 83, Weslaco, TX 78596 USA; [4]Texas AgriLife Research, 1619 Garner Field Rd, Uvalde, TX 78801, USA

Email: mapulamo@gmail.com

INTRODUCTION

Leafy vegetables such as lettuce (*Lactuca sativa* L.) are high-value crops and major components of healthy, nutritious diets around the world. Identifying cultivars and cropping systems that are suitable for off-season production at different locations is important to ensure year-round supply. The purpose of this study was to screen lettuce cultivars for off-season production in a hydroponic growing system.

MATERIALS AND METHODS

Four loose leaf lettuce cultivars, namely Ezatrix, Lunix, Matahari and Vera were evaluated under a heated high tunnel production system. Four week old seedlings were transplanted and grown on drip irrigated raised beds filled with pine sawdust. Three overlapping cropping cycles (each lasting approximately 2 months) were raised in this system from May to September. Each cropping cycle was laid out in a randomised complete block design with three replications. Growth variables measured included fresh mass, leaf number, head circumference, plant height, stem diameter, stem length and dry leaf mass.

RESULTS AND DISCUSSION

In cycles one (May-July) and two (June-August), Ezatrix and Vera had significantly higher fresh mass yields compared to Lunix and Matahari although Vera had fewer leaves. Even though Lunix and Matahari exhibited the lowest fresh mass yields, the average number of leaves per plant was significantly greater in Matahari compared to the other cultivars. In cycle three (June-August), all cultivars demonstrated a significant increase in fresh mass, leaf number, stem length and plant height. However, Ezatrix and Vera had tipburn resulting in poor quality plants at harvest.

CONCLUSIONS

The results indicated that Ezatrix and Vera are more suitable for cooler growing seasons whereas Lunix and Matahari are more adapted to warmer growing seasons. The data demonstrated that off-season production/supply of high quality lettuce under high tunnels can be achieved by selecting appropriate cultivars for each cropping cycle.

ACKNOWLEDGEMENTS

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Keywords: Lactuca sativa L., high tunnel production, lettuce quality, tipburn

SOIL HEALTH, YIELD AND FRUIT SIZE DISTRIBUTION OF AVOCADO AS INFLUENCED BY DIFFERENT COMPOST APPLICATION RATES

Mohale, M.P., Novela, P., Nzanza, B. and Pieterse, P.

ZZ2-Bertie van Zyl, Po Box 19, Mooketsi, 0825

Email: mm79935@gmail.com

INTRODUCTION

The role of compost in improving root health, ameliorating tree stress, increasing yield and fruit size in avocadoes are well documented (Wolstenholme *et a*l., 1997; Moore-Gordon *et al*., 1997). However, there is a lack of information on the rate of compost required to enhance soil health, improve avocado tree performance and increasing yield and fruit size. The aim of this study is to determine the rate of compost required to improve soil health, avocado tree performance and increased yield and fruit size.

MATERIALS AND METHODS

A four year field trial was conducted at ZZ2 Bertie van Zyl farms viz. Politsi with soil textural class of clay (45% clay, 19% silt and 36% sand) and Mooketsi, sandy clay loam (24% clay, 5% silt and 71% sand), Limpopo, South Africa during 2010 to 2014 growing seasons. The trial was laid out in a completely randomised design on commercial Hass avocado orchard. Compost was applied at 0, 10, 20 and 30 m3/ha with three replications. Re-application of compost was done after harvest on yearly basis. Soil samples were collected after each harvest to determine soil health indicators (chemical and biological).Leaf chemical analysis, yield and fruit size distribution were also determined at harvest. Collected data was subjected to ANOVA using statistix (version 10.0) and Fisher's least significant difference (LSD) test was used to separate treatment means at 5% confidence level.

RESULTS AND DISCUSSION

Compost application rate had a significant effect on soil chemical properties; however, the effect was site or climate dependent. Soil Na, K, active carbon increased with application rate at both sites. Soil pH and P content increased with the application rate at Mooketsi while there was no difference at Politsi. Similarly, soil Mg and Ca content increased with the increasing application rate at Politsi. Higher compost application rates increased leaf N and Cu content at both sites. Furthermore, increasing application rate increased the leaf content of P, K, B, and Fe at Politsi while there was no effect at Mooketsi site. Increasing application rate increased the percentage of larger fruits at Mooketsi than in Politsi farm. Avocado yield, economically important nematodes, nematode trophic groups, (bacteriovres, fungivores, omnivores, plant parasites and predators) and ecological indices of nematodes were not significantly affected by compost treatments at both sites.

CONCLUSION

Compost application improved soil chemical properties; leaf Cu, N, P, K, B and Fe content and avocado fruit size as compost rate increases. Therefore there is sufficient evidence to conclude that compost application at higher rate (30 m3) is essential for improving soil health and increasing avocado fruit size depending on climatic condition.

Keywords: avocado, compost rates, fruit size, soil health

GRAIN YIELD AND WATER USE EFFICIENCY OF RAINFED SUNFLOWER UNDER DIFFERENT SOURCES OF ORGNIC MANURE

Mokgolo, M.J., Mzezewa, J. and, Odhiambo, J.J.O.

Department of Soil Science, University of Venda, Private Bag X5050,
Thohoyandou 0950, South Africa

E-mail: matomej.josphistos19@gmail.com

INTRODUCTION

The application of organic manures as alternative to reduce the use of mineral fertilizers is considered a good agricultural practice for smallholder farmers. Therefore, the main objective of this study was to determine the effect of three organic manures on sunflower (*Helianthus annuus* L.) grain yield and water use efficiency under rainfed conditions.

MATERIAL AND METHODS

A field experiment was carried out during the 2013/2014 and 2014/2015 cropping seasons at the University of Venda experimental farm which is located in Thohoyandou, Limpopo province. The experiment was a randomized complete block design (RCBD) with four treatments and four replications (control (C0), cattle manure (CM), poultry manure (PM) and their combination (CM + PM)). All organic manures were applied 21 days before planting at a rate equivalent to 20 t ha-1. ANOVA was done using SPSS software. The differences between treatment means were separated using the LSD procedure.

RESULTS AND DISCUSSION

Dry matter yield, LA and LAI at flower bud, flowering and maturity stages increased with the application of different manures compared to the C0. Manure application showed a significant ($p<0.05$) effect on dry matter at all growth stages in the second cropping season. PM and CM recorded the highest LA values in the flower bud (3935.4 cm2) and maturity stages (4904.1 cm2) respectively. Organic manure had a significant effect on LAI only at flower bud stage of the first cropping season, with PM and CM + PM recording the highest similar value of 1.31. The manure application also showed a significant ($P<0.05$) effect on plant height and stem girth in all growing stages in the second cropping season, whereas in the first cropping season the significant effect was only in the flower bud stage for both parameters.

Grain yield was significantly affected by the manure application in the second cropping season. Manure application in the second cropping season resulted in an increase in the grain yield compared to the first cropping season, except for PM where the grain yield decreased significantly by 167.92 % from the first cropping season.

The manure application had a significant effect ($p<0.05$) on water use efficiency (WUE) in the second cropping season. The WUE recorded the highest values under CM and CM+ PM treatments in second cropping season than in first cropping season, while PM recorded the highest WUE value in the first cropping season.

CONCLUSIONS

Generally, organic manures used obtained higher grain yield and WUE compared to control. Lack of positive response by dry matter and grain yield in the first cropping season may be due to frequent rainfall experienced towards the end of cropping season resulting in fungal diseases, hence causing a decrease in LA and LAI at maturity.

Keywords: cattle manure, poultry manure, smallholder farmer

INVESTIGATING CITRUS RIND PITTING SUSCEPTIBILITY ON SELECTED SWEET ORANGE (*Citrus sinensis*) CULTIVARS IN SOUTH AFRICA

Mothapo, M.J.[1], Mathaba, N.[1] and Mafeo, T.P.[2]

[1]ARC-ITSC, Private Bag X11208, Nelspruit, 1200; [2]University of Limpopo, Private Bag X1106, Sovenga, 0727

E-mail: mothapomj@arc.agric.za

INTRODUCTION

Citrus rind pitting is a physiological disorder that reduces the commercial value and marketability of most sweet orange citrus fruit (Maritz, 2000). The disorder is unpredictable and its incidence and severity varies season to season or even during the same season. Alférez et al. (2003) reported that citrus rind pitting may also occur prior to harvest at fruit ripening when temperature decreases and consequently air humidity is reduced. However, there is no research describing the effect of these environmental factors and their effect on the development of rind pitting in sweet oranges. The current study investigated the effect of environment on appearance of citrus rind disorders (pitting) on various sweet oranges, namely “Benny”, “Midknights” and “Lavelle”.

MATERIALS AND METHODS

Sweet orange citrus fruits were harvested from three different regions namely: Limpopo (Mahela Boedery), Mpumalanga (Schoeman Boerdery) and the Eastern Cape (Addo). After harvesting, fruits were dipped in Sporekill® solution and waxed with Avoshine® (Citrashine Pty Ltd). Fruits were packed and transported to the Postharvest Laboratory at the ARC-ITSC in Nelspruit. Fruits were re-packed into small boxes, each containing 30 fruits, with three replicates per treatment, and subjected to cold storage temperatures (-0.5 and 4.5°C) for 28 days. After 28 days of cold storage, fruits were evaluated for rind pitting, weight loss, firmness, Total soluble solids (TSS), Titratable Acidity (TA), Brix° and Electrical Conductivity (EC).

RESULTS AND DISCUSSION

Amongst all the studied cultivars, rind pitting was more severe after withdrawal from storage on “Benny” when compared with “Midknights” and “Lavelle” stored at -0.5°C. However, slight rind pitting was observed after withdrawal from storage on “Midknights” and “Lavelle” when compared with “Benny” under 4.5°C storage temperatures. Furthermore, no rind pitting has observed before storage on “Midknights” and “Lavelle” as compared with the “Benny” cultivar. Subsequently, a significant increase in weight loss percentage and firmness loss was observed in “Midknights”, “Lavelle”, and “Benny” stored under extended low temperatures (-0.5°C) when compared with the 4.5°C storage temperatures. In addition, fruits significantly lost firmness during shelf life in both -0.5 and 4.5°C storage temperatures, with no significant changes in internal quality parameters.

CONCLUSIONS

In conclusion, storage temperature (-0.5°C) had a significant effect on external quality of “Benny” cultivar, as the fruits were severely affected by rind pitting. However, the internal quality variables of the selections were not affected by -0.5°C storage temperature.

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Keywords: sweet orange fruit (*Citrus sinensis*), rind pitting disorder, storage temperature, firmness, weight loss percentage

DOES 72 YEARS OF BURNING, MULCHING AND FERTILIZATION AFFECT SOIL PHYSICO-CHEMICAL PROPERTIES IN A LONG-TERM SUGARCANE TRIAL?

Mthimkhulu, S.S.[1], Podwojewski, P.[2], Hughes, J.[1], Titshall, L.[3] and Van Antwerpen, R.[4]

[1]University of KwaZulu-Natal; [2]Institut de recherche pour le développement; 3Institute for Commercial Forestry Research; 4South African Sugarcane Research Institute

Email: Sandilemthimkhulus@gmail.com

INTRODUCTION

Sugarcane residue retention at harvest and fertilizer application affect soil structure. This study was carried-out in KwaZulu-Natal, South Africa to investigate changes in selected soil properties and their effect on aggregation induced by 72 years' of residue burning or mulching, with and without fertilizer application on a sugarcane trial arranged in a split-plot design with four replications.

MATERIALS AND METHODS

The main plot treatments were a) green cane harvesting with all residues mulched (M), b) cane burnt prior to harvest (no residue) with cane-tops left scattered on the plots (BS) and c) cane burnt prior to harvest with all cane-tops removed from the plots (BR). Split-plot treatments consisted of fertilized (F; applied annually as 5:1:5(46) at 670 kg ha-1) and unfertilized plots (F0). Soil samples for physico-chemical and aggregate stability analysis were collected at depths of 0 - 10 and 10 - 20 cm from 24 plots.

RESULTS AND DISCUSSION

In comparison with burning, mulching slightly increased total carbon (Ct), organic carbon (OC), mean weight diameter (MWD), total nitrogen (N), exchangeable potassium (K), exchangeable acidity and aluminum (Al) and decreased exchangeable sodium (Na), exchangeable calcium (Ca), exchangeable magnesium (Mg), effective cation exchange capacity and pH under fertilized treatments. Aggregate stability estimated by MWD, exchangeable cations, Al, exchangeable acidity and pH were significantly affected by fertilizer application. An increase in acidity and a decrease in MWD and exchangeable cations (Ca and Mg) on the fertilized plots were attributed to mining of nutrients by sugarcane and nitrification and subsequent leaching of the cations due to the presence of Al. The N, Ct and OC showed no differences across all the treatments.

CONCLUSIONS

Annual fertilizer applications may lead to soil structure deterioration under sugarcane regardless of the harvesting method practiced. Increasing additions of organic matter do not always correspond to an improvement of MWD and related soil properties.

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Keywords: fertilizer application, mean weight diameter, residues retention, sugarcane mulching and burning

EFFECT OF PLANTING DATE AND GENOTYPE ON FLOWER RETENTION AND POD ABORTION OF CHICKPEA (*Cicer arietinum*) CROP IN NORTH EASTERN PART OF SOUTH AFRICA.

Mubvuma, M. T.[1], Ogola, J. B. O.[1] and Mhizha, T[2]

[1]Department of Plant Production, University of Venda, Private Bag X5050, Thohoyandou 0950, South Africa; [2]Department of Physics, University of Zimbabwe. P. O. Box MP 167, Mt Pleasant Zimbabwe

Email: mubvumamagm@yahoo.co.uk

INTRODUCTION

Manipulation of sowing date and crop genotype to improve flower retention and reduce pod abortion is vital to increase chickpea yield under water limiting conditions in North-Eastern Region of South Africa. This study aimed at evaluating the effect of planting date on flower retention (FR) and pod abortion (PA) of five chickpea genotypes grown under different water regimes was conducted over two winter seasons (2014-2015) at the University of Venda, South Africa.

MATERIALS AND METHODS

In each season, two experiments were laid in a split plot design, with planting date (1 May (early planting), 14 May (Normal planting), and 28 May (late planting) as the main plots and five genotypes (ICCV 99010, Range 1, Range 3, Range 4 and Range 5) as sub-plots. Experiment I was well watered throughout the season but, experiment II was watered three times only at planting, flowering and pod formation. Measurements were done on FR, PA, seed weight, and pod weight (PW) and grain yield. FR was recorded by tagging all newly developed flowers per plant and count all tagged flowers that had transformed into pods successfully. Pod abortion was defined as all pods that were shed off from the plant or those which were not fertile Leport et al., (2006). Infertile pods consisted of small pods with small or no seed or large pods with no seed.Results were analysed by Genstat statistical software version 14. Treatment separation was by standard error of means at 5% significant level.

RESULTS AND DISCUSSION

The pattern of FR and PA among genotypes varied markedly between planting dates, water regime and seasons. Planting early to normal resulted in lower PA, higher FR, PW and grain yield comparable to late planting in all genotypes. FR and PD were more affected by planting date than by genotype regardless of water regime and growing season. PW and grain yield in all treatments was closely associated with FR and PA. PW from late planted crop was lower and had smaller and fewer seeds compared to early planted crop. A well-watered cultivar Range 3 planted early recorded significantly ($P< 0.05$) higher FR (91%) whilst cultivar Range 4 planted late in dryland had significantly higher PA (26%).

CONCLUSIONS

Planting date and genotype do affect FR, PA and also PW and grain yield.

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Keywords: chickpea, flower retention, genotype, planting date and, pod abortion

MACADAMIA GROWTH, YIELD AND QUALITY RESPONSE TO REDUCED WATER USE IN A SUBTROPICAL CLIMATE

Murovhi N.R. and Madzunye, E.I.

Agricultural Research Council, Levubu Research Farm, P.O. Box 247, Levubu, 0929

E-mail: romeo@arc.agric.za

INTRODUCTION

In South Africa as in many other parts of the world, the need for efficient use of limited water supplies is becoming increasingly important. It was projected that the demand for water will outstrip supply by the year 2025. The agricultural sector is among one of the highest consumer of water with 62% of water resources being utilized by this sector. Therefore, there is a need to establish ways to save water. One way to optimise water resources is to employ deficit irrigation (DI) strategy. DI involves supplying less than 100% crop potential evapotranspiration (ETc) throughout the year. The application of DI not only contributing to water saving but also to the reduction of greenhouse gas emissions, which can ease the negative effects of climate change on agricultural production. The objective of this study was to assess the response of macadamia growth, yield and quality to reduced water use.

MATERIALS AND METHODS

The study was carried out for two consecutive growing seasons (2013/14 and 2014/15) at the Levubu experimental farm of the Agricultural Research Council in Limpopo Province (South Africa). The orchard comprised 10-year-old macadamia trees (cv. Beaumont), at a spacing of 6 x 3 m. Two rows of macadamia trees, uniform in growth and in a good physiological condition as possible, were selected. Each row represented a treatment (i.e. Treatment A: Full irrigation (control) and Treatment B: Water stressed (reduced irrigation). The Full irrigation received 100% evapotranspiration (ETc), over the entire cropping season while reduced (Water stressed) treatment was irrigated at 50% ETc during the rest of the season. Tree stem diameter, yield (NIS) and nut quality were measured.

RESULTS AND DISCUSSION

The results of this investigation have shown no significant growth different between the water-stressed and 100% irrigation trees. Water-stressed trees had on average of 94 mm stem diameter while trees from 100% irrigation had 96 mm stem diameter. Treatment A produced 2.83 kg of nut per tree (1019 kg ha-1) when compared with treatment B which produced 2.75 kg of nuts per tree (1000 kg ha-1). Furthermore, there was no significant different between the two treatments in terms of nut quality. Fifty percent of water was saved by reducing the amount of irrigation water from 100% down to 50% in the water stressed treatment.

CONCLUSIONS

The study has established that reducing irrigation water by 50% under the subtropical climate did not have a negative impact on the growth as well as yield and quality of macadamia nut. However, further investigation is needed to assess the effect of water stress on the physiological parameters of the trees.

ACKNOWLEDGEMENTS

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Keywords: deficit irrigation, macadamia, quality, stress, water use, yield

GROWTH, BULB YIELD AND QUALITY RESPONSE OF SHORT-DAY ONION (*Allium cepa* L.) AS AFFECTED BY NITROGEN AND ORGANIC MANURE FERTILIZATION

Ncayiyana, M.[1], Maboko, M.M.[1] and Bertling, I.[2]

[1]Agricultural Research Council–Vegetable and Ornamental Plants (ARC-VOP), Private Bag X293, Pretoria, 0001;[2]Horticultural Science, University of KwaZulu-Natal, Private Bag X01, Pietermaritzburg, 3201

E-mail: ncayiyanam1@arc.agric.za

INTRODUCTION

Onions (*Allium cepa L*.) are the third most popular vegetable crop in South Africa, after potatoes and tomatoes. They are generally used to add flavour to dishes but are also widely used for medicinal purposes due to their antibacterial and antioxidant action (Michael and Smith, 2005). Onion is a high value and nutrient responsive crop, typically treated with high rates of nitrogen fertilizers to ensure acceptable yields and large bulb sizes (Drost *et al*., 2002). Excessive nitrogen applications, however, raise environmental concern. The objective of the study was to determine the effect of various nitrogen levels and different organic manures on growth, yield and storability of locally grown cultivars.

MATERIALS AND METHODS

Two field trials were conducted at the ARCouncil - Vegetable and Ornamental Plants Institute, Roodeplaat, during February and October 2014. The first experiment tested performance of four short-day onion cultivars ('Mata-Hari', 'Mikado', 'Cristalina' and 'Star5516') under six nitrogen (N) levels (0, 30, 60, 90, 120 and 180 kg N/ha). In the second experiment, poultry and cattle manure (at 10 t/ha), three levels of N (60, 120 and 180 kg /ha) and six combinations of manure and N levels were investigated. Both experiments were arranged in a randomised complete block design, with four replicates. The number of plants harvested per plot was determined, as well as yield and bulb size. Ten bulbs per treatment were selected and stored for 120 days. Moisture loss and disease development was determined weekly.

RESULTS AND DISCUSSION

In the first experiment, an increase in N level significantly increased total yields from 15.34 t/ha (0 kg N/ha) to 46.50 t/ha (180 kg N/ha); however, highest marketable yields were obtained at 120 kg N/ha (26.48 t/ha), with the highest unmarketable yield of 17.81 t/ha at 180 kg N/ha as a result of thick necks and extra-large bulbs. The application of 180 kg N/ha resulted in a 12% storage loss due to outer skin cracking, moisture loss and diseases incidence. 'Mata-Hari' had lower storage losses than 'Cristalina' and 'Mikado'. In the second experiment, no significant differences were observed on total bulb yield with poultry manure (39 t/ha) and the recommended nitrogen rate of 120 kg N/ha (43.91 t/ha). The application of the 60 kg/ha N combined with cattle manure improved marketable yield of onion.

CONCLUSIONS

Results indicate that high N application rates (above 120 kg/ha) reduce marketable yield and quality of onion. Poultry manure can be used as an alternative source of nitrogen.

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*Keywords: o*nion (*Allium cepa L*), nitrogen, poultry manure, cattle manure

CONSERVATION AGRICULTURE SYSTEM EFFECTS ON THE YIELD OF MAIZE

Nel, A.A.

ARC-Grain Crops Institute, Private bag X1251, Potchefstroom 2520

E-mail: nela@arc.agric.za

INTRODUCTION

It is well known that tillage based crop systems enhances soil erosion, reduces soil quality and is subsequently unsustainable. Conservation agriculture (CA) based crop systems on the other hand is sustainable. It consist of the practices of minimum soil disturbance, maintenance of a permanent or semi-permanent soil cover of crop residues and crop rotation. Scientifically generated knowledge and experience with maize production in CA systems under South African conditions, is lacking. The objective of this work was to determine how the yield of maize is affected by different CA systems on a loamy sand soil in the North-West province and to identify causes for possible yield differences.

MATERIALS AND METHODS

Maize was grown in a field trial on a Hutton soil with 16% clay in the Ventersdorp district. Treatments were maize in monoculture on 25 cm deep ploughed soil (control) and five CA crop systems namely, maize in monoculture, maize following a legume or sunflower, and maize following millet and a legume or sunflower, all in no-till. No-tillage consisted of a soil disturbance of 10 cm deep on 90 cm spaced rows during planting. Fertilizer, herbicides, pesticides and the cultivars used, were according to the best recommendations for the area. The completely randomized block design trial with four replicates started in 2009/10.

RESULTS AND DISCUSSION

The yield of maize was affected by crop system in four and three of the six years where legume and sunflower crops were respectively included in the rotation system. During these seasons when mid-summer droughts occurred, maize yields of the CA systems were between 54 and 170% higher compared to the conventional system. The CA systems organic carbon content of the upper 50 mm were, after 6 years, between 42 and 84% higher compared to the conventional system while water infiltration rates of the CA systems were up to five times higher than that of the conventional tillage system.

CONCLUSIONS

Maize yield was improved by CA when compared to the conventional tillage system during years with a mid-summer drought. The improved quality of the upper soil layer of CA soils explains the yield differences.

ACKNOWLEDGEMENT

Financial support from the Maize Trust is gratefully acknowledged.

Keywords: conservation agriculture, maize, soil quality, yield

THE EFFECT OF SHADE NET ON PHYSIOLOGY, PHENOLOGY, FRUIT PRODUCTION AND QUALITY OF 'Nadorcott' MANDARIN

Ngwamba, I.F.[1], Roets, N.J.R.[2], Ngcobo, M.E.K.[2] and Tesfay, S.Z[1]

[1]University of KwaZulu-Natal, Private Bag/Scottville, 3209, South Africa; [2]Agricultural Research Council – Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, South Africa

E-mail: NgwambaI@arc.agric.za

INTRODUCTION

Shade nets are increasingly used by South African citrus growers to protect trees against excessive solar radiation and hail. However, the physiological responses of certain citrus cultivars, especially mandarins, under a shade net environment are still largely unknown. The aim of the experiment was to investigate the effect of low shade intensity white shade nets on fruit production, quality, tree physiology and phenology of 'Nadorcott' mandarins.

MATERIALS AND METHODS

The current study was carried out in the Nelspruit area on nine year old 'Nadorcott' mandarin trees. Two reference blocks were used, one block was covered with low intensity white shade net (20%) and the other block without shade net (control). The trial layout was a pseudo-random block design, consisting of six replicates. Orchard climate, physiology (transpiration, stomatal conductance, photosynthesis), tree phenology (leaf chlorophyll content, leaf thickness, leaf area and flowering), fruit quality (rind thickness, fruit firmness, weight, TSS/TA, vitamin C content, rind lycopene, juice and rind lycopene content), yield and fruit size parameters were measured. Data was analyzed using GenStat.

RESULTS AND DISCUSSION

Orchard micro-climate was significantly affected by shade net. Night temperatures were higher, while day temperatures were slightly lower under the net. Relative humidity and dew point were also increased by the shade net. Transpiration and stomatal conductance for both the shade net and control treatments were similar in the morning (9:00), but during midday (12:00) the stomatal conductance and transpiration rate of trees under the net were significantly higher. The rate of photosynthesis was also higher. This implied that shade net increased tree water usage. Trees under the net displayed adaptations to the lower light environment by having significantly higher leaf areas and leaf chlorophyll content. Flower intensity was not significantly affected by shade netting, but trees under shade net yielded significantly more leafy inflorescences than open trees. Percentages of vegetative flush and dormant buds were not affected by shade netting. With regard to fruit quality, shade net had no significant effect on rind thickness and fruit firmness, but the TSS/TA-ratio was higher for fruit under the net. Shade net had no effect on yield but resulted in increased fruit size.

CONCLUSIONS

Results from the study have provided useful data for measuring differences in terms of interactions of environmental variation (temperature, light and humidity) and white shade net relative to plant responses. Data collection continues for fruit set and retention, fruit growth, flush vigour and physiological measurements.

Keywords: transpiration, orchard micro-climate, flowering, stomatal conducta

THE USE OF MULTIPLEX PCR FOR RAPID DETECTION OF TARGET-SITE RESISTANCE MUTATION

Nienaber, H. and Sydenham, S.L.

ARC – Small Grain Institute, an Institute of the Field Crops Division, Private Bag X29, Bethlehem, 9700

E-mail: deweth@arc.agric.za

INTRODUCTION

Ryegrass resistance in South Africa is a problematic situation for producers for which few practical and economical solutions are available. Normally detection of resistance in ryegrass is done in the glasshouse, although this is very effective, it is a time consuming process. In the last few seasons researchers from ARC-SGI optimised currently available mutation markers. These 12 mutation markers were done separately, which lengthened the marker screening process. Researchers then decided to develop a multiplex PCR reaction as to overcome this restraint. To our knowledge little published evidence could be found of the successful use of multiplex PCR to detect multiple target-site mutations in a single reaction.

MATERIAL AND METHODS

Previously, target-site resistance in ryegrass biotypes was detected by using DNA, extracted from bulked leaf material. ALS- and ACCase target-site mutation CAPS-PCR markers were then used to identify specific target-site mutations present in the different biotypes. Based on this genotypic data, which proved to be very effective on South African ryegrass biotypes, a decision was made to try and streamline the screening process further. Since the final objective of this project is to develop this into a diagnostic service, cost saving needed to be taken into consideration. From literature, a series of multiplex reactions were designed and optimised to be able to detect several target-site mutations in a single reaction. The multiplex allows for the detection of the most prominent target-site mutations in current South African ryegrass populations (Pro-197, Trp-574 and Asp-2078) with one reaction. This is possible because their targeted PCR fragments differ in size. The use of the multiplex thus decrease the cost involved in the screening process and is also a faster process.

RESULTS AND DISCUSSION

Several trial multiplex reactions were conducted on different South African ryegrass populations and the results correlated with previously validated data from the normal PCR genotypic screening that was conducted. This method proves that there is potential to develop further multiplex combinations to detect other target-site mutations as well. Originally target-site resistance was only detected in the Western Cape. Subsequently target-site resistance has, through this service, no also been detected in the Eastern Cape, an onion field in Barrydale and in the irrigation areas of the Northern Cape.

CONCLUSIONS

This methodology has also proved to be successful in other grass weed species. The detection of target-site resistance in several provinces, is the first validation of the possible vectors, being contracted implements. Other factors, like pollen-mediated gene flow, may also contribute to the spread of the resistance. By using the multiplex, researchers will however be able to detect target-site resistance quickly and efficiently in any province.

Keywords: muliplex, PCR, ryegrass, target-site resistance

PLANT POPULATION ANALYSIS OF THREE SPECIAL TEA (*Monsonia burkeana*) HABITATS

Nnzeru, L.R., Ntushelo, K. and Mudau, F.N.

Department of Agriculture and Animal Health, University of South Africa, Private Bag X6, Science Campus, Florida, 1710

E-mail: Lnnzeru@gmail.com

INTRODUCTION

Special tea (*Monsonia burkeana*) is native to Southern Africa predominantly in South Africa, Botswana, Mozambique, Lesotho, Swaziland, and Madagascar. *M. burkeanais* a prominent medicinal plant which is used to cure minor ailments. A partial plant population analysis of special tea in three habitats, namely, Zebediela, Chuenespoort and Rietondale was conducted for differences in plant traits, fat content, protein content and secondary metabolite profiles of representative plants from the three selected populations.

MATERIAL AND METHODS

The plant population analysis, a solitary quadrant about 4000 square meters, was used to collect the data in each of the three localities chosen for the study. In each locality, sixty plants were collected. Stem diameter, plant height and number of leaves per plant were determined to assess phenetic differences of the plants from the supposedly environmentally different sites. Additional parameters measured were fat and protein content of the plants from three plants per locality. Secondary metabolite profiles of three plants per locality were determined by 1H NMR analysis. In each locality three representative soil samples were collected as well as climatic data, to undertake a correlation study between differences in soil fractions, rainfall and temperature data. Weather data was collected three months prior the field survey.

RESULTS AND DISCUSSION

Analysis of variance of data on plant height, stem diameter and number of leaves per plant showed significant differences between the different localities. Similar findings were obtained with the data on protein and fat content of the representative plants. Principal component analysis of 1H NMR data revealed minor differences between the populations. Rainfall and temperature data for the period three months before the sampling indicated that Rietiondale received more rainfall (130mm) compared to Chuenespoort and Zebediela which received rainfall of 70mm. The temperature for Rietondale was higher (28.95°C) than Chuenespoort and Zebediela (26.9°C). These climatic differences influenced phenetics between the special tea populations. The composition of soil fractions for the different sites differed and this also influenced the plant traits measured.

CONCLUSIONS

Vegetative characteristics of *M. burkeana* from the sites sampled were different, probably due to the differences in the environmental factors. Further differences were discovered in the protein and fat content of representative plants as well as slight differences in secondary metabolite profiles.

ACKNOWLEDGEMENTS

This study was funded by the National Research Foundation. We are also thankful to Mr. Phumudzo Tshikhudo, Mr. Livhuwani Nemutandani and Mr. Mpho Nematswerani for assistance during the field survey. Ms. Kemello Mathe assisted with NMR analysis.

Keywords: plant population analysis, *Monsonia burkeana*, 1H NMR analysis

SECONDARY TREE FRUIT GENE-BANKS: ARE THEY IMPORTANT?

North, M. and Sokomani, B.

Agricultural Research Council, Infruitec-Nietvoorbij, Stellenbosch, 7600

E-mail: northm@arc.agric.za

INTRODUCTION

The Agricultural Research Council (ARC) is mandated by the South African (SA) government to maintain and manage genetic resources important to SA agriculture as National Assets. ARC Infruitec-Nietvoorbij is responsible for managing nine genetic resource projects including deciduous tree fruit crops (Bester et al., 2013). The SA deciduous fruit industry employs more than 400 000 workers on a total area of 75 000 ha mostly under apples, table grapes, pears, peaches, plums and apricots and is one of the world's leading export countries. The future success of this industry may depend on genetic resources for breeding new more competitive cultivars. Secondary tree fruit crops such as almond, berry fruit, fig, kiwifruit, pecan and pomegranate offer alternative sources of income for both commercial and rural farmers and diversification into more marginal non-traditional fruit farming areas. Gene-banks may be used for breeding programs and student instruction on management practices. We report on the progress made by ARC Infruitec-Nietvoorbij in developing secondary fruit gene-banks.

MATERIALS AND METHODS

The Secondary Tree Fruit Gene-bank was initiated in 2013 as part of the ARC Infruitec-Nietvoorbij gene-bank project. A mandate from DAFF for an edible fig repository led to the preparation of a site at the Robertson Research Farm. Plant material from various sources was collected by SAPO during 2014 and propagated. Blueberries, cherry, guava, kiwifruit and pomegranate accessions and some indigenous fruit kinds have also been identified.

RESULTS AND DISCUSSION

Accessions of fig (31), pomegranate (10), blueberry (16) and kiwi-fruit (23) were established during 2014/15 at Robertson and cherry cultivars (7) at the Elgin Research Farm. Fig growth has been recorded and DNA fingerprinting started.

CONCLUSIONS

The secondary tree fruit gene-banks serve as a repository for maintaining, characterising, instructing and distributing potentially important plant genetic material.

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ACKNOWLEDGEMENTS

Funding from the DST and DAFF is greatly appreciated.

Keywords: crop diversification, fig accessions, genetic resources, plant breeding

EFFECT OF PRUNING TIME ON FLOWER DIFFERENTIATION, YIELD AND FRUIT SIZE DISTRIBUTION OF AVOCADO GROWING ON DIFFERENT CLIMATIC AREAS

Novela, P. and Nzanza, B.

ZZ2 (Bertie van Zyl), P.O. Box 19, Mooketsi, 0825

E-mail: preciousnovela@gmail.com

INTRODUCTION

Avocado (*Persea americana*) has its origins in the Central America and Mexico, where it grows naturally as a rainforest species. As such, it still retains the growth habit of a rainforest tree and shows a distinct bias towards strong vegetative growth. This situation is exacerbated by the appearance of the summer vegetative flush, which occurs when the fruit have attained 10-40% of their final mass. The competition arising from these flushes may cause 45-60% of the set fruit to drop, necessitating summer pruning and the use of plant growth regulators to minimize negative impact of the flush. However, timing of pruning plays an important role since it influences the amount of regrowth during flowering and fruit set. Therefore, this study aims to establish the optimum pruning time to improve avocado yields and fruits size.

MATERIALS AND METHODS

A three year field study was conducted at ZZ2 (Bertie van Zyl farms) commercial Hass and Fuerte orchards on two sites viz, Mooketsi and Olyfberg farms, Limpopo. The Mooketsi area is characterized by an annual rainfall of < 650mm with the maximum and minimum temperature of 26.9 and 15°C, respectively. While the Oylfberg area is characterized by an annual rainfall of >1000mm, with a maximum and minimum temperatures of 22.5 and 11°C, respectively. Light pruning (tree shaving to control summer flush) was applied at different times viz: early pruning (first week of October), mid–pruning (third week of October), late (first week of November) and double pruning (first week of October and two months after the first pruning). Trees were pruned at the same time every year from 2012 to 2014. Flower intensity rating was done each year during the flowering period (at full bloom). Yield and fruit size distribution were also determined during harvest.

RESULTS AND DISCUSSION

Pruning time had a significant effect on the percentage of Hass flowers at Olyberg farm during 2014 season, while there was no treatment effect on both cultivars at Mooketsi area through the three seasons. Double pruning resulted in lower reproductive shoots while there was no difference between early, mid and late pruning. Hass yield was reduced by double pruning through the three seasons at Olyfberg farm, while there was a slight decrease on both cultivars at Mooketsi area on double pruned treatments. Pruning time had an effect on fruit size of Fuerte cultivar on both sites during the 2013 and 2014 season. There was an increase in proportion of larger fruits (notable class 1 fruits) corresponding with decreases in the proportion of smaller fruit (class 4). However, the treatments had no effect on fruit size distribution of the Hass cultivar on both sites.

CONCLUSIONS

Study showed that pruning time has potential to influence the avocado tree productivity. Double pruning reduced the flowering intensity and yield. However, there were no significant differences between early, mid and late pruning, resulting in wide window for pruning without affecting yields.

Keywords: avocado, flowering, fruit size, pruning time, yield

EFFECT OF SPECTRAL LIGHT QUALITY UNDER THE PHOTO-SELECTIVE SHADE NETS ON LETTUCE PHYTOCHEMICALS AT HARVEST AND AFTER POSTHARVEST STORAGE

Ntsoane, M.L., Sivakumar, D. and Soundy, P.

Tshwane University of Technology, Department of Crop Sciences, P/Bag X680, 0001

Email: ntsoanelucia@gmail.com

INTRODUCTION

Light intensity generally affects phytochemical concentration and accumulation in plants (Lin et al., 2013:87). Light quality within shade nets can make a substantial difference, therefore the ChromatiNet® has been developed to not only reflect special optical properties that allow the modification of light but also modifying the spectral light composition with different light scattering properties. Storage conditions after harvest may also have a large impact on the phytochemicals compounds. Lettuce (*Lactuca sativa* L.) is the most important vegetable crop consumed as salad, although is a perishable crop. Meanwhile, consumers demand high quality lettuce with significant nutritional value for a healthy diet. The quality of lettuce therefore can be improved by the manipulation of light quality during production. In the present study, the influence of photo-selective nets on lettuce phytochemicals at harvest and after postharvest storage was investigated.

MATERIAL AND METHODS

This study was conducted during the 2012 winter growing season at the Tshwane University of Technology (TUT) Experimental Farm, Pretoria North. Three leafy lettuce cultivars (Ashbrook, Aquarell and Exbury) were tested under photo-selective knitted coloured shade nets (Red, Pearl, Yellow & Black) using a randomized complete block design with three replications assigned to each of the coloured shade nets. The total and scattered light spectra were measured with a spectroradiometer. Air temperature (AT) and relative humidity (RH) were also recorded using Tinytag T/RH data loggers.Fresh and postharvest quality traits (ascorbic acid (AA), antioxidant scavenging activity (ASA), phenols, flavonoids, anthocyanin, chlorophyll a & b and ß-carotene) were measured.

RESULTS AND DISCUSSION

Lettuce cultivars produced under the black net showed higher chlorophyll, AA, phenolics, ß-carotene, anthocyanin and ASA at harvest. A general decline in phytochemical composition was noted after 7 d postharvest storage. Cv. Exbury was rich in ascorbic acid, anthocyanin, phenols, flavonoids and ASA at harvest and after postharvest storage. Although lettuce production under the black nets showed higher retention of phenols and ASA after postharvest storage, pearl nets showed less weight loss, higher ascorbic acid content, moderate retention of phenols and antioxidant activity after postharvest storage.

CONCLUSIONS

Our results confirm that (a) light quality and quantity (PAR) influences the production of phytochemicals, (b) cultivars Exbury and Ashbrook can be recommended for mixed salad packs in terms of phytochemical quality; and (c) overall pearl net can be recommended to produce all three lettuce cultivars to maintain the overall postharvest quality.

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Keywords: lettuce, photo-selective, phytochemicals, quality, spectral light

WATER PRODUCTIVITY OF TRADITIONAL LEAFY VEGETABLES

Nyathi, M.K.[1], Fessehazion, M.K.[1], Du Plooy, I.[1], Molopo, K.[1] and Van Halsema, G.E.[2]

[1]Agricultural Research Council-Vegetable and Ornamental Plant Institute; [2]Water Resource Management Group, Wageningen University, Droevendaalsesteeg 3a, 6708 PB, Wageningen, The Netherlands

E-mail: melvinnyathi@702mail.co.za

INTRODUCTION

The agricultural sector is faced with a challenge to produce more food from less water for a population that is growing rapidly, expected to reach 58.1 million in South Africa by the year 2030 (Moomaw *et al*., 2012). This can be achieved by maximizing water productivity (WP) of crops. Traditional leafy vegetables (TLVs) are the main sources of micronutrients for resource poor households. However, there is limited information on their water use and water productivity. The objective of this study was to assess water productivity of traditional leafy vegetables using *Amaranthus cruentus*, *Cleome gynandra*, and *Ipomoea batatas* var. *Bophelo* as test crops.

MATERIALS AND METHODS

Experiments were conducted under a rain-shelter during the 2013/14 and 2014/15 seasons, with two factors: 4 crops (*Amaranthus cruentus*, *Cleome gynandra*, *Ipomoea batata*s *var. Bophelo,* and *Beta vulgaris var. cicla*) and 3 irrigation levels (irrigating back to field capacity when 30% (W1), 50% (W2), and 80% (W3) of plant available water is depleted). Treatments were replicated three times and the trial laid out as a randomized complete block design. Dry biomass and soil water content were measured. Water productivity was calculated as biomass per amount of actual evapotranspiration. A two way analysis of variance was conducted using GenStat version 14 (VSN, UK) to evaluate the interaction effect of crops and irrigation on water productivity of TLVs. Means were separated using the Tukey HSD test at 5% confidence interval.

RESULTS AND DISCUSSION

There was an interaction effect between crops and water for both seasons ($p = 0.05$). Water productivity for traditional leafy vegetables ranged from 6 – 34 kg ha-1 mm-1 for 2013/14 season and from 11.3 – 29 kg ha-1 mm-1 for 2014/15 season, whereas for Swisschard; it ranged from 16 - 23 kg ha-1 mm-1 for 2013/14 season and from 16 - 22.5 kg ha-1 mm-1 for 2014/15 season. The highest water productivity was observed from the combination of *Cleome gynandra* and W2 treatments.

CONCLUSIONS

This suggests that traditional leafy vegetables are comparative to Swisschard. Crop water productivity can be increased significantly if irrigation is reduced and crop water deficit is induced. These results can be used to schedule irrigation for these crops.

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Keywords: water productivity; traditional leafy vegetables; water scarcity; deficit irrigation

EFFECT OF GLYPHOSATE APPLICATION AT DIFFERENT GROWTH STAGES ON GLYPHOSATE TOLERANT MAIZE HYBRIDS

Odendaal, H.B.[1], Hugo, E.[2] and Van den Berg, J.[1]

[1]Unit for Environmental Sciences and Management, Private bag X6001, North-West University, Potchefstroom, 2531;[2]ARC-Grain Crops Institute, Private bag X1251, Potchefstroom, 2520

E-mail: HugoE@arc.agric.za

INTRODUCTION

Glyphosate applications expanded significantly with the trend to minimise tillage in crop production and the introduction of transgenic Roundup Ready (RR) crops. During 2002 the patent rights expired on glyphosate and the price of herbicides containing glyphosate decreased considerably, promoting the planting of RR crops and application of glyphosate. The aim of this study was to evaluate the effect of glyphosate on plant growth parameters of RR maize.

MATERIALS AND METHODS

Two field trials were conducted during two seasons (2013 to 2015) where the effect of glyphosate products and timing of application were determined on five glyphosate resistant maize cultivars (DKC73-76R, DKC78-35R, DKC80-30R, KKS4479R, BG5685RR). Glyphosate (Roundup PowerMax™, 540g ae l-1) and a generic glyphosate (Slash Plus, 540 g ae l-1) were applied at 2 l ha-1 in both trials. Glyphosate applications were done at four different maize growth stages i.e. at V4, V4 and V6 (V4/V6), V6 and V8. Control treatments for each cultivar were included (no glyphosate applied) and weeding was done by hand. The trial layout was a strip-split design and all treatments were replicated three times. Plant height and shoot mass were sampled before each herbicide application and again seven days after glyphosate applications. Maize ears were hand harvested at physiological maturity, threshed and weighed to determine kernel mass.

RESULTS

During 2013/14 the highest reduction in plant height (10%) was recorded in treatments in which glyphosate was applied at the V6 growth stage. Plant height was reduced (5%) where glyphosate was applied at V8 during the 2014/15 season. Shoot mass was reduced with 20% at V8 during the 2014/15 season, across cultivars. Yield was reduced during 2013/14 in all growth stages and differed significantly from control treatments where glyphosate was applied at V6 (20%) across cultivars. The highest reduction of plant height was less than 7% when generic glyphosate was applied at V4 and V4/V6 for KKS4479R during 2013/14. Shoot reduction of 27% was recorded for DKC78-35R during the 2013/14 season at V6 application. KSS4479R showed a reduction of 14% when generic glyphosate was applied at V4/V6 and V6 during 2014/15 season. During the 2014/15 season BG5685RR yield was reduced with >10% when generic glyphosate was applied at V4 and V4/V6.

CONCLUSIONS

Although reductions in plant height, dry mass and yield was recorded in treatments where glyphosate and generic glyphosate was applied at different growth stages of maize, tendencies were not consistent between seasons. Results from this study indicated that certain glyphosate-resistant maize cultivars differed significantly in reaction to glyphosate applications.

ACKNOWLEDGEMENT

Financial support from the Maize Trust is gratefully acknowledged.

Keywords: cultivars, glyphosate, generic glyphosate, maize, yield

COST BENEFIT ANALYSIS OF MUNICIPAL SLUDGE AS LOW-GRADE NUTRIENT SOURCE: A CASE STUDY FROM SOUTH AFRICA

ZM Ogbazghi[1], EH Tesfamariam[1], YF Gebrehiwot[2], JG Annandale[1]

[1]University of Pretoria, Department of Plant Production and Soil Science, P.Bag: X20, Hatfield 0028, Pretoria, South Africa;
[2]Department of Agriculture, Forestry and Fisheries, Private Bag: X250, Arcadia 0001, Pretoria, South Africa

E-mail: zekarias.ogbazghi@tuks.co.za

INTRODUCTION

Sewage sludge has economic value as a low grade fertilizer for it consists of appreciable amounts of the primary macro nutrients (N and P), secondary primary nutrients (Ca, Mg, and S), as well as micronutrients (Zn, Fe, Mn, Cu, B, Mo, and Cl). When using sludge as fertilizer, the economic aspect should be taken into account because of the associated transporting and spreading costs. To promote the beneficial agricultural use of municipal sludge as a low grade source of the primary macro nutrients, the following specific objectives are identified: a) to investigate the economic feasibility of using sludge as a substitute or complementary source of plant nutrients to commercial inorganic fertilizer; b) to estimate the maximum economic distance that a sludge can be transported as a fertilizer; and c) to test the economic feasibility of selling sludge using commercial inorganic fertilizer as bench mark.

MATERIALS AND METHODS

The cost benefit analyses for sludge was conducted using commercial inorganic fertilizer as benchmark and certain assumptions were done to simplify economics processes. It consists of three interrelated sections: 1) transport related information, 2) commercial fertilizer price related information, and 3) Cost benefit analyses section.

RESULTS AND DISCUSSION

The plant-available nutrient content of this sewage sludge has a potential annual value of R200-300 per ton, based on a commercial inorganic fertilizer price of R18.6/kg N and 3% of sludge N content. The results also showed that the total cost of commercial fertilizer was higher 3-4 times as compared to the total cost of sludge across all sites and agro-ecological zones in South Africa. However its utilization is poor because of the associated transportation cost. This study find out, it was not economical feasible to transport air dried sludge with 3 % N content at the distances of higher than 8 km in the arid and semi-arid regions and 81 km in the humid regions between the waste water care work and the farm. The maximum selling cost of sludge was lower by 30-40% across all sites as compared to the prices of commercial fertilizers.

CONCLUSIONS

Therefore, it is economical wise for farmers to haul and spread sludge as compared to the current costs of commercial inorganic fertilizers.

ACKNOWLEDGEMENTS

The authors would like to thank the Water Research Commission (WRC) and East Rand Water Care Works (ERWAT) for funding.

Keywords: assumptions, cost-benefit analyses, inorganic fertilizer, municipal sludge

WATERMELON (*Citrullus lanatus*) AS LIVE MULCH FOR CLIMATIC CHANGE ADAPTATION IN AFRICAN HUMID TROPICS' CROPPING SYSTEM

Ojo, D.

Box 4078, university of Ibadan post office, Ibadan, Nigeria

E-mail: drdavidojo@gmail.com

INTRODUCTION

In-situ live mulch crops such as watermelon (*Citrullus lanatus*) can suppress weed populations resulting in reduced reliance on herbicides, reduced soil temperature, improved soil moisture, and additional income from sale of produce harvested in mixed cropping systems in sub Saharan Africa. The present investigations therefore seek to quantify the impact of various densities of in-situ watermelon live mulch on weed control, yield potential and climatic change adaptation capability strategy in the humid tropics amaranth production system.

METHODS AND MATERIALS

Treatments comprised three sowing densities of watermelon: 1.5 x 0.45m; 1.5 x 0.90m; 1.5 x 1.50m. Grain amaranth as an intercrop was transplanted at 0.75 x 0.75 m spacing. There was a control plot left bare without cropping and a check plot with only grain amaranth forming five treatments in each of five replicates in an RCBD design. Weeding was at 3 week intervals commencing 3 weeks after planting (WAP) of watermelon. Naturally occurring weed population was used.

RESULTS AND DISCUSSION

Averaged over the two consecutive croppings, amaranth grain and watermelon fruit yields were highest at 1.5 x 0.90 m watermelon plant spacing. All mulch densities transmitted less PPFD relative to the control. Soil moisture content was significantly greater in the live mulch treatments compared to the bare soil.

CONCLUSIONS

Our research demonstrated that live mulch suppress weeds, had greater light extinction, and lower diurnal soil temperature amplitude that account for usefulness of live mulch in cropping systems and we believe offer opportunities in adaptation of agricultural production systems under climate change scenarios.

Keywords: watermelon, cropping system, climate change, humid tropics, temperature

LEAF MORPHOLOGICAL CHARACTERISTICS DO NOT CONFER GLYPHOSATE RESISTANCE TO *Conyza bonariensis* (L.) Cronq.

Okumu, M.N., Robbertse, P.J., Vorster, B.J. and Reinhardt, C.F.

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

Email: u13315049@tuks.co.za

INTRODUCTION

Conyza bonariensis has been reported to have evolved resistance to glyphosate in South African biotypes. Reduced uptake and absorption of glyphosate has been reported to be a mechanism of herbicide resistance, especially in weeds with unique morphological characteristics like overproduction of cuticular wax, dense trichomes and thick cuticles. These leaf morphological characteristics tend to resist wetting by foliar-applied post-emergence herbicides, and absorption thereof, including glyphosate. The aim of this study was to use microscopy techniques to examine leaf morphological characteristics as possible mechanisms of resistance to glyphosate in *Conyza bonariensis*.

MATERIAL AND METHODS

Seeds of selected *Conyza bonariensis* populations that had previously been screened for glyphosate tolerance were established in the glasshouse under controlled temperature conditions. Two resistant biotypes from Swellendam and Piketberg, and two susceptible ones from George and Fauresmith were used in the experiment. Plants were watered and fertilized as required. At the 4-6 leaf stage, five leaves per plant per biotype were sampled and prepared for viewing under the microscope. For the experiment on trichome density, trichomes on abaxial and adaxial surfaces were counted under a light microscope. Transmission electron microscopy photographs were used for estimating cuticle thickness. Wax was extracted in chloroform and weighed to determine amount of wax per leaf area and biomass for comparison across the populations. All experiments were arranged in a completely randomized design with 5 replicates, data were subjected to ANOVA using SAS statistical package and means separated using Turkey's HSD test.

RESULTS AND DISCUSSION

The interaction Population X Leaf surface was not significant in the trichome density experiment. The same observation was made in amount of wax and cuticle thickness in the tested biotypes. These results show that leaf morphological characteristics of trichome density, leaf wax and cuticle thickness are not likely mechanisms of resistance of these *C. bonariensis* biotypes to glyphosate.

CONCLUSIONS

Leaf morphological characteristics of *Conyza bonariensis* from South Africa probably do not confer resistance of the weed to glyphosate. Research is continuing on other plant mechanisms that could explain glyphosate resistance in certain provenances of this weed.

Keywords: Conyza bonariensis, glyphosate, leaf, morphology, resistance

PERFORMANCE OF SUBSURFACE DRIP IRRIGATION SYSTEMS: RESULTS FROM A SUGAR INDUSTRY SURVEY

Olivier, F.C.[1], Jumman, A.[1] and Stevens, J.[2]

[1]South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe, 4300; [2]University of Pretoria, Private Bag X20, Hatfield, 0028

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

INTRODUCTION

Smaller profit margins caused by dramatic increases in production costs (labour, diesel, fertiliser and electricity) have forced farmers to look at alternative and more efficient ways of growing sugarcane. As a result, the area under sub-surface drip irrigation (SDI) has steadily increased over the past few years. Conflicting reports, however, have been received with regards to the performance of SDI systems. These include clogging of emitters and poor germination and ratoon establishment. In order to identify potential constraints and gauge the current performance of SDI systems (design, maintenance and management), an industry wide farmer survey was conducted. Outcomes will be used to develop best management practice guidelines.

MATERIALS AND METHODS

Twenty-two farmers with SDI systems, covering approximately 6 000 ha, were identified by local extension specialists in the irrigated sugarcane regions (Malelane, Komatipoort, Pongola, Umfolozi, Northern Zululand and Swaziland). Each of these farmers were personally visited and asked to complete a comprehensive questionnaire. The questionnaire covered aspects such as general farm information, system design (installation depth, emitter discharge rate and spacing within the lateral), maintenance (flushing and chemical cleaning) and irrigation management strategy (frequency and duration). An Excel spreadsheet was used to analyze all data.

RESULTS AND DISCUSSION

Based on the survey data, 86 % of SDI systems in the sugarcane industry were designed by accredited designers. Hydraulic considerations however received more attention than attempts to match design to soil type and infiltration rate. Occasional clogging of filters (algae) and emitters (algae and roots) did occur, but was limited by regular flushing and chemical treatment (peroxide, chlorine and Treflan). Poor germination was reported by 19 % of farmers, but was resolved by using dual irrigation systems and/or avoiding planting later than September/ October, when temperatures were excessively high. Only 13 % of farmers accurately schedule irrigation, the rest follow a fixed Winter/Summer irrigation schedule without any measurement. Farmers indicated high initial capital cost, high post-harvest maintenance (damage by vehicles) and the need for additional management time as main disadvantages. Energy saving, less labour and yield gains were highlighted as advantages.

CONCLUSIONS

SDI systems generally perform well compared to other irrigation systems. Improvements in design and management are possible by placing more emphasis on soil type during design and by developing clear maintenance and irrigation scheduling guidelines.

Keywords: design, management, maintenance, subsurface drip irrigation, sugarcane, questionnaire

THE EFFECT OF UNICONAZOL ON GROWTH, PRODUCTION AND QUALITY IN MACADAMIA

Penter, M.G., Nkwana, E.M. and Nxundu, K.Y.

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

E-mail: mark@arc.agric.za

INTRODUCTION

In the historically established tree crops, apples for example, growers can rely on dwarfing rootstocks to reduce scion vigour and increase productivity. This is not currently an option for macadamias which are still closely related to the wild type, and yet to undergo improvement through breeding and selection. Macadamia rootstock selection is based on scion compatibility and rootstock vigour in the nursery – rootstocks which reach grafting size the quickest are favoured. While the macadamia industry does not yet have access to dwarfing rootstocks, there is still the option of controlling tree vigour by means of growth inhibitors. The use of growth inhibitor uniconazol has been widely investigated in another subtropical crop, namely avocado, where it not only inhibited growth but also increased yields and altered fruit shape. With this in mind a series of initial trials in macadamia have been initiated to determine the response of the crop to this product.

MATERIALS AND METHODS

Foliar applications of a 1% uniconazol solution, with 2% urea phosphate added to improve uptake, was applied by means of a mistblower as a full cover spray to four varieties, namely 695, 772, 788 and 816. Vegetative growth, yield and quality parameters, including kernel recovery, kernel size and shell thickness, were determined. In a separate trial, uniconazol was applied as a soil drench (7ml in 20l water per tree) to the 695 cultivar. Again, vegetative growth, yield and kernel quality parameters were monitored.

RESULTS AND DISCUSSION

The foliar applications of uniconazol between anthesis and early fruit development had no significant effect on vegetative growth of flushes present at the time of application. These applications, however, had a considerable effect on kernel recovery. This was primarily due to an increase in kernel size, but in some cultivars there was also a decrease in shell weight due to a thinner shell. This is significant in that thinner shells require less force to crack and may result in fewer damaged kernels. In the case of the soil drench, significant reductions in flush length were observed – up to a 50% decrease in growth. This was accompanied by a change in leaf morphology and size. In some instances this reduction may have been excessive in that it resulted in overly compact growth, with terminal leaves shading those below them. The soil application also had a significant residual effect, with flushes produced eighteen months after the application still showing marked reductions in extension. Whether this application method will result in residues in the nut kernel will need to be established. Unlike the foliar applications, the soil drench had no significant effect on nut size or kernel recovery. Both the soil and foliar applications resulted in increased yields, although this effect was more pronounced in the case of the foliar applications.

CONCLUSIONS

Uniconazol is a growth inhibitor registered for use in a number of tree crops, but not in macadamia. In these trials it was shown that direct fruit/foliar applications have little effect on vegetative growth, but alter certain fruit characteristics, specifically kernel recovery and kernel size, in a positive way. While a soil drench had little effect on fruit characteristics, it was a potent inhibitor of vegetative growth, still having a marked effect on flushes produced eighteen months after application. Both application methods resulted in yield increases.

Keywords: Macadamia, uniconazol, growth inhibition, nut quality

SOIL AND VEGETATION CHARACTER ALONG THE TOPOGRAPHICAL GRADIENTS IN NORTHERN KZN

Pretorius, M.L.[1, 2] and Van Huyssteen, C.W.[2]

[1]Department of Soil, Crop, or Climate Sciences, University of the Free State, Bloemfontein
[2]Applied Behavioural Ecology and Ecosystem Research Unit, UNISA, Johannesburg

Email: Pretorius.lulu@gmail.com

INTRODUCTION

Although the Maputaland Coastal Plain (MCP) is regarded as part of one of Africa's most important biodiversity hotspots and centres of endemism and is a unique area with a variety of habitats, surprisingly few studies have been done on the soil and the plant-soil relationships in north-eastern KwaZulu-Natal - especially in wetlands. Additionally, this sandy coastal aquifer is regarded as an area where wetland delineation is difficult due to the well-drained aeolian cover sands. This was the motivation for this study, which aimed to characterize the soil, as well as determine which soil properties are the main determinants of vegetation communities along a topographical gradient in the various wetland types.

MATERIALS AND METHODS

Five different wetland types were surveyed along the topographical gradient. Altogether 59 profiles were classified - 19 by investigating profile pits, and 40 by hand auger. Soil samples were collected and analyzed for nine properties – N, C, K, Na, CEC, Mg, Ca, Mn, Fe and Resistance. At each soil survey site vegetation data was collected using the Braun-Blanquet cover abundance scale in 1x1 m^2 plots. A multivariate analyses technique named CCA was applied to the data in order to elucidate the plant-soil relationships.

RESULTS AND DISCUSSION

Based on the soil characteristics the five different wetland types are quite distinctive from each other, although some types have similarities in certain wetness zones. The soils are distinguished based on high organic substrate, clay, or sand. Carbon is a major distinguishing factor in wetlands on the MCP. Different combinations of permanently-, seasonally-, and temporarily saturated zones are present in the different wetland types, and the vegetation composition and soil characteristics differ accordingly.

CONCLUSION

The wetlands on the MCP are vastly different from wetlands in other parts of the country, mainly due to the substrates high in organic carbon, as well as the prevalence of aeolian cover sands. The major determinants of vegetation communities are the substrate type and hydrological regime within the various wetland types.

Keywords: Maputaland Coastal Plain, wetlands, vegetation, soil

THE EFFECT OF THREE DIFFERENT NITROGEN SOURCES, APPLIED IN DIFFERENT COMBINATIONS, ON SOIL ACIDIFICATION AND YIELD OF QUEEN PINEAPPLE, *Ananas comosus* (L) Merr.

Rabie, E.C.[1], Heine, M.H.[2] and Mbatha, B.W.[1]

[1]ARC-ITSC, Hluhluwe Research Station, P.O.Box 194, Hluhluwe, 3960; [2]Omnia Fertilizer, P.O.Box 45, Howick, 3290

E-mail: erabie@mtuba.co.za

INTRODUCTION

Queen pineapples are mainly cultivated in the northern part of Kwa-Zulu Natal (Hluhluwe district) on both sandy and structured clay soils. Standard nitrogen (N) fertilization practices on pineapples in the area consist of approximately 500 kg ammonium sulphate as pre-plant N source followed by up to 1500 kg ammonium sulphate as topdressing at various growth stages. This source of N is one of the most acidifying, especially in such sandy soils with a lower buffer capacity to resist the change in pH and acid saturation. A trial was implemented to look at the effect of ammonium sulphate, as well as two other N sources, on soil acidification and yield.

MATERIALS AND METHODS

Three sources of N fertilizer (ammonium sulphate, urea and Greensulph – a sulphate containing granular calcium ammonium nitrate) were applied at planting in September 2012 to three planting ridges per fertilizer treatment. Each ridge consisted of six rows of pineapple plants. The three N sources were applied again post planting in a split plot design replicated four times. Treatments were applied at two and four months post planting, thereby achieving all possible combinations of pre- and post-plant N source. The total pre-plant N was 84 kg/ha, followed by two applications of 87 and 177 kg/ha. Phosphorus and potassium was applied according to soil analysis, with the differences in sulphur additions accounted for by the use of potassium sulphate in those treatments. Flower induction and harvest was completed in April and November 2013, respectively. Plant sap (OmniSap®) and conventional leaf tissue samples were analysed for each replication in May 2013. Soil samples in 300 mm increments to a depth of 900 mm were analysed for all replicates at harvest (Dec 2013) and post-harvest in September 2015 to look at the long term effect of N source on soil acidification before the following pineapple crop is planted.

RESULTS AND DISCUSSION

Although no significant differences in yield were expected or observed amongst treatments, slight differences did occur for pre- and post-plant application. Differences in acidification and N source occurred post-harvest. The soil profiles from the ammonium sulphate + ammonium sulphate treatment produced the most soil acidity, followed by the Greensulph + ammonium sulphate and Greensulph + urea treatment. The three Greensulph pre-plant applications and the three post-plant urea applications produced more consistent and slightly higher yields.

CONCLUSIONS

Results indicate that options in terms of N source can be considered in pineapple production, leading to a possible reduction in the cost of liming. Future research should focus on more careful nitrogen management to lessen the acidifying effect that any N source would have.

ACKNOWLEDGEMENTS

Omnia fertilizer for their financial contribution towards soil and leaf analyses.

Keywords: acid saturation, ammonium sulphate, Greensulph, pH, urea

AGRONOMIC AND ECONOMIC COMPARISONS OF HARVEST AGE EFFECTS ON RAINFED SUGARCANE IN SOUTH AFRICA

Ramburan, S.

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

E-mail: Sanesh.Ramburan@sugar.org.za

INTRODUCTION

Sugarcane may be harvested between 12 to 24 months of age in the rainfed regions of South Africa. The optimal harvest age (HA) for individual growers is dependent on temperatures (altitude) and the presence of the African sugarcane stem-borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae), which restricts ageing of sugarcane. There has been recent grower uncertainty around HA effects and the economics associated with different HAs. SASRI has embarked on the development of a tool to assist researchers to perform economic conversions of routine field trial data. It is envisaged that such a tool can be used to provide insight on optimal HA choices for growers. Therefore, the objectives of this study were to: (i) investigate and illustrate the importance of HA relative to cultivar and ratoon effects on productivity of rainfed sugarcane; and (ii) compare the economics of different HAs using a prototype economic conversion tool for research results.

METHODS

The recoverable value (RV) yields from four separate cultivar x HA field trials were analysed using linear mixed models. Three trials compared the 12 vs. 18-month HAs in the coastal region, while one trial compared the 18 vs 24-month HA in the midlands region. Trials were harvested over multiple ratoon crops. In all trials cultivar, HA, and ratoon were treated as fixed effects, while replicate was considered random. The magnitude of F values for different terms were used to evaluate the relative importance of each term in the linear model. Cultivar x HA interactions were interpreted in relation to eldana prevalence. The trial data were used as input for the MS Excel-based economic conversion tool, which accounted for all sugarcane planting, management, harvesting, and transport costs. A gross margin (GM) was calculated to determine the most profitable HA for each trial over multiple ratoon crops.

RESULTS AND DISCUSSION

The HA and its associated interaction terms were highly significant ($P<0.001$) and generally accounted for more variation than the cultivar and ratoon main and interaction terms in all trials. When eldana levels were low on the coast (2 out of 3 trials), RV yields of the 18-month HA were significantly higher than the 12-month HA. However, when eldana levels were high (1 trial), the opposite was true. In this case, only an eldana resistant cultivar (N21) showed a significant improvement in RV yields when aged. The economic analysis showed that GMs were improved by R1 951/ha/annum with three 12-month crops compared with two 18-month crops in the coastal trials. In the midlands trials, three 24-month crops were more profitable by R6 614/ha/annum than four 18 month crops. Cultivar x HA interactions did influence the most profitable HA option, and these are discussed further in the paper.

CONCLUSIONS

The RV yield benefits of two 18-month crops did not result in improved annualised GMs compared with three 12-month crops in these trials. Further trials, with greater RV responses to 18-month harvesting will be analysed to determine the margin of yield improvement needed to make the 18-month HA more profitable. The economic conversion tool proved very useful to gain insights into HA effects on profitability and further analyses are planned.

Keywords: economics, harvest age, sugarcane

ELUCIDATING THE EFFECTS OF DYNAMIC CONTROLLED ATMOSPHERE AND INITIAL LOW OXYGEN STRESS IN CONCENTRATION OF VOLATILES ASSOCIATED WITH SUPERFICIAL SCALD INCIDECNCE IN 'Packham's Triumph' PEAR

Ramokonyane, T.M.[1], Vries, F.A.[2], van der Merwe, J.A.[2], Crouch, E.A.[3] and Opara, U.L.[1]

[1]South African Research Chair in Postharvest Technology, Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch; 7602; [2]Department of Postharvest and Wine Technology, ARC Infruitec-Nietvoorbij, Private Bag X5026, Stellenbosch, 7599; ; [3]Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602

E-mail: sekepe1981@gmail.com

INTRODUCTION

'Packham's Triumph' pears are susceptible to superficial scald which may develop during or after cold storage. The market for South African grown pears is export oriented and therefore requires that fruit are treated with diphenylamine (DPA) to extend the marketing window. There is a need to develop alternative technologies to control superficial scald and to understand their mode of action. The aim of this paper was to investigate the effect of dynamic controlled atmosphere (DCA) and initial low oxygen stress (ILOS) on the incidence of superficial scald on pears.

MATERIALS AND METHODS

'Packham 's Triumph' pears were harvested from Grabouw, Western Cape, South Africa and stored for up to 7 months at -0.5°C in DCA, controlled atmosphere (CA) preceded by ILOS, CA , RA preceded by ILOS , and RA (control). Peel tissue samples for volatile analysis were taken at harvest and after 2, 3, 5 and 7 months in cold storage followed by 0, 3 and 7 days shelf life at 20°C. Gas chromatography mass spectrometry (GC-MS) analysis was used to measure a-farnesene concentration and its oxidation product MHO.

RESULTS AND DISCUSSION

MHO concentration was significantly lower in treatments which suppressed scald (DCA, CA and CA preceded by ILOS) and higher in RA and RA preceded by ILOS. Concentration of a-farnesene in fruit peel was negatively correlated with scald severity (R2 = -0.90), whereas the concentration of MHO in the fruit peel was positively correlated with scald severity (R2 = 0.93).

CONCLUSIONS

The results suggest that DCA and ILOS inhibit incidence of superficial scald by keeping concentration of MHO lower in 'Packham's Triumph' pears. Concentrations of a-farnesene and MHO showed a precursor and by-product relationship, confirming that MHO is an autoxidation product of a-farnesene.

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Keywords: a-farnesene, MHO, 'Packham's Triumph' pear, superficial scald, DCA, ILOS

LESSONS LEARNT FROM RESEARCH IN THE "SOUTH AFRICAN HERBICIDE RESISTANCE INITIATIVE" (SAHRI)

Reinhardt, C.F., Okumu, N.M., Hamman, M. and Vorster, B.J.

Univ of Pretoria PBag X28 Hatfield 0028

E-mail: dr.charlie.reinhardt@gmail.com

INTRODUCTION

Prior to the present research focus in the SAHRI, investigation of herbicide resistance in the RSA was effectively focussed on a single region, the Western Cape. *C. bonariensis* is often the most dominant and widely distributed weed in annual and perennial cropping systems in both the summer and winter rainfall regions. Objectives were: (1) to assess the response to glyphosate in different *C. bonariensis* populations from which seed was sampled from across the country, and (2) to generate and to convey knowledge about best practices for controlling this weed, and weeds in general.

MATERIALS AND METHODS

Screening of different *C. bonariensis* populations was done through pot experiments to determine levels of tolerance to glyphosate. Plants were treated at the 4-6 leaf growth stage with the herbicide at rates of 0, 225, 450, 900, 1800 and 3600 g a.e. glyphosate per hectare (200 L/ha total spray volume). This dose-response approach allowed for calculation of ED_{50} values that were used to rank populations in terms of them being either susceptible, tolerant or resistant towards glyphosate.

RESULTS AND DISCUSSION

ED_{50} values calculated from dose-response relationships varied significantly between populations. Glyphosate use history revealed that high frequency of glyphosate use, application beyond the label-recommended growth stage, and lack of diversity in herbicide mechanisms of action employed were linked to either high tolerance or resistance. A major factor identified as probably contributing to the evolvement of glyphosate-resistant weeds is variable growth stage of the target weed in a particular cropping system. Other factors include non-adherence to label recommendations, not following prescribed steps in resistance management strategies, high reliance on a single or a limited number of herbicide mechanisms of action, in particular under zero-tillage practice.

CONCLUSIONS

Weed growth stage is underestimated as a major driver for the evolvement of herbicide resistance. Zero-tillage systems are particularly vulnerable to the evolvement of herbicide resistance. Solutions include employing multiple herbicide mechanisms of action that can best be achieved through tank mixtures. New technology in the form of adjuvants that promote herbicide efficacy also hold good promise. We must be more attentive with regards the extent to which weed control, and crop production practices in general, contribute to the risk of herbicide resistance evolvement.

ACKNOWLEDGEMENTS

Financial support provided by mainly Monsanto South Africa, and also the National Research Foundation is gratefully acknowledged.

Keywords: glyphosate, herbicide resistance, zero-tillage

COMBINED EFFECT OF EFFECTIVE MICROORGANISMS AND KELPAK ON GROWTH AND YIELD OF BEETROOT

Satekge, T.K., Mafeo, T.K. and Kena, M.A.

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

E-mail: satekgetk@gmail.com

INTRODUCTION

The influence of effective microorganisms (EM) and) Kelpak in combination with organic and inorganic fertilisers on growth and yield of various crops is well documented. However, their combined effect has not been studied. Where two are applied separately, farmers have often cited application costs as the main challenge in adopting them as alternative fertilisers. Thus, shade house and micro-plot experiments were initiated to study their combined effect on growth and yield of beetroot.

MATERIALS AND METHODS

Under both experimental sites, 4 treatments (Control, Kelpak, EM and EM+Kelpak) were arranged in a RCBD with 10 replicates. Seedlings were transplanted and immediately followed by treatment application (soil drench at a rate of 400 mL per plant/pot), thereafter; treatment was repeated at 7-day intervals. Number of leaves was counted at week 2, 4 and 6 and chlorophyll content; root weight and root diameter measured at harvest.

RESULTS AND DISCUSSION

Bio-fertilisers, singly and in combination, significantly ($P = 0.05$) increased the number of leaves at week 4 compared with the control and was not significant ($P > 0.05$) at week 2 and 6, under micro-plot. However, under shade, bio-fertilisers significantly increased leaf number at week 6 and were not significant at weeks 2 and 4. Application of Kelpak and EM separately significantly increased chlorophyll content compared with the control, under micro-plots. However, a combination of the two bio-fertilisers neither decreased nor increased the variable compared with the control. Treatments were not significant for chlorophyll content under shade. Treatments were also not significant for root weight and root diameter for both environments. The contrasting results for both sites were attributed to variations in the growing conditions and senescence of leaves. The increase in some variables was attributed to increase in available nutrients and phytohormones from EM and Kelpak (Calvo et al., 2014).

CONCLUSIONS

The results showed that application of EM and Kelpak singly or in combination did not differ in terms of growth and yield of beetroot. Therefore, application of two bio-fertilisers in combination would reduce the application costs associated with them.

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ACKNOWLEDGEMENTS

AgriSeta is greatly acknowledged for funding the research.

Keywords: Ecklonia maxima, seaweed concentrates (SWCs), sustainable agriculture

POTENTIAL APPLICATION OF MEDICINAL PLANT EXTRACTS AS ANTIFUNGAL AGENTS AGAINST PLANT PATHOGENS

Sathekge, N.R.[1], Botha, F.[2], Seepe, H.[1], Amoo, S.O.[1] and Du Plooy, C.P.[1]

[1]ARC-Vegetable and Ornamental Plants, Private Bag X293, Pretoria 0001, South Africa; [2]Department of Paraclinical Science, University of Pretoria, Onderstepoort 0110, South Africa

E-mail: RSathekge@arc.agric.za

INTRODUCTION

Plant diseases caused by plant pathogenic fungi are among the most important factors limiting vegetable production in South Africa. Therefore, protection of plants from pathogens remains a primary concern of agricultural scientists. Over the past few decades, various attempts to eradicate or control plant diseases have been made through the development of synthetic fungicides. Applications of synthetic fungicides often present environmental problems as they take long periods of time to be degraded completely, with potential health risk to humans and animals (Kishore and Pande, 2007). The development of drug-resistant pathogenic strains also remains a constant threat. The objective of this study was to evaluate the antifungal potential of some plant extracts against plant pathogens for the formulation of local products useful in smallholder farming.

MATERIALS AND METHODS

The antifungal potential of 18 leaf acetone extracts from 18 medicinal plants against *Alternaria solani* (PPRI10922), *Fusarium oxysporum* (PPRI10195) and *Fusarium solani* (PPRI11428) was evaluated using microdilution method (Eloff, 1998) and bioautography technique. The minimum inhibitory concentration (MIC) and inhibition zone diameter for each of these extracts were determined.

RESULTS AND DISCUSSION

The lowest overall MIC value of 0.07 mg/ml was obtained with *Vangueria infausta* leaf extract against *F.solani*.Leaf extracts of *Ruta graveolens*, *Lobostemon fruticoscus*, *Tulbaghia violaceae and Acacia nilotica* demonstrated good inhibitory activity against F. solani with the MIC value of 0.15 mg/ml. *Lobostemon fruticoscus* and *Acacia nilotica* inhibited the growth of *A.solani* with the MIC value of 0.15 mg/ml*. Ziziphus mucronata* leaf extract with MIC value of 0.15 mg/ml inhibited the growth of *F. oxysporum*.

CONCLUSIONS

The antifungal potential of some of the selected medicinal plant extracts against the three plant pathogens was established. The use of plant extracts obtained from locally available plant materials is affordable, sustainable and environmental-friendly especially in smallholder farming.

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Keywords: Fusarium, medicinal plants, plant diseases, plant extracts

DYNAMIC NOWCASTING OF DAILY MINIMACANOPY AND AIR TEMPERATURES

Savage, M.J.

School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, P/Bag X01, 3209 Scottsville

E-mail: savage@ukzn.ac.za

INTRODUCTION

The ability to predict daily minimum canopy and air temperature six or less hours before sunrise occurrence would be beneficial to agriculture. The aim of this work was to assess the relative accuracy of a dynamic model nowcasting method, applied to canopy and air temperature, using both night-time exponential and square root temperature models applied every hour after midnight. The accuracy of the exponential and square root models applied to canopy temperature for the 2- and 4-h ahead of sunrise nowcasts was also investigated. Night-time exponential and square root models were applied and mathematically inverted for nowcasted minimum canopy and air temperatures, using an infrared thermometer (IRT) and air temperature measurements. The physically plausible exponential model mimicked Newton's law of cooling for a heated surface after sunset and before sunrise.

MATERIAL AND METHODS

All measurements, every 15 min, were conducted at the Everson Estate of Westfalia Fruit, mainly an avocado (Hass) orchard in the KwaZulu-Natal Province (29°26'36.88" S, 30°16'21.33" E) at an elevation of 1080 m in Howick. Canopy and air temperatures were measured for the period 2nd December 1994 to 31st April 1996. Four IRTs were used for above-canopy temperatures. The IRTs were positioned 45o with the horizontal, directed towards the south and 2 m above the canopy. The hourly dynamic nowcasting method, applied from midnight, involved nowcasts at midnight, 1 am, 2 am, 3 am and 4 am for exponential (models 1 and 2) and square root (model 3) models. The exponential model used an exponential decay factor b that was either computed an hour or so before the nowcast (model 1) or fixed at 2.2 (model 2).

RESULTS AND DISCUSSION

For the 2-h ahead nowcasts, model 1 exponential comparisons yielded the greatest coefficient of determination (R2) and smallest root mean square (RMSE) compared to model 2 (b = 2.2) and model 3 (square root). The 4-h ahead canopy temperature nowcasts were more variable than those for 2 h for all models used (1, 2, 3). In each case, there was a reduced R^2 and increased RMSE. The dynamic nowcasting method for the exponential model using b = 2.2 allowed for nowcasting at midnight, 1 am, 2 am, 3 am and 4 am. For both canopy and air temperature regressions, there were significant increases in R2 and significant decreases in the RMSE from midnight to 4 am.

CONCLUSIONS

Exponential and square root dynamic nowcasting models for daily minimum canopy and air temperatures were successfully applied using sub-hourly temperatures. The exponential model yielded a lower RMSE compared to the square model.

ACKNOWLEDGEMENTS

The UKZN Teaching and Learning Office and the NRF funded the web-based system.

Keywords: diurnal temperature modelling, early warning of minimum temperature, frost

EFFECT OF COLD AND GA_3 STRATIFICATION IN SEEDS OF YELLOW KIWIFRUIT, *Actinidia chinensis*

Sekhukhune, M.K., Roumiana, N., Maila, M.Y. and Mphosi, M.S.

University of Limpopo

E-mail: mmatshelo@webmail.co.za

INTRODUCTION

Actinidia chinensis, in the *Actinidiaceae* Family, is widely spread within the temperate and subtropical regions of Asia and is currently cultivated in many other countries, including South Africa (Li et al. 2009). Due to the accelerating market demand in Kiwifruit, new improved cultivars of the small varieties with sweeter fruits than *A. delicosa* are gradually being introduced in South Africa (DAFF, 2014). However, embryo dormancy has been an obstacle in the successful establishment of *A. chinensis* in South Africa. The objective of this study therefore, was to investigate the effect of cold and GA_3 stratification in germination of *A. chinensis* seeds.

MATERIALS AND METHODS

Seeds were cold stratified for 4 weeks at 4°C prior to soaking for 24 h in 0, 500, 1000, 1500, 2000 and 2500 ppm of GA3. Treated seeds were then germinated in baby jar bottles containing distilled water and filter papers. Treatments were arranged in a completely randomized design with 5 replicates and kept in a 12 h light/dark growth chamber at 25°C and 50-60% RH for 6 weeks. The number of germinated seeds were recorded daily and expressed as germination percentage (GP) and seedling performance variables, namely, mean germination time (MGT), germination rate (GR) and germination index (GI). Data was subjected to ANOVA using SAS software and then subjected to lines of the best fit.

RESULTS AND DISCUSSION

Both untreated and treated seeds with cold and GA3 stratification germinated. The optimum GA3 concentration and GP of cold stratified seeds were 1530 ppm and 40%, respectively, whereas for seedling performance variables optimum values were 1600 ppm and 35 days for MGT, 1000 ppm and 0.23 seedling/day for GI and 1166 ppm and 0.08 seedling/day for GR. The combined effect of cold stratification at 4°C and GA3 treatment improved germination in *A. chinensis* seeds.

CONCLUSIONS

In conclusion, cold and GA3 stratification treatment had an effect in *A. chinensis* seeds and germination was improved as well as the seedling performance variables.

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Keywords: embryo immaturity, plant growth regulator, vegetative propagation, temperate habitat

EVALUATION OF 'ROSY GLOW' APPLE (*Malus domestica* Borkh) TREES GRAFTED ON VARIOUS ROOTSTOCKS

Siboza, X.I.[1], Kotze, W.P.[2] and Steyn, W.J.[3]

[1]HORTGRO Science, PO Box 12789, Die Boord 7613 ; [2]Dutoit Agri, PO Box 236, Ceres 6835; [3]HORTGRO Science, PO Box 12789, Die Boord 7613; Dept. of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602

E-mail: xolani@hortgro.co.za

INTRODUCTION

Apple trees are engineered to meet grower's needs by using precocious, productive, yield efficient and disease resistant rootstocks that are able to tolerate adverse soil and climate conditions (Costa, 2011). The objective of this study was to evaluate various new dwarfing, semi-dwarfing and semi-vigorous apple rootstocks from the GENEVA® range against the South African industry standard M793, M7, M25 and MM109 rootstocks. The performance of different M9 clones was also assessed.

MATERIALS AND METHODS

Apple (*Malus* × *domestica* Borkh.) trees grafted to 'Rosy Glow' were planted during winter 2010 at Paardekloof in the Witzenberg Valley. Dwarfing and semi-vigorous rootstocks were grouped together in two adjacent plots that are managed separately. CG222, CG3007, CG6210, Cepiland, Lancep, M793, M7, MM106, MM109 with a M9 interstem (MM109/M9) and RN29 were planted in 5 blocks at 4 x 1.25 m spacing as the more dwarfing site while CG222, CG228, CG778, CG934, M25, M793, Maruba and MM109 were planted in 6 blocks at 4 x 1.5 m spacing as the more vigorous site. The South African industry standard, M793, as well as CG222 were included in both plantings for comparison. 'Royal Gala' trees were planted in every 10th position to serve as cross pollinators. The trees were pruned, irrigated and fertilised based on industry recommendations. Vegetative and reproductive performance parameters of the trees were assessed. Fruit quality (mass, diameter, pink colour, stem-end russet, sunburn, soluble solids and acid levels) as well as maturity parameters (background colour, flesh firmness and starch conversion) were measured at harvest.

RESULTS AND DISCUSSION

A general inverse relationship between tree size and yield efficiency is evident after three harvest seasons. Canopy size is beginning to affect fruit quality, with less red colour development in larger canopies and more sunburn in smaller canopies. CG778, RN29 and MM109/M9 trees are much more yield efficient than expected from their size. Lancep trees are also very yield efficient but seem stunted and had smaller average fruit size in 2015 compared to other M9 clones.

CONCLUSIONS

The performance of CG778 is very encouraging and this rootstock seems to outperform industry standard MM109 in the same vigour class in terms of yield parameters. RN29 and MM109/M9 are performing better than other dwarfing rootstocks and would be good choices for higher density plantings.

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Keywords: apple, dwarfing, fruit quality, vigorous, yield, yield efficiency

GENETIC TRAIT MODELLING: ACHIEVEMENTS AND LESSONS FROM SUGARCANE

Singels, A.[1], Hoffman N.[1], Jones M.R.[1], Ramburan, S[1], Eksteen, A.[1]

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

E-mail: abraham.singels@sugar.org.za

INTRODUCTION

It is hypothesized that realistic crop models with accurate genetic trait parameter values can be used to identify important traits and their ideal values for current and future environments. This could assist crop improvement programs. This requires crop models that adequately represent genetic control of genotype response to environmental factors. Model parameters should accurately capture genetic effects of heritable traits for which exploitable genetic diversity exists. Furthermore, rapid and precise phenotyping is required to accurately estimate trait parameter values for large numbers of genotypes. The objective of this paper was to review progress in sugarcane trait modelling and explore the way forward for implementation.

MODEL DEVELOPMENT

A fundamental shortcoming in the DSSAT-Canegro model is the disconnect between simulated organ development/growth and biomass accumulation/partitioning. This was addressed by refining algorithms to mimic genotype specific, dynamic source-sink control of biomass partitioning and structural growth and development (Jones et al., 2011). Results from a model verification exercise were encouraging, but further evaluation was required.

TRAIT PARAMETER ESTIMATION

Measurements on a genetic mapping population showed that stalk elongation rate per unit thermal time (SERo) and photosynthetic radiation use efficiency (RUEo) were highly heritable and genetically diverse traits (Singels et al., 2010). RUEo values were estimated accurately from rapid measurements of chlorophyll fluorescence or stomatal conductance. Phenotyping methods for other traits needed improvement to increase throughput and accuracy. Recent studies showed that parameter values for canopy development and drought coping traits can be estimated from experimental data and subjective observations (expert ratings). Observed genotype performance in an irrigated field trial was predicted well, and RUEo was identified as a key trait for irrigated crops. High throughput phenotyping using proximal sensing with UAVs offers great potential for determining green canopy cover and stomatal conductance (from canopy temperature). Parameter values for growth vigour and drought coping traits can therefore be determined for large numbers of genotypes in early stages of breeding programs.

TRAIT IMPACT MODELLING

A trait modelling study suggested that enhanced root growth without an associated enhanced RUEo will not necessarily lead to higher sugar yields because the increased investment of carbon in roots resulted in less carbon being available for sugar production. This study also surprisingly revealed that early stomatal closure in response to water deficit is detrimental to sugar yield in all environments tested. The slight improvement in crop water status is not enough to counter the associated reduction in carbon assimilation.

CONCLUSIONS

Genetic trait modelling holds great promise for identifying ideal values for key genetic traits. This could enable targeted crossing and early screening in sugarcane breeding programmes, thus accelerating breeding gain. Further refinement of models and phenotyping methods are however required for practical implementation.

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Keywords: breeding, genetic trait, genotype, parameter estimation, phenotype, sugarcane

USING CARD MODEL TO GENERATE NONPHYTOTOXIC CONCENTRATION OF NEMARIOC-AL PHYTONEMATICIDE ON AFRICAN GERANIUM (*Pelargonium sidoides*)

Sithole, N.T.[1], Pofu, K.M.[2], Mashela, P.W.[1] and Dube, Z.P.[1]

[1]University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa; [2]Agricultural Research Council-VOP, Private Bag X293, Pretoria 0001, South Africa

E-mail: nooku.nt@gmail.com

INTRODUCTION

African geranium (*Pelargonium sidoides*) has been identified as an important economic future crop, with numerous medicinal opportunities. However, it is highly susceptibility to root-knot *(Meloidogyne* species) nematodes, with no resistance genotypes. Fumigant nematicides, which were relied upon for managing nematode population densities, had since been withdrawn from agrochemical markets. Nemarioc-AL phytonematicide, with active ingredient cucurbitacin A, was researched and developed as an alternative to fumigant nematicides at University Limpopo, South Africa. However, as the active ingredients of phytonematicides are allelochemicals, Nemarioc-AL phytonematicide has phytotoxicity challenges. The objective of this study, therefore, was to determine mean concentration stimulation (MCSR) of Nemarioc-AL phytonematicide on African geranium.

MATERIALS AND METHODS

Cuttings of African geranium were cultivated in 30-cm-diameter pots containing 10 l steam-pasteurised sand and Hygromix at 3:1 (v/v), with each inoculated with 5 000 eggs and second-stage juveniles (J2s) of *M. javanica*. Six treatments, namely, 0, 2, 4, 6, 8 and 10% concentrations of Nemarioc-AL were arranged in a randomised complete block design, with seven replicates. At 56 days after inoculation, significant (P=0.05) data for plant variables were subjected to the CARD model to generate the seven biological indices required in the computation of MCSR of Nemarioc-AL phytonematicide.

RESULTS AND DISCUSSION

At 56 days after inoculation, phytonematicide levels significantly (P = 0.05) reduced affected dry root mass and plant height, contributing 67% and 23% to total treatment variation (TTV), respectively. The optimum concentration which can stimulate plant growth and reduce the nematodes was established at 6.38%, with level of sensitivity (k) of these plant variables at 3, suggesting that the plant is highly tolerant to active ingredients in this phytonematicide.

CONCLUSIONS

The non-phytotoxic concentration of nemarioc-AL phytonematicide on African geranium was 6.38%. This concentration should be used at each application in order to avoid phytotoxicity to African geranium plants, however, since *Meloidogyne* species are consistently reduced at MCSR = 2.63%, the concentration should be reduced to the latter.

ACKNOWLEDGEMENTS

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Keywords: Cucumis myriocarpus, fermented crude extracts, organic amendments, nematodes

INFLUENCE OF SINK-SOURCE ALTERATIONS ON CITRUS (*Citrus spp*.) FLOWERING

Stander, O.P.J[1], Cronje, P.J.R[1] and Barry, G.H.[2]

[1]CRI, Department of Horticultural Science, University of Stellenbosch, P. Bag X01, Matieland, Stellenbosch, 7602; [2]XLnT Citrus Company, Helderberg, Cape Town, South Africa

E-mail: jakkie@sun.ac.za

INTRODUCTION

Carbohydrate availability is an important determinate of flowering in citrus (*Citrus* spp.) (Goldschmidt and Golomb, 1982). Fruit are major sinks, and consumes photo-assimilates, at the expense of storage and utilization for flower development in the subsequent spring (Martínez-Alcántara et al., 2015). Using a late-maturing mandarin (*Citrus reticulata* Blanco) cultivar as model, the objective of this study was to determine the effects of different sink-source alterations in winter, on citrus leaf carbohydrate metabolism, and flowering in the subsequent spring.

MATERIALS AND METHODS

The experiment was conducted on adult 'Nadorcott' mandarin trees, in De Doorns (33°51'S, 19°52'E). The following branch-treatments were replicated eight times (n=8) prior to winter, in a randomized complete block design, in which an individual tree equals a block: 1) Control: fruiting branch; 2) De-fruited branch; 3) Girdled, fruiting branch; and 4) Girdled, and de-fruited branch. Leaf samples were collected from each branch replicate over a six-week period, starting on day of treatment. Leaf carbohydrate contents were determined using the phenol–sulphuric acid assay, and total chlorophyll contents with spectrophotometric analysis. Analysis of variance (ANOVA) was performed using STATISTICA software (version 12; Dell Inc.). Mean separations were carried out using the LSD test, where applicable (P = 0.05).

RESULTS AND DISCUSSION

Removal of sinks prior to winter, resulted in a rapid build-up of leaf carbohydrates. Consequently, leaf total chlorophyll content decreased, and resulted in leaf yellowing (leaf chlorosis). Whenever at least one sink prevailed, leaf carbohydrates and leaf total chlorophyll contents were not altered. Winter de-fruiting and girdling treatments resulted in profuse flowering during spring.

CONCLUSIONS

Carbohydrates accumulate in leaves in response to low sink activity during winter. Accumulation of leaf carbohydrates results in development of leaf chlorosis. Accumulated leaf carbohydrates are utilized after winter, and results in profuse flowering during spring.

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Keywords: flowering, girdling, leaf carbohydrates, leaf chlorophyll, leaf yellowing

THE EFFICACY OF CHEMICAL AND MECHANICAL THINNING STRATEGIES FOR 'AFRICAN ROSE™' JAPANESE PLUM (*Prunus salacina* Lindl.)

Steenkamp, H.[1], Steyn, W.J.[1, 2] and Theron, K.I.[1, 2]

[1]Dept. of Horticultural Science, Stellenbosch University, Private Bag X1, Matieland 7602; [2]HORTGRO Science, PO Box 12789, Die Boord 7600

E-mail: kit@sun.ac.za

INTRODUCTION

South Africa is an important role-player in the international deciduous fruit market and constant innovation is needed to remain competitive. Japanese plum production is a significant component of the South African deciduous fruit industry. In the past, labour cost in South Africa was relatively low compared to other fruit producing countries, but recently labour cost has increased and will keep on escalating. Thinning of Japanese plum (*Prunus salicina* Lindl.) is highly labour intensive. Developing new ways to thin flowers or fruit may reduce costs substantially. The purpose of this study was to evaluate new chemical thinning strategies on 'African Rose™'.

MATERIALS AND METHODS

During 2013/14 and 2014/15, trials were conducted on the farm Sandrivier (33°35'58.0" S, 18°55'40.1" E) near Wellington in the Western Cape, South Africa. The mature 'African Rose™' trees, on Mariana rootstocks, were planted in 2009 at a spacing of 3.5 m x 1 m. The chemicals evaluated were 1-aminocyclopropane-1-carboxylic acid (ACC) at 150, 300 and 500 µl.L^{-1} in the 1st season and 400, 600 and 800 µl.L^{-1} in the 2nd season, and 6-benzyladenine (6-BA) at 100 or 300 µl.L^{-1} in the 1st season and 100 µl.L^{-1} in the 2nd season. 6-BA was included to prevent ACC-induced leaf drop. ACC was also combined with mechanical thinning utilizing the Darwin 300™ and hand thinning during bloom was included as a treatment. All the foliar applications were made when the average fruitlet size was 8-10 mm.

RESULTS AND DISCUSSION

ACC consistently reduced the commercial hand thinning requirement in both seasons. In the second season, there was a linear decrease in yield efficiency as the ACC rate increased, while a quadratic response was seen in fruit size with the two higher rates inducing larger but similar fruit size. The combination treatment of ACC (600 or 800 µl.L^{-1}) and the Darwin 300™ thinned more aggressively, improved fruit size and shifted harvest distribution earlier without decreasing the yield efficiency compared to the control. The recommended ACC rate for 'African Rose™' would be 600 µl.L^{-1}. No leaf drop/phytotoxicity or broken stones were recorded.

CONCLUSIONS

The thinning effects we obtained with ACC on 'African Rose™' plums were promising. The indications are that for a self-fertile cultivar like African Rose™ a relatively high rate of 600 µl.L^{-1} should be used and possibly also combined with mechanical flower thinning. In addition, the option of applying ACC earlier at the 4 - 6 mm fruitlet diameter stage should be investigated.

Keywords: 1-aminocyclopropane-1-carboxylic acid (ACC), 6-benzyladenine (6-BA), thinning, yield, fruit quality

RESOURCE USE EFFICIENCIES OF POTATO PRODUCTION IN SOUTH AFRICA

Steyn, J.M.[1], Franke, A.C.[2], Van Der Waals, J.E.[1] and Haverkort, A.J.[3]

[1]University of Pretoria; [2]University of the Free State; [3]Wageningen University and Research Center, University of Pretoria

E-mail: martin.steyn@up.ac.za

INTRODUCTION

Potato is the most important vegetable crop in South Africa and is produced in 16 distinct geographical regions of the country. Regions differ in climate, soils, production practices and distances to points of sale, which affect the amount of input resources required to produce potatoes, and therefore also the resource use efficiencies. Resource use efficiencies impact directly on the environmental and financial sustainability of potato production and should therefore be optimised. The objectives of this study were to assess and benchmark South African potato production regions regarding their use of land, water, nutrients and energy to produce potatoes and to identify resource-intensive practices. This will allow exploitation of conditions to make production systems more efficient and to ensure economic and environmental sustainability of production.

MATERIAL AND METHODS

Surveys were conducted by interviewing a representative sample of growers in all regions, which provided data for the calculation of resource use efficiencies. Potential crop yields per region were calculated using the LINTUL-POTATO DSS model (Haverkort *et al*. 2015) and the Cool Farm Tool-Potato (Haverkort and Hiller 2011) was used to calculate carbon footprints as a measure of energy use efficiency. Variability in the yield gap (difference between potential and actual yield) was subsequently used to identify yield limiting factors per grower and region.

RESULTS AND DISCUSSION

Actual yields achieved were on average 66% of the yield potential, which suggests optimal use efficiency of available resources. However, water, seed and nutrient use efficiencies differed widely between and within regions and were not directly proportional to the water requirements and yields achieved, indicating that significant improvements are possible by improving production practices.

The total amount of CO2-equivalent greenhouse gases produced per ton of fresh potatoes ranged widely between regions. Dryland systems had the lowest land use efficiency (yield), but achieved high energy use efficiency due to lower input levels than irrigated production. Fertilizers (34%) and irrigation (30%) were the greatest contributors to energy use. Energy for pumping of water was not only related to the amount of irrigation water applied, but also strongly depended on the depth and distance of pumping. Long distance travel of produce to retail points contributed substantially to energy use in some regions. Large variability in resource use efficiencies and the yield gap between farms, systems and regions offer opportunities for improving resource use efficiencies, not only for the studied systems, but the potato industry at large.

CONCLUSIONS

The study revealed strong differences in the efficiencies of resource use (land, water, nutrients, energy and labour) between the 16 potato growing regions that were assessed. The outcome of this study should assist growers to make improved strategic, tactical and operational decisions to improve sustainability, profitability and competitiveness of potato production. The use of decision support systems is recommended to adjust dose and timing of input resources.

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Keywords: input resource use efficiency, agro-ecological zones, yield potential, crop model, sustainability, yield gap analysis, energy use efficiency, water use efficiency, nutrient use efficiency

LONG-TERM HYDROLOGY OF THE WETLANDS IN WEATHERLEY

Stolk, A. and Van Huyssteen, C.W.

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

E-mail: anizkastolk@yahoo.com

INTRODUCTION

Wetlands in South Africa are defined as areas of land where "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil". The question therefore arose as to the meaning of "usually" and "at or near the surface". The aim of this paper was therefore to evaluate the temporal nature of soil water saturation in the wetlands of the Weatherley catchment to inform decisions on the timing of wetland delineation measurements.

MATERIALS AND METHODS

Long-term (11 years) soil water measurements in 28 selected soil profiles in Weatherley catchment, located in the Eastern Cape province of South Africa, were evaluated. Soil water contents was measured weekly with a neutron water meter and the volumetric water content calculated by using measured bulk density values. Degree of soil saturation was calculated as the fraction of porosity saturated with water. Profiles were classified as wetlands, based on the long-term duration of water saturation and the presence of wetland vegetation. The long-term hydrograph of each was then examined to determine the frequency and duration of saturation events over the eleven-year period.

RESULTS AND DISCUSSION

Results indicated a correlation between response to rainfall events and the soil water flow regime: orthic A, E, yellow-brown apedal B, and neocutanic B horizons, located on the hillslope, responded quickly to rainfall events and were associated with interflow, while overland flow was linked to permanently saturated orthic A, E, and G horizons on the footslope and valley bottom.

Keywords: classification, degree of water saturation, hydropedology, water saturation

CONSERVATION AGRICULTURE - THE ANSWER TO SUSTAINABLE AGRICULTURE

Strauss, J.A.[1]

[1]Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7607

E-mail: johannst@elsenburg.com

A REVIEW

To feed a world population of 9 billion by 2050 is a challenge for agriculture. . Half of the topsoil on the planet has been lost in the last 150 years and as if that is not alarming enough erosion over the past 40 years has caused 30 percent of the world's arable land to become unproductive (David Pimentel, 2014). Soil erosion is now second only to population growth in the category of the biggest environmental problems the world faces.

The expansion possibilities for agriculture is scares and only Africa and a small part of South America might still be a viable option when it comes to increasing arable land. The questions are: How can we sustainably produce more on the same soil and how can we convert marginal fields to productive land? There is no simple solution, but researchers and producers from around the globe have shown that conservation agriculture (CA) is the answer (6th World Congress on Conservation Agriculture, 2014). Unfortunately in South Africa less than 40% of arable land is currently under any form of CA practices. It differs from province to province, with the Western Cape leading the way in adoption rates (Findlater, 2015). Although uptake is good in the Western Cape, not all the CA cornerstones are implemented (ARC and Western Cape Government survey, 2012). For CA to be the answer to our food needs, all 3 cornerstones, minimum soil disturbance, maximum cover and crop diversity (including cover crops), must be applied during production (Derpsch, 2013).

To ensure the sustainability or even regenerative agriculture we have to manage and improve two key areas. The first is the practical knowledge base of CA in the South African context including the buy in of industry and the general public. Secondly that our soil is not simply a medium to keep the plant upright, but the very substrate that can save us (Olsen, 2014). We have to speak with one voice (this includes scientists from all disciplines working together) when it comes to sustainable farming, there is still too many old-school ideas driving production in our country. Soil is a living system (Nichols, 2014) with an interaction between soil, plants and air, and if we are not going to recognise that and improve on the old way of thinking about production, we will not be able to produce enough food.

This talk is focussed on giving possible answers to where we are heading or rather where we should be heading with the 3 cornerstones in mind to ensure sustainable agriculture.

Keywords: complexity, knowledge, soil health,

DEVELOPMENT OF DIVERSE FHB, RWA AND RUST RESISTANT GERMPLASM

Sydenham, S.L.[1], de Villiers, C.[2] and Tolmay, V.[2]

[1]ARC-SGI PRIVATE BAG X29 BETHLEHEM 9700; [2]ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700

E-mail: sydenhams@arc.agric.za

INTRODUCTION

With the shift in South African wheat production reliant predominantly on spring wheat grown in the Western Cape and under Irrigation, a refocus on germplasm development research has been needed. In South Africa, Fusarium head blight, Russian wheat aphid and cereal rusts are serious wheat production constraints. In the Western Cape germplasm with stem rust (Ug99-race group) resistance with a reasonable level of RWA resistance is targeted. The irrigated wheat requires protection against FHB with a good backbone of multiple rust resistance. However, in recent seasons different biotypes of Russian wheat aphid (RWA) are becoming a concern on irrigated wheat as well. All of these fungal diseases and insect pests can cause significant yield losses on their own, but in combination can be devastating. This study aims to answer the need to fast track the combination of multiple pest/disease resistances for the different wheat production areas concerned.

MATERIALS AND METHODS

In this study diverse resistance sources carrying well characterised FHB resistance QTL (*Fhb1*, 3BSc QTL, 5A QTL, 3A QTL, 4A QTL), multiple rust genes (*Lr34*, *Sr24* and *Sr35*) and targeted RWA resistance (resistant to*RWASA1*, *RWASA2* and *RWAS3*) were used during the development of multiple pre-breeding lines. Multiple flanking SSR markers targeting the FHB QTL and certain gene-specific markers for the rust genes were used. RWA resistance was evaluated phenotypically with seedling assays.

RESULTS AND DISCUSSION

A number of backcross lines carrying multiple targeted FHB resistance genes/QTL, in combination with different rust genes and potential RWA resistance have been identified. These lines were developed in the backgrounds of high yielding wheat cultivars/lines from different pre-breeding programmes.

CONCLUSIONS

The unique combination of multiple pest/disease resistances in this manner is a significant achievement in a relatively short time period. This material should have significant impact on the South African wheat industry and international wheat community as a whole.

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Keywords: Diuraphis noxia, DNA, fusarium, rusts, spring wheat SSRs

GROWTH PROMOTION OF *Bacillus subtilis* ON POTATO IN THE PRESENCE AND ABSENSE OF *Pectobacterium carotovorum* subsp. *brasiliense*: A PRELIMINARY STUDY

Taboga, M. and Ntushelo, K.

Department of Agriculture and Animal Health, College of Agriculture and Environmental Sciences, University of South Africa, Private Bag X6, Florida, 1710

Email: mathibamt@gmail.com

INTRODUCTION

Boosting growth of the potato plant is important for higher tuber yields and better quality of the harvested tubers. In addition, the potato plant must be protected against the diversity of soil-borne pathogenic bacteria which continue to threaten yield and quality. In a plethora of studies, Bacillus subtilis, was found to be an abundant soil resident which has been shown to improve growth of different crop plants (Adesemoye *et al*., 2008; Felici *et al*., 2008) as well as protect them against different soil-borne pathogens (Kloepper *et al*., 2004). The growth boosting capabilities of B. subtilis on the potato plant have, up until this study, not been quantified especially in the presence of the devastating stem-breaking bacterial pathogen *Pectobacterium carotovorum* subsp. *brasiliense*. The aims of this study were therefore to quantify potato growth enhancement by B. subtilis both in the presence and absence *of P.carotovorum* subsp*. brasiliense* and to assess the metabolomic responses of the potato plant to the presence of *Pectobacterium carotovorum* subsp. *brasiliense and B. subtilis* in the growth medium.

MATERIALS AND METHODS

The growth boosting qualities of *Bacillus subtilis* on the potato plant in the presence and absence of *Pectobacterium carotovorum* subsp. *brasiliense* (*Pbc*) were assessed through a randomized complete block (RCB) experimental design with the following experimental treatments, plant growth medium 1) amended with live *B. subtilis* cells, 2) amended with dead *B. subtilis* cells, 3) amended with a combination of live *B. subtilis* cells and live *Pbc* cells, 5) amended with a combination of dead *B. subtilis* cells and dead Pbc cells, 6) amended with live *Pbc* cells, 7) amended with dead *Pbc* cells, 8) amended with dead *B. subtilis* cells and live Pcb cells and 9) amended with live *B. subtilis* cells and dead *Pbc* cells. All amended growth media were seeded with potato cultivar BP1 and the plants were maintained in the glasshouse at 25°C/20°C day night temperature regime with a day/night photoperiod split 12/12 hours. Irrigation began four days after seeding in three overhead daily rations of five minutes each in eight hour intervals. Growth response (stem height and diameter) data were collected every third day as well as stomatal conductance and chlorophyll content. Twenty seven days after seeding, leaves were sampled from the plants, ground with liquid nitrogen and their secondary metabolite profiles were determined using 1H NMR spectra.

RESULTS AND DISCUSSION

Differences in plant growth and secondary metabolite shifts were observed across treatments. However, the magnitude of the differences differed with some treatments not significantly differing from the control and from each other.

CONCLUSIONS

Bacillus subtilis induces potato plant growth with varying degrees in the presence and absence of *Pectobacterium carotovorum* subsp. *brasiliense*. The potato plant shows different secondary metabolite responses to treatment with B. subtilis in the presence and absence of *Pectobacterium carotovorum* subsp. *brasiliense*.

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Keywords: Bacillus subtilis, *Pectobacterium carotovorum* subsp. *brasiliense*, *potato*

MODELLING TRANSPIRATION OF CITRUS ORCHARDS

Taylor, N.J.[1], Vahrmeijer, J.T.[2], Van Der Merwe, S.M.[1], Ibraimo, N.A.[1] and Annandale, J.G.[1]

[1]Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa;[2]Citrus Research International, Nelspruit, 1200, South Africa and Department of Plant Production and Soil Science, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

E-mail: nicolette.taylor@up.ac.za

INTRODUCTION

Citrus is grown in semi-arid regions or subtropical regions where rainfall is seasonal and irrigation is a necessity. This represents a significant irrigation requirement and with more emphasis being placed on the conservation of water, it is becoming increasingly important to accurately estimate water use of these crops and schedule irrigation accordingly. As transpiration in tall, fruit tree crops is largely modulated by canopy conductance (G_c), models of transpiration which include estimates of G_c should improve the precision of empirical approaches for the estimation of citrus water requirements.

MATERIALS AND METHODS

Transpiration was determined in a 9 year-old 'Washington' Navel orchard and 7 year-old 'Midknight' Valencia orchard in Citrusdal, Western Cape using the heat ratio sap flux density technique. Ancillary measurements included canopy dimensions, interception of photosynthetically active radiation (PAR), stomatal conductance and water potential. Transpiration was modelled using a simplified canopy conductance model (Villalobos et al. 2013), based on vapour pressure deficit and interception of PAR by the canopy.

RESULTS AND DISCUSSION

The bulk G_c was fairly consistent throughout the season in the 'Washington' Navel orchard but showed more variation in the 'Midknight' Valencia orchard, especially in winter. In the 'Washington' Navel orchard G_c varied between 0.020 and 0.242 mmol m-2s-1, whilst in the 'Midknight' Valencia orchard it varied between 0.028 and 0.501 mmol m-2 s-1. Parameterisation of the model for the two orchards showed slight variations in model coefficients between the two orchards. Whilst reasonable estimates of transpiration were obtained on a seasonal basis in both orchards, the model did not perform as well on a monthly basis, especially during spring, when transpiration was underestimated in both orchards. Model performance was, however, much improved in autumn and winter.

CONCLUSIONS

The simplified canopy conductance and transpiration approach of Villalobos et al. (2013) provided good seasonal estimates of transpiration in both orchards, but not on a monthly basis. Future modelling efforts will focus on improving estimates of fractional interception of PAR by the canopy over the season

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ACKNOWLEDGEMENTS

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Keywords: canopy conductance, radiation interception, transpiration, vapour pressure deficit

VARIATION IN *Puccinia triticina* COLLECTED FROM WHEAT AND TRITICALE IN SOUTH AFRICA

Terefe, T.G.[1], Visser, B.[1] and Pretorius, Z.A.[2]

[1]Agricultural Research Council - Small Grain Institute, Private Bag X29, Bethlehem 9700, South Africa; [2]Department of Plant Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa

E-mail: terefet@arc.agric.za

INTRODUCTION

Leaf rust caused by *Puccinia triticina* (*Pt*) is a major disease of bread wheat in the winter rainfall regions of South Africa (SA). Frequent emergence of new *Pt* races which could overcome resistance in existing cultivarshas been a major challenge to sustainable control of leaf rust using genetic resistance. Regular rust surveyshelp to timeously detect virulence changes and identify resistance genes to be used in resistance breeding. The main objective of this study was to determine phenotypic diversity of *Pt* races detected in SA from 2010 to 2014.

MATERIALS AND METHODS

Wheat and triticale leaves infected with *Puccinia triticina* were collected from different localities in the major wheat growing regions (Eastern Cape, Free State, KwaZulu-Natal, Mpumalanga, Northern Cape and Western Cape). Suspension of urediniospores in mineral oil (Soltrol-170) was spray-inoculated onto seedlings of 20 differential lines. Inoculated seedlings were incubated in a dew chamber and then placed in a glasshouse under conducive conditions for leaf rust development. Infection types were recorded using a 0-4 scale 10-14 days after inoculation. Races were identified based on their virulence profiles on the differential lines.

RESULTS AND DISCUSSION

Ten Pt races were identified from 619 isolates pathotyped. Race 3SA145 (CCPSJ, North American notation) was most commonly found with an average frequency of 47%. This race was first detected in SA in 2009 and has since dominated the leaf rust race population. It differs from previous races being virulent on the adult plant resistance gene Lr37. Three new races were detected during this study and they were 3SA115 (CBPSG), 3SA146 (MCDSJ) and 3SA147 (FBPTG). The frequency of 3SA115 (first detected in 2012) significantly increased in 2014. In seedling tests, most wheat cultivars and breeding lines were resistant to 3SA115 but more than 45% of current SA cultivars and breeding lines were susceptible to 3SA146 suggesting a need for new resistance sources. Genes which are effective against 3SA146 and other Pt races in SA have been identified and are being incorporated in breeding lines.

CONCLUSIONS

Three new Pt races were detected in this study indicating a continued variability of the Pt population in SA. Rust surveillance and identification of resistance sources should be conducted regularly to ensure sustainable availability of resistant cultivars to wheat producers in SA.

ACKNOWLEDGEMENTS

Joyce Mebalo and Bomikazi Gqola for technical assistance. The Winter Cereal Trust, South Africa and CIMMYT (the Durable Rust Research in Wheat Project) for financial support.

Keywords: leaf rust, *Puccinia triticina*, race, wheat

MUNICIPAL SLUDGE AS LOW GRADE FERTILIZER FOR MAIZE PRODUCTION IN SOUTH AFRICA: CROP YIELD, NITROGEN AND PHOSPHORUS BALANCES

Tesfamariam, E.H., Annandale, J.G. and Steyn, J.M.

University of Pretoria, x021, Hatfield, 0028, Pretoria

E-mail: eyob.tesfamariam@up.ac.za

INTRODUCTION

Proper nutrient management is vital for sustainable agricultural use of treated municipal sludge. The aim of this study was to test the hypothesis that optimal crop production with minimal environmental impact from nitrate leaching and labile P accumulation is possible i) if sludge application rates are adjusted according to the availability of water (rainfed vs. irrigated cropping systems), and ii) if the P:Fe molar ratio of sludge used is less than unity.

MATERIALS AND METHODS

A field experiment is in progress since 2014/15 growing season at ERWAT, near Johannesburg, South Africa. An 8 t ha-1 sludge control was compared with annual application rates of 0, 4, and 16 t ha-1 for dryland maize and irrigated maize-oat rotation, on a loamy, kaolinitic, soil (Hutton form).

RESULTS AND DISCUSSION

Forage and grain yield of both cropping systems increased as the sludge application rate increased. Under rainfed maize production, where water was limiting, both total N and NO3-N increased across years in the soil profile of the 8 t ha-1 and higher sludge application rates. In contrast, under irrigated maize-oat rotation, both total N and NO3-N decreased across years for all treatments including the highest sludge application rate of 16 t ha-1. Nitrogen exported in forage from irrigated maize-oat rotation was at least three times higher than similar dryland maize treatments. Despite the very low P:Fe ratio of the sludge used (0.2-0.4), both total P and Bray-1P increased as the sludge application rate increased. In addition, Bray-1P was higher under irrigated system compared with similar dryland systems.

CONCLUSIONS

Synchronising sludge application rates with the availability of water (rain) minimised nitrate accumulation in the soil profile. Plant available P accumulation in the soil profile, however, increased as time progressed despite a sludge P:Fe ratio of less than unity. Therefore, hypothesis 1 was accepted but hypothesis was rejected.

Keywords: grain, forage, nitrate leaching, nitrogen, phosphorus

HYDROPEDOLOGICAL REACTION OF ENRICHED INDUSTRIAL WATER IN A VERTIC CATENA

Tinnefeld, M., Bouwer, D., Kuenene, B.T. and le Roux, P.A.L.

Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein, 9300, South Africa

Email: mtinnefeld@gmail.com

INTRODUCTION

Hydro-pedology of a catena is the hydrological response of the interaction of water with the unsaturated zone above groundwater. The unsaturated zone has three sub-divisions behaving differently: soil as the upper zone, saprolite as intermediate zone and fractured rock zone, the lower part. Soil morphology and chemistry serve as indicators and soil physical parameters as controls of the flow paths and storage of water in these zones. An accidental spill of enriched water redistributed in the hillslope. It is hypothesized that the partitioning of flow is associated with the distribution of enriched water.

MATERIAL AND METHODS

Profile pits were excavated to refusal. Soils were described, sampled at 100 mm intervals and analyzed for ammonium, nitrate, sulphate and pH. Permeability and hydraulic conductivity at saturation and 30, 80 and 150 mm tension were measured in representative horizons.

RESULTS AND DISCUSSION

Mayo, Arcadia and Rensburg soil forms occur in this catenal distribution. Several morphological indicators of vertical and lateral flow paths were described in the soil, saprolite and fractured rock including colour, cracks, root channels, carbonate precipitates, thin and thick gleyed horizons, redoximorphy and horizonisation. Saturated hydraulic conductivity of the vertic A-horizon exceeds 34 mm h^{-1} in all conditions and the saprolite 25 mm h^{-1}. The distribution of chemical compounds are associated with these morphological indicators.

The conceptual hydrological response of the hillslopes indicate that all the soils recharge (infiltrate) at high rates. It flow by cracks and bio-pores of the vertic A-horizon to wet up the saprolite and G-horizons. With increased wetness the infiltration rate of the vertic A-horizon slows down but cracks re-appear within a few hours. In the Arcadia, saprolite split flow in slow vertical flow recharging fractured rock and interflow in the bottom of the vertic A-horizon. Fractured rock are recharged directly and faster under the Mayo soils. Water return from the fractured rock to the soil in the Rensburg soils.

CONCLUSIONS

Soil morphology of vertic catenas is an effective pedo-transfer function. The conceptual hydrological response model serves as an indicator of the partitioning of water and solutes.

Keywords: conceptual hydrological response model, flow paths, industrial hydro-pedology, morphological indicators

EVALUATING ACCESSIONS FOR RESISTANCE TO FOUR SOUTH AFRICAN *Diuraphis noxia* BIOTYPES

Tolmay, V.L.[1] and Booyse, M.[2]

[1]Agricultural Reseach Council-Small Grain Institute; [2]Agricultural Research Council-Biometry

E-mail: tolmayv@arc.agric.za

INTRODUCTION

Russian wheat aphid (RWA) (*Diuraphis noxia* Kurdjumov) (Hemiptera: Aphididae) has been the target of a host plant resistance breeding programme for bread wheat in South Africa since the late 1980's. Resistant cultivars are recognised and used as an effective management option to mitigate damage by RWA in South Africa and internationally. However a fourth RWA biotypes has been reported in South Africa, prompting a renewed interest in the identification of durable resistance genes. In order to ensure that the RWA resistance donor accessions being used are effective and relevant this study aims to: 1. Re-evaluate genotypes already in use as RWA resistance donors in the pre-breeding programme with the extended spectrum of South African RWA biotypes while 2. Simultaneously evaluating a few genotypes not yet tested with South African RWA.

MATERIALS AND METHODS

Twenty seven bread wheat accessions and five check genotypes were evaluated using a 21-day seedling bioassay (Tolmay *et al*., 2012) with six replicates for each of the four RWA biotypes present in South Africa vis. RWASA1, RWASA2, RWASA3 and RWASA4. Data were subjected to ANOVA using GenStat for Windows®TM 15th Edition (VSN International 2012) after confirming orthogonality of design and homogeneity of variance.

RESULTS AND DISCUSSION

The mean damage rating for the four biotypes differed significantly ($p<0.001$; df=3; LSD= 0.5102) with the lowest mean obtained from RWASA1 and the highest from RWASA4 while means for RWASA2 and RWASA3 were intermediate to the others and did not differ from each other. Only five of the genotypes tested in this study showed resistance to all four South African RWA biotypes. Two of these accessions were identified as resistant for the first time and will be incorporated into the pre-breeding programme.

CONCLUSIONS

This study confirms that a variety of RWA resistance donor lines are in use, covering a spectrum of reactions to the RWA biotypes that occur in South Africa. The pre-breeding programme will continue to ensure stewardship of valuable resistance genes by promoting their responsible deployment and concomitant emphasis on the use of multiple, distinct resistance genes in preference to over-reliance on a particular resistance source.

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ACKNOWLEDGEMENTS

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Keywords: bread wheat, damage rating, RWA biotypes

CONTRIBUTION OF *Athrixia phylicoides* (BUSH TEA) TO CO-EXISTING ROADSIDE PLANT COMMUNITY AT HAENERTSBURG, WITVLAG AND KHALAVHA IN THE LIMPOPO PROVINCE OF SOUTH AFRICA

Tshikhudo, P.P., Ntushelo, K. and Mudau, F.N.

University of South Africa, Department of Agriculture and Animal Health, Private Bag X6, Florida, 1710, South Africa

E-mail: tshikhudopp@gmail.co

INTRODUCTION

Athrixia phylicoides DC is a South African indigenous shrub commonly used by Zulu and Bushman people to brew herbal tea. The aim of the current study was to understand the role of the micro-environment on *A. phylicoides* plant communities, traits of *A. phylicoides* in Haenertsburg, Witvlag and Khalavha areas, Limpopo Province, South Africa. These areas are well known for their high summer rainfall and warm tropical/subtropical climate and wild bush tea grows abundantly on the roadside.

MATERIALS AND METHODS

Five sites were selected for this study (two of these were in Haenertsburg, two in Khalavha and one in Witvlag). In each of the five selected sites, a hundred meter transect divided into one square meter quadrats every five meters was demarcated. Plant community data was collected from each quadrat to determine species richness, percentage area covered by plants, number of bush tea plants, height of each bush tea plant, stem diameter of each bush tea plant and the number of leaves per plant. The data was collected at three intervals from November 2014 till January 2015. In the final survey, plants in Witvlag and in one transect in Khalavha were uprooted, dried and nitrogen, phosphorus, potassium, anion and cation contents were determined in each of the represented plants leaf samples. 1H NMR analysis was done to determine secondary metabolite profiles of the plant leaves from the Khalavha and Witvlag quadrats. From soil samples representing all five quadrats, fractions and the content of nitrogen, phosphorus and potassium were analyzed. Rainfall and temperature data were retrieved from weather stations for three months before and during the survey.

RESULTS AND DISCUSSION

From this study, the micro-environment (rainfall, temperature, soil characteristics) influenced the different plant community features (species richness, vegetation cover and frequency of bush tea) of the habitats represented by the five quadrats; plant traits (height, stem diameter and numbers of leaves) were also influenced. Chemistries of the samples leaves from the plants in Khalavha and Witvlag were also influenced by the micro-environment. The plants grew taller and thicker as the summer season progressed but the number of leaves was not affected. These results were expected and gave a good insight into the growth dynamics of bush tea within its natural habitat.

CONCLUSIONS

It was concluded that the micro-environment influences plant community dynamics in bush tea habitats, as well as traits and chemistries of leaves of bush tea plants.

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Keywords: Athrixia phylicoides, micro-environment, plant community, plant trait

EFFECT OF 75 YEARS OF FERTILISATION AND MULCHING ON SOIL ACIDIFICATION IN SUGARCANE

Van Antwerpen, R.[1, 2], Miles, N.[1, 3] and Podwojewski, P.[3, 4]

[1]South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa; [2]Department of Soil, Crops and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa; [3]Soil Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, South Africa; [4]IRD, UMR 242 IEES-Paris, 32 Av. H. Varagnat 93143, Bondy cedex, France

E-mail: rianto.vanantwerpen@sugar.org.za

INTRODUCTION

It is widely known that land management practices affect soil properties. The degree to which properties are affected is dependent on the land management practices and the resistance of the soil to changes. This paper will explore the effects of regular burning or mulching at harvest (with and without fertiliser) on the depth to which a well buffered soil is affected after 75 years of continuous sugarcane production. The hypothesis is that soil acidification is due to the total N applied and the export of base cations and the objective is to determine the soil depth affected by the treatments

MATERIALS AND METHODS

The oldest sugarcane trial in the world (BT1, established in October 1939) is located on the premises of the South African Sugarcane Research Institute. The soil of the long term sugarcane burning and mulching trial contains 40 – 45% clay, and is classified as a Mayo soil form. The main treatments are: (i) green cane harvested with retention of the mulch blanket (100% soil cover), (ii) burning prior to harvest with unburnt residue left scattered on plots (67% soil cover) and (iii) burning prior to harvest with all unburnt residue removed (0% cover). The subplot treatments are either (a) unfertilised or (b) fertilised annually with 140 kg N/ha, 20 kg P/ha and 140 kg K/ha. Treatments are replicated four times in a randomised split-plot design. In this paper the results of soil samples collected at depths 0-200, 200-400 and 400-600 mm are discussed.

RESULTS AND DISCUSSION

In general, higher yields were obtained where fertiliser was applied, and yields also increased with an increase in the amount of residue returned to the soil after harvest. Topsoil Ca and Mg levels remained above the threshold values for sugarcane production, but their depletion was significantly greater in the plots receiving fertiliser compared to those unfertilised; furthermore, topsoil depletion of these cations increased with the amount of residue left on the surface after harvest because more water is conserved and nutrients recycled leading to larger biomass and therefore higher rate of nutrient depletion. In the subsoil, Mg levels of the fertilised plots decreased, but Ca was unaffected. The removal of cations was also reflected by a reduction in pH, an increase of soil Mn levels and soil acid saturation which was higher in the fertilised plots with residue retained.

With regard to the factors responsible for acidification: It is well known that N fertilization is a management factor promoting acidification. The average N returned to the soil from dry residue (mixture of brown and green leaves) was 60 and 82 kg/ha for the unfertilised and fertilised treatments respectively. The average N returns from the ash left in the field after burning at harvest were 0.35 and 0.50 kg/ha for the unfertilised and fertilised treatments, respectively, and are considered insignificant. A further factor contributing to acidification is the removal of base cations contained in sugarcane stalks delivered for sucrose extraction at the mill. Estimated amounts of Ca and Mg removed from the trial site over the last 50 harvests amounts to 1.8 and 3.6 tons Ca/ha and 2.1 and 4.2 ton Mg/ha from the unfertilised and fertilised treatments respectively.

CONCLUSIONS

After 75 years of applying the same treatments consistently only the 0-200 mm soil layer was altered for the unfertilised treatments. By comparison soil properties of plots receiving the fertilised treatments were altered to a depth 600 mm. Whilst acidification through N cycling is well-documented, the accelerated acidification under increasing residue retention reported here is particularly noteworthy. To guard against the accelerated acidification due to the use of fertilisers and residues it is recommended that farmers sample their fields regularly and apply the recommended amounts of lime.

Keywords: acidification, BT1, Ca, Mg, Mn, Sugarcane

A VISION TO REVITALISE SOIL CLASSIFICATION

Van Huyssteen, C.W.

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

E-mail: vanhuyssteencw@ufs.ac.za

INTRODUCTION

Soil Science has traditionally been an agricultural science. Soil classification therefore also focused primarily on the classification of soil for agricultural purposes. Soil Taxonomy - A Taxonomic System for South Africa has been used effectively for soil classification since 1991.

DISCUSSION

Soil classification aims to organise knowledge, provide maximum knowledge with least cognitive effort, organise the environment, reveal relationships, learn new relationships, and to provide objects/classes for research (Boul *et al*., 1989). It should also establish groups for predicting behaviour, determine best use, estimate productivity, identify problems, and to aid in information transfer. Rather ominously Cline (1961) warns that one should strive to avoid *rigor mortis* in the classification system and that "a classification system to become prisoners of our own taxonomy". Hartimink (2015) states that internationally the use of soil classification is declining while the use of soil description is increasing. This implies the need to communicate soil information, but an adversity to classification. Should we therefore follow a more pragmatic approach in soil classification? Classification is a human trait. Humans therefore has a built-in desire and capacity to classify their environment. Refer, for example to Miller's rule (1951). On the other hand the value gained should not exceed the cost incurred (Webster, 1977). The system should also be general acceptable and accessible. One should guard against focussing on regional (or personal) preferences and/or peculiarities. And lastly the system should not get it precisely wrong: i.e. what is the cost of being accurate as opposed to the cost of being wrong.

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Keywords: acceptability, accuracy, cost, error

HORSES FOR COURSES: WHICH DIGITAL SOIL MAPPING TOOL TO USE

Van Zijl, G.M.

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

E-mail: vanzijlgm@ufs.ac.za

INTRODUCTION

Digital Soil Mapping (DSM) has recently moved from the research phase to become a sub-discipline in Soil Science. With these tools, one can create soil maps at a fraction of the price of conventional soil surveys. However, in South Africa adequate tools have not been developed yet for the challenges soil surveyors face in the field. Currently there is work being done to create appropriate tools for three different scenarios which soil surveyors encounter. These tools are disaggregation of Land Types, for situations where no field data is available and some soil distribution information is needed, expert knowledge approaches, where soil class distribution is needed and some data can be collected and lastly, geostatistical approaches, when soil properties for large areas are to be mapped. This project assessed the potential of different methods to create a soil map for an area near Ntabelanga, South Africa.

MATERIALS AND METHODS

Soil maps were created with the above mentioned methods. Botha *et al*. (2016) describes the Land Type disaggregation method. The Soil Land inference Model (SoLIM) was used for the expert knowledge approach, while multinomial logistic regression (MLR), C5 decision trees (C5) and Random Forests (RF), were used in the statistical program R as geostatistical methods. All the methods used 87 soil observations, and the same set of 24 environmental variables.

RESULTS AND DISCUSSION

The Land Type disaggregation method achieved a Kappa value of 0.2, while the expert knowledge approach's Kappa was 0.56. The accuracy of the three geostatistical methods differed quite a bit, and obtained Kappa values of 0.57, 0.23 and 0.45 for MLR, C5 and RF, respectively. Thus the most accurate soil map was the MLR geostatistical map, but being comparable to the expert knowledge map. As could be expected disaggregation did not provide a very accurate map, which could be expected with no field work. The disaggregation method shows promise for quick desktop studies though. The fact that MLR proved better than expert knowledge shows the sampling density for this study was adequate for the use of geostatistical methods, however their varying results cautioned to choosing the specific method wisely.

CONCLUSIONS

There are different DSM tools for different scenarios. In this study MLR geostatistical method proved best, obtaining results similar to that of the expert knowledge approach. Thus the sampling density of this study is close to the threshold where geo-statistical methods become favoured over expert knowledge approaches. One must take care when choosing a geostatistical method, as results could differ greatly.

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Keywords: disaggregation, expert knowledge, geo-statistics

RESPONSE OF WHEAT (*Triticum aestivum* L.) AND CANOLA (*Brassica napus*) TO A ONCE-OFF STRATEGIC TILLAGE IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

Van Zyl, J.[1], Labuschagne, J.[2], Agenbag, G.A.[1] and Van Zyl, H.[2]

[1]Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland,7602; [2]Directorate Plant Sciences, Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7607

E-mail: JohanvZ@elsenburg.com

INTRODUCTION

Conservation agriculture (CA) is a very important management strategy in the grain producing areas of the Western Cape. Although the benefits of CA is well known, secondary effects, such as nutrient stratification, increased bulk density, weed control challenges and habitat improvement for certain pests and diseases may develop. Although soil tillage is not recommended under CA, the question however arises whether strategic use of once-off tillage under CA could be feasible and if so, what short term consequences on crop performance can be expected.

MATERIALS AND METHODS

The study was done (2014 and 2015) at the Langgewens Research Farm of the Western Cape Department of Agriculture near Moorreesburg (33016'42.33" S; 18042'11.62" E; 191 m). The experimental design was a randomised complete block with a split-plot treatment design. Three cropping sequences: medic-clover/wheat/medic-clover/wheat (McWMcW), wheat/lupin/wheat/canola (WLWC) and lupin/wheat/canola/wheat (LWCW) were allocated to main plots and replicated four times. The last letter in the sequence represents the crop on the field at the time of data collection. Tillage treatments were allocated to sub-plots namely: continuous no-till (NT), soil left undisturbed until planting and then planted with a tined no-till planter, non-inversion tillage (DT), deep tine to a depth of ~400 mm and inversion tillage (MP), soil inverted using mouldboard plough to a depth of ~250 mm). Yield components (ear bearing tillers m-2, spikelets per ear, kernels per ear and kernel weight for wheat and number of canola plants m-2, pods per plant, seeds per pod and seed weight of canola) as well as yield and quality of wheat and canola were recorded.

RESULTS AND DISCUSSION

Yield components for wheat and canola will covered in detail during the presentation. Data for the 2014 growing season showed no significant differences ($P>0.05$) in the amount of wheat kernels per ear between tillage treatments. However NT resulted in marginally increases in the number of kernels per ear compared to DT and MP in LWCW. Similar increases were observed in McWMcW although not significant ($P>0.05$). No significant differences were recorded between tillage treatments for protein content although there was a slight increase of 0.27% for LWCW in MP compared to NT and DT. DT resulted in an increased ($P>0.05$) protein content (0.6 %) in McWMcW compared to NP and MP. Tillage treatments did not influenced wheat grain yields in McWMcW (4066 kg ha-1 for MP, 3925 kg ha-1 for DT and 3888 kg ha-1 for NT). LWCW produced 3802 kg ha-1, 3800 kg ha-1 and 3656 kg ha-1 grain for DT, MP and NT respectively. NT, DT and MP resulted in canola yields of 1913, 2044 and 2131 kg ha-1 respectively.

CONCLUSIONS

Although differences were recorded no definite trends, positive or negative, in the response of wheat or canola to the different degrees of soil disturbance was observed during the 2014 growing season.

Keywors: canola, no-till, plough, rip, wheat

WETLAND SOIL PROPERTIES CONDUCIVE TO THE AESTIVATION OF THE RIFT VALLEY FEVER VIRUS IN CENTRAL SOUTH AFRICA

Verster A.M. and van Huyssteen, C.W.

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

E-mail: 5klippies@gmail.com

INTRODUCTION

Rift Valley fever (RVF) is a disease of increasing global importance and is one of the many diseases around the world that affects both humans and animals. An outbreak can therefore have deleterious effects on the economic and socio-economic aspects of a country. RVF is spread through the bite of the *Aedes* mosquito that is infected with the Rift Valley fever virus. The virus survives between epidemics in two ways, either through viral transmission between livestock or through infected *Aedes* mosquito eggs that have been deposited in the soil. Mosquito larvae move through the soil into the water, while they grow through their different life stages to become an adult. This study forms part of a bigger study that involves animals, plants, and humans. The study area in central South Africa consists of 22 study sites that range from endorheic wetlands to pans to river systems.

MATERIAL AND METHODS

Standard soil analytical procedures were used to determine the texture, pH, EC, soluble and exchangeable cations, CEC, organic carbon, and total nitrogen (through dry combustion). XRD and XRF were used to determine the mineralogy. Water levels, temperature, pH, Eh and EC were measured weekly from May 2015 to May 2016. Water levels and temperature are measured with leveloggers (Per Levelogger Edge LT) that are installed in wells at each site.

RESULTS AND DISCUSSION

Three biomes are present in the study area namely Grassland, Savannah, and Nama Karoo. Addo and Montagu are the dominant soil forms with Augrabies, Katspruit, Kroonstad, Tukulu, and Brandvlei as subdominant soil forms. This paper will report on seven months' detailed water measurements as well as chemical and physical properties of the 22 wetlands. Soil microbiology results of the different wetlands will also be discussed as well as the active carbon.

CONCLUSIONS

The broad aim of this study was to identify if any of the soil characteristics (chemical, physical, mineralogy and microbiology) play a role in the aestivation of the *Aedes* mosquito eggs and Rift Valley fever virus in central South Africa.

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Keywords: Rift Valley fever, mosquitoes, soil properties

RESPONSE OF MAIZE PLANTS DURING EARLY GROWTH TO ZINC FERTILIZATION OF A SANDY SOIL

Wessels, C.F.[1], Du Preez, C.C.[2] and Ceronio, G.M.[2]

[1]Omnia fertilizer, Klerksdorp 2571, Flamwood drive 12, Glen Eden 11; [2]Department of Soil, Crop and Climate Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300

E-mail: derickwessels1@gmail.com

INTRODUCTION

Maize is the largest produced field crop and the most important source of carbohydrate in Southern Africa. Approximately half of the maize produced in South Africa is for human consumption and un-sieved meal should contain at least 18 mg Zn kg-1 to fulfil nutritional requirements. This is often not the case, since maize is produced largely on sandy soils which are prone to Zn deficiency.

MATERIAL AND METHODS

A sandy soil was selected for a glasshouse study and treated with ZnSO4, ZnO and ZnEDTA to increase its zinc content with 0 mg kg-1, 0.5 mg kg-1, 1 mg kg-1, 2 mg kg-1 and 4 mg kg-1. Phosphorus as phosphoric acid and nitrogen as ammonium nitrate were added to the soil at a constant rate. The specific fertilizers were dissolved in water and applied as a solution to soil before it was thoroughly mixed. Maize seeds were planted 50 mm deep and soil was maintained at drained upper limit during the growing period. During the five week growing period stem thickness and plant height were measured weekly while leaf area, dry mass and zinc uptake were measured at week five only. The experiment was repeated.

RESULTS AND DISCUSSION

Zinc sulphate was superior to ZnO and ZnEDTA with regard to all measured parameters. This is contrary to most other studies where a better plant response to chelated fertilizers such as ZnEDTA was observed than with either ZnSO4 or ZnO. Plant parameters showed an initial increase with higher soil Zn concentrations followed by a decrease, confirming an optimum level of about 2 mg Zn kg-1 soil. Zinc uptake, with the exception of ZnO, increased with higher levels in soil Zn concentration.

CONCLUSIONS

These glasshouse results should be verified with field experiments before advocated to farmers.

Keywords: plant parameters, zinc source, zinc uptake

CALIBRATION OF CAPACITANCE SOIL MOISTURE SENSOR FOR COMMERCIAL AGRICULTURE: A DETAILED REPORT ON LABORATORY AND FIELD STUDIES

Zeelie, A.

Akasha Irrigation Management (Pty) Ltd, 25 Vygie Str., Bellair,
Bellville, 7350, South Africa

E-mail: angelique@akashairrigation.co.za

INTRODUCTION

Globally soil moisture measurement via capacitance-based technology has been evaluated as a means to improve soil moisture management. Little research has however been published locally on the topic of capacitance soil moisture sensors and especially concerning how this technology measures against current standard soil moisture measurement methods. The objectives of this study were: (a) correlating measured gravimetric- and volumetric soil water content data with dimensionless (Scaled Frequency, SF) data; therefore (b) to determine calibration equations for soil specific scenarios (*in situ* calibration experiment).

MATERIALS AND METHODS

Independent studies were conducted as follow: a) selective soil chemical- and physical properties per soil textural class were analysed; and b) *in situ* gravimetric sampling was conducted and correlated against the capacitance sensors output for each soil textural class's full soil water regime. The *in situ* study focused on deriving valid calibration equations by comparing the soil moisture sensor SF-readings with actual soil water content values. The *in vitro* analysis were conducted to enable future comparisons to be made and hence using internationally recognized standard criteria.

RESULTS AND DISCUSSION

The following soil textural classes were evaluated: sand, clay, silt-loam, loam and clay-loam. All regression analyses where derived as linear relationships, therefore the Y-variables are expressed as the mean response to the variables of X. The mathematical representation of the regression equations are:

$$Y = a + ß*x$$

The regression coefficients a and ß define the relationship between the SF and the soil moisture content. These values were derived for each of the soil types described. A generic soil regression analysis was also conducted.

CONCLUSIONS

Soil calibration equations derived for the selective sensor is unique to the product and should by no means be used for calibrating other capacitance products. The reported equations were conducted for both gravimetric- and volumetric soil water content per soil type, as different soil water measuring units are used internally. It is strongly recommended when selecting an equation that it is based on the soil particle size distribution, textural class, of the soil closest to that which the sensor will be installed in. If in doubt with regards to the soil textural class, a generic soil calibration equation needs to be available for commercial use in agricultural farming practices.

Keywords: calibration methods, capacitance, soil moisture content, soil moisture sensor

EFFECT OF COMBINED AGRONOMIC VARIATIONS ON MAIZE YIELD UNDER A CHANGING CLIMATE

Zinyengere, N., Crespo, O., Tadross, M. and Hewitson, B.

Climate System Analysis Group, Department of Environmental and Geographical Science, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, South Africa

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

INTRODUCTION

Incremental adaptation to climate change through tactical agronomic adjustments has regularly been recommended for smallholder dryland farmers in low income regions such as southern Africa (Zinyengere et al., 2014). Investigations into the utility of such strategies are limited. Where they exist, they regularly focus on limited agronomic strategies. This study sought to investigate the effect of multiple agronomic strategy adjustments on climate change impacts on maize yields.

METHODS AND MATERIALS

Three commonly used agronomic management options were investigated for usefulness for adapting maize production to climate change in three locations in Southern Africa (Mohale's Hoek – Lesotho, Lilongwe – Malawi and Big Bend – Swaziland). The CERES-Maize crop model was used to provide insight into the effect of not only each management option (fertiliser application, planting date adjustment and planting density) but also on the emerging effect of a combination of strategies (a total of 294 combinations). Simulations were performed under the SRES A2 CO2 emission scenario, driven by downscaled climate scenarios from four GCMs. Simulated yields were averaged across the GCM climate scenarios for baseline (1961–2000) and future (2046–2065) periods per variable simulation.

RESULTS AND DISCUSSION

In Big Bend (hot and dry area), adjusting agronomic practices led to only a meagre yield change advantage. Most variations of strategies exacerbated the negative impacts of climate change, with yield declines of up to 34%, particularly under high fertiliser amounts and late planting. In Mohale's Hoek and Lilongwe (Malawi) (cool and moderate climates respectively), adjusting agronomic practices had high potential to counterbalance negative impacts of climate change. Future yield increases of up to 15% were simulated under some combinations of fertiliser increase and timing of planting. Interaction between agronomic strategies (combinations) resulted in significantly different yield outcomes from those under single factor changes of one agronomic strategy. These benefits or losses resulting from the interactions of different agronomic strategies are not accounted for when only single agronomic strategies are tested independently.

CONCLUSIONS

The study confirms that adjusting on-farm agronomic management strategies can help to reduce the expected negative impacts of climate change and simulating combinations of multiple agronomic options together accounts for non-linear interactions and provides a better understanding of adaptation potential.

REFERENCES

Zinyengere N., Crespo O., Tadross M., Hachigonta S., 2014. Local impacts of climate change on dryland crops in southern Africa. Agriculture ecosystems and Environment. 197: 1-10.

Keywords: adaptation, agronomic practices, CERES-MAIZE, GCMs, climate change