Abstracts:

Oral Presentations

COLOUR VARIATION IN GREEN MATURE PEPPER FRUIT IN RELATION TO PIGMENT CONCENTRATION

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INTRODUCTION

Various shades of green are found in unripe pepper fruit, even within a particular cultivar. Moreover, the peel of a green pepper is darker than the flesh. This colour variation can be expressed mathematically according to the CIELAB colour system, particularly in terms of a* (green to red) and b* (blue to yellow). Chlorophyll and yellow carotenoids are responsible for the colour of green peppers. The objectives of this study were to relate the colour variation in green pepper fruit to pigment concentration, and to determine a suitable CIELAB colour value for estimating pigment content.

MATERIALS AND METHODS

Green mature pepper fruit (*Capsicum annuum* L., cv Sondela) of various shades were peeled and the a* and b* colour values of the peel and flesh of each fruit measured. Samples were freeze-dried and analysed spectrophotometrically for total chlorophyll, chl a, chl b and total carotenoids (Lichtenthaler, 1987). Chl a/b and chlorophyll/carotenoid ratios were calculated for each sample. Flesh and peel attributes were tested for significant differences using ANOVA (F-test).

RESULTS AND DISCUSSION

As the green colour of plant tissue became darker, a* increased and b* decreased, so that paler flesh samples had lower (more negative) a* and higher b* values than peel samples. Concentrations of total chlorophyll, chl a, chl b and total carotenoids increased with increasing a* and decreasing b* values. Chl a/b and chlorophyll/carotenoid ratios were significantly lower in the flesh of each fruit than in the corresponding peel. The higher b* (yellow) values of flesh were probably the result of a higher proportion of chl b (yellow-green) to chl a (blue-green) and a higher proportion of yellow carotenoids to chlorophyll.

CONCLUSIONS

There is a significant relationship between colour and pigment concentration in green pepper fruit (*Capsicum annuum* L., cv Sondela). Results indicate that the dark green colour in peppers is due to relatively high chlorophyll and carotenoid concentrations, chlorophyll/carotenoid and chl a/b ratios. Concentrations of total chlorophyll, chl a, chl b and total carotenoids can be estimated from either a* or b* colour values.

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LICHTENTHALER, H.K., 1987. Chlorophylls and carotenoids: pigments of photosynthetic biomembranes. *Methods Enzymol.* 148, 358-382

Keywords: Capsicum annuum, carotenoids, chlorophyll, CIELAB, green fruit,

COLOUR CHANGE IN RIPENING RED PEPPER FRUIT IN RELATION TO PIGMENT CONCENTRATION

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INTRODUCTION

Ripening fruit of red pepper varieties change colour from green to red as a result of the concurrent disappearance of chlorophyll and formation of red carotenoid pigments. This process of colour change can be expressed in terms of the CIELAB colour system (McGuire, 1992). The aims of this study were to relate fruit colour to pigment concentration and to determine a suitable CIELAB colour value for estimating pigment concentration.

MATERIALS AND METHODS

Pepper fruit (*Capsicum annuum* L., cv STAR 6651) were harvested at various stages of ripeness from green mature to over-ripe (deep red). Similarly coloured exocarp portions (outer 2 mm of the pericarp) of each fruit were excised and CIELAB values L*, a*, b*, C* and h^o measured (five readings per fruit). Samples were freeze-dried and analysed spectrophotometrically (470 nm, 648.6 nm, 664.2 nm) to determine chlorophyll and carotenoid concentrations (Lichtenthaler, 1987). Data were subjected to analysis of variance (F-test) to determine significant differences (Rayner, 1967).

RESULTS AND DISCUSSION

Concentrations of total chlorophyll, chl a and chl b decreased quadratically with increasing a* as fruit turned from green to deep red, such that a* was the most suitable colour value for estimating concentrations of these pigments. Total carotenoid concentration increased with increasing a* until the bright red stage (maximum C*, no chlorophyll detected), but a*, b* and C* were lower for deep red fruit which had the highest concentration of carotenoids. The relatively dull colour of deep red fruit could have been due to the presence of small amounts of chlorophyll as well as to high carotenoid concentrations. The relative rate of chlorophyll disappearance to red carotenoid formation differs among fruit, even within a certain cultivar. This further compromises the suitability of using a* values to estimate carotenoid concentrations in ripening fruit. Carotenoid concentration increased linearly with decreasing hue angle ($h^o = \tan^{-1}$ b*/a*). Hue angle was therefore the most suitable colour value for estimating carotenoid concentration.

CONCLUSIONS

No single CIELAB colour value could be used to estimate concentrations of both chlorophyll and carotenoids in ripening red pepper fruit (*Capsicum annuum* L., cv STAR 6651). Hue angle was most representative of carotenoid concentration, and a* of chlorophyll concentration.

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RAYNER, A.A., 1967. A first course in biometry for agriculture students. University of Natal Press, Pietermaritzburg.

Keywords: carotenoids, chlorophyll, CIELAB, red pepper, ripening fruit,

PEARL MILLET (*Pennisetum glaucum*) RESPONSE TO WATER UNDER LINE SOURCE SPRINKLER SYSTEM

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INTRODUCTION

Pearl millet (*Pennisetum glaucum*) is a C_4 plant which has dual purpose, both as staple crop and forage, in semi-arid and arid regions. Apart from being drought resistant, pearl millet attributes include high nutritional value and ability to grow on a wide variety of soils. This study was carried out to investigate the response of the crop to water in a semi-arid region of South Africa.

MATERIALS AND METHODS

Two lines of pearl millet, 06 GCI-PM 17 and local variety Monyaloti were cultivated for two seasons (2008/2009 and 2009/2010). The field experimental site was Kenilworth Experimental farm of the Department of Soil, Crop and Climate Sciences of the University of the Free State, Bloemfontein during the summer of each season. The soil at the experimental site belongs to loamy aridic ustorthents (*Amalia family*). The experiment was laid out as a split plot design with four replications and a line source sprinkler was used as source of irrigation. The treatments include five levels of water application from fully irrigated, plots closest to the line source (W5), to rainfed plots (W1). The rainfed plots were twice the size of the irrigated plots to avoid the effects of border and lateral movement of water. Irrigation water was supplied once the plant available water fell below 70% in the W5 treatment plots. The field soil water content was monitored weekly with the aid of a Waterman Neutron moisture meter. Plants were thinned to two plants per station two weeks after emergence. Parameters such as leaf area, above ground biomass, radiation interception and yield components were collected at weekly intervals.

RESULTS AND DISCUSSION

Different water level treatments affected leaf area index, above ground biomass and radiation interception of the two lines of pearl millet during the two seasons. Maximum canopy development was attained in GCI 17 earlier than Monyaloti. W4 and W3 plots produced the highest leaf area and biomass compared to the rest of the treatments in the two lines of pearl millets. Rainfed plots produced the lowest leaf area index and above ground biomass in all water treatments during the study period. Development of reproductive parts was significantly affected by water treatment in the improved line while the local variety was not affected. Yield components that were affected by water treatments include number of heads per stand and grain yields.

CONCLUSIONS

The results show that pearl millet being a rainfed crop can still be cultivated and production improves under irrigation. Quantity of water applied plays an important role in the development of the crop.

ACKNOWLEDGMENT

This project was funded by Water Research Commission project (WRC K5/1771/4).

Keywords: Above ground biomass, leaf area index,, pearl millets, water treatments

COVER CROP INTERFERENCE WITH THE EARLY DEVELOPMENT AND GROWTH OF MAIZE AND YELLOW NUTSEDGE UNDER CONTROLLED CONDITIONS

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INTRODUCTION

Winter cover crops can fulfill an important part in sustainable agriculture because of their ability to suppress weed growth (Moore, Gillespie & Swanton, 1994). The objective of the study was to determine the ability of cover crops to suppress yellow nutsedge growth and influence early maize growth in a pot trial.

MATERIALS AND METHODS

Three cover crop species, stooling rye, oats and three annual ryegrass cultivars were planted in pots and grown for 21 weeks where after they were killed with glyphosate-isopropylamine. Four treatments were applied to the cover crops, two weeks after they were sprayed. Treatment one consisted of the dead cover crop material being left intact while in the second treatment the cover crop leaf material was cut and removed, leaving the roots intact. For treatment three leaf material were placed on top of previously unused sand while for treatment four the leaf material were soaked overnight in water where after it was placed on top of the unused sand. Ten maize seeds and ten yellow nutsedge tubers were planted separately into the four treatments. Emergence was recorded. Four weeks after planting, maize height, diameter and the dry weight of both test species were determined.

RESULTS AND DISCUSSION

Two weeks after maize emergence, growth of both test species was significantly inhibited in the root residues of the different cover crops compared to the control and leaf material treatments. By soaking the leaf material overnight in ordinary tap water, the suppressive qualities of the leaf material were reduced. Of all the cover crops tested, annual ryegrass was more suppressive than either stooling rye or oats with the cultivar Midmar being the most inhibiting. Chemical analysis of the leachate collected from the root material of the different cover crops indicated the presence three known allelochemicals at different concentrations.

CONCLUSIONS

Strong evidence exists for allelopathy to have caused the growth reductions of maize and yellow nutsedge growing in cover crop residues. The stunting of growth was more pronounced as the plants grew in sand increasing the availability of the allelochemicals. The results of this study support the findings of the field trial in which the annual ryegrass cultivar Midmar suppressed maize and yellow nutsedge growth.

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Keywords: allelopathy, cover crops, weed management

PRE- AND POSTHARVEST TREATMENTS ON 'HASS' AND 'FUERTE' AVOCADOS TO CONTROL ANTHRACNOSE (*Colletotrichum gloeosporioides*) AND PROLONG FRUIT RIPENING

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INTRODUCTION

Due to long distance shipping, South African avocado fruit require extended low temperature shipping. This may result in internal disorders (Leclereq, 1990), softening in transit (Eksteen, 1990) and an increase in postharvest disease incidence (Whiley *et al*., 2002). Anthracnose (*Colletotrichum gloeosporioides*) can cause considerable losses (Kotzé, 1978). This is often present as a latent infection, and is activated on ripening as antifungal compounds in the fruit decline. The objective of the study was to use systemic resistance inducers to enhance the production of antifungal compounds.

MATERIALS AND METHODS

'Hass' and 'Fuerte' fruit were subjected to a preharvest treatment of phosphorous acid (500 $mg.L^{-1}$ a.i.) and harvested at 0, 7, 14 and 21 days thereafter. Separate fruit were treated postharvest with phosphorous acid (500 $mg.L^{-1}$ a.i.) or potassium silicate (1000 $mg.L^{-1}$ a.i.). The fruit were stored for 28 days at either 5.5°C or 1°C ('Hass') or 2°C ('Fuerte') before ripening. Exocarp was sampled at five stages of softening during ripening. A total of 20 fruit (replicates) per sampling stage were used. Fruit condition was evaluated at each stage, and exocarp analysed for total phenolics, diene concentration, epicatechin and phenylalanine ammonia lyase activity. Ethylene and CO_2 production of fruit was analysed using Genstat.

RESULTS AND DISCUSSION

Ripening was prolonged for fruit stored at lower temperatures, as well as when subjected to phosphorous acid for both pre- and postharvest treatments. Both potassium silicate and phosphorous acid decreased the presence of anthracnose, indicating an effect on antifungal compounds.

CONCLUSIONS

Preharvest application of phosphorous acid appears to prolong ripening, and postharvest applications of phosphorous acid and potassium silicate may alter the antifungal characteristics of avocado fruit which could lead to an alternative postharvest disease control method.

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Keywords: Anthracnose, 'Hass', 'Fuerte', Phosphorous acid

EVALUATION OF MAIZE PRODUCTION UNDER LARGE-SCALE RAINWATER HARVESTING AND CONSERVATION TECHNIQUES

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INTRODUCTION

Less than 15% of South Africa's land area is arable. This implies very limited scope for conventional food production. In addition, South Africa is a semi-arid, water-scarce country with an average rainfall of less than 500 mm per annum (Schulze *et al.,* 1997). Rainwater harvesting and conservation (RWH&C) practices have not only been demonstrated to increase agricultural production but also to be environmentally sustainable. This study seeks to assess RWH&C techniques for improved cropland productivity.

MATERIALS AND METHODS

Cropland field experiments were carried out over two seasons (2008/09 and 2009/10) in three provinces on the Glen/Swartland; Glen/Oakleaf; Fort Cox/Oakleaf; Towoomba/Hutton and Towoomba/Arcadia ecotopes to compare RWH&C techniques. Five treatments, *viz.* conventional tillage (*CON* - control), in-field rainwater harvesting (*IRWH* – 2-m and 2.4-m runoff areas), Daling plough (*DAL*), mechanized basins (*MB*) and minimum/no-till (*MIN/NT*), replicated four times, were laid out in a randomized block design. Maize was used as the test crop and the indicators used were practicality, grain yield, dry matter production and rainwater productivity (RWP).

RESULTS AND DISCUSSION

Field preparation, implementation, planting, maintenance and harvesting went well with the implements only posing minor practical problems. Variations in yields and RWP were observed between seasons, as well as between localities. The preliminary general trend observed was that all RWH&C techniques, except for *MB,* produced higher grain and biomass yields, as well as RWP values, compared to *CON*.

CONCLUSIONS

Preliminary results indicate that RWH&C techniques induced higher yields and RWP values than *CON* with *DAL* and *IRWH* being the most effective.

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Keywords: Rainwater harvesting, conservation tillage, maize

EVALUATION OF MATURITY INDICES AND THEIR RATES OF CHANGE TO PREDICT OPTIMUM HARVEST MATURITY OF 'FORELLE' PEARS

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INTRODUCTION

'Forelle' (*Pyrus communis* L.) is a late blush pear cultivar grown in South Africa. It requires a mandatory 12 weeks of storage at -0.5°C, to allow even ripening and good eating quality. Firmness is one variable applied by the industry to determine harvest maturity for release dates (DFPT technical services, 2010). Firmness alone has been viewed not to give a good indication of ripening potential, which may result in loss of earlier marketing opportunities. Hence, the aim of the study was to use various maturity indices, and their rates of change to identify variables that could be reliably used in a prediction model for optimum harvest maturity and relate this to ripening potential and eating quality of 'Forelle'.

MATERIALS AND METHODS

'Forelle' fruit were sourced from three climatically diverse areas: Warm Bokkeveld, Koue Bokkeveld and Elgin. Fruit were harvested biweekly on five harvest dates over three consecutive seasons (2007-2009). Firmness (kg), ground colour, total soluble solids (%) (TSS), titratable acidity (%) (TA), starch breakdown (%) and ethylene ($\mu L \cdot kg^{-1} \cdot h^{-1}$) were measured and plotted against days after full bloom (DAFB) to determine rates of change and adjusted R^2 values.

RESULTS AND DISCUSSION

Seasons had a significant ($P < 0.05$) influence on the rates of change of the maturity variables. TSS increased at a higher rate (0.564%·day^{-1}) in 2007. This was linked to higher accumulated heat units (>17500) compared to 2008 and 2009. Firmness changed at a higher rate (> 0.420 kg·day^{-1}) than all other variables, and was comparable to ground colour. Furthermore, firmness and ground colour displayed a strong linear relationship to DAFB as explained by R^2_{adj} of more than 90% and 73%, respectively. Behaviour of TSS and TA over growing season showed inconsistency. Our study confirmed that post-harvest cold treatment is a prerequisite for 'Forelle' to allow accumulation of 1-aminocyclopropane-1-carboxylic acid for even ripening (Wang et al., 1985), since no ethylene was detected at any of the harvest dates.

CONCLUSIONS

Firmness could be combined with ground colour to reliably predict harvest maturity of 'Forelle' pears. TA and TSS will remain useful aids, only if coupled with other maturity variables when predicting harvest maturity.

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Keywords: Heat units, pre-harvest temperatures, prediction model

WATER CONTENT MEASUREMENT: A METHODS AND FIELD APPLICATIONS SHORT COURSE

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The measurement of soil water content is essential for many research applications in Soils, Crop Science, Weed Science, Environmental Science and Horticulture. With the recent proliferation of available measurement techniques, it can be difficult to determine which measurement technology is optimal for a particular research application. With a combined 70+ years of instrumentation experience, the authors will discuss the theory of measurement and relative strengths and weaknesses of several common soil water content techniques including gravimetric analysis, neutron thermalization, thermal analysis, and dielectric sensors (TDR, FDR/capacitance). The discussion of each method will include measurement theory, practical benefits and drawbacks, relative cost, and best field practices. The intended audience for this short course is laboratory and field researchers, technicians and students who need to make measurements of soil water content.

Keywords: Soil water content

EFFECT OF NUTRIENT CONCENTRATION DURING SUMMER ON GROWTH, YIELD AND QUALITY OF LEAFY LETTUCE IN A HYDROPONIC SYSTEM

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INTRODUCTION

Nutrient solution concentration is one of the most practical and effective ways to control and improve yield and nutritional quality of crops for human consumption. Literature shows conflicting results concerning the optimum electrical conductivity (EC) levels of nutrient solution for leafy lettuce in a closed hydroponic system (Serio *et al.,* 2001; Samarakoon *et al.,* 2006). The objective of this study was to determine whether growth, yield and quality of leafy lettuce can be influenced by nutrient solution concentration during the summer season.

MATERIALS AND METHODS

The study was conducted under a 40% black and white shade-net structure. The trial was laid out as a Latin Square Design with four electrical conductivity levels of nutrient solution (1, 2, 3 & 4 mS/cm) and four replicates. Lettuce cultivar, NIZ 44-675, was transplanted into mini-hydroponic tables filled with gravel as the growing medium. Plant growth parameters that were measured at the end of the growing season included leaf number, leaf area, fresh leaf mass, dry leaf mass and dry root mass. Minimum and maximum temperatures were monitored and measured daily using thermometer. Chlorophyll content was measured weekly using a Minolta SPAD meter while quality (taste) tests were done at the end of the season by performing sensory evaluations. Plant growth data were analysed using the statistical software Genstat (2003).

RESULTS AND DISCUSSION

Leaf number and dry leaf mass were not significantly affected by the treatments, while dry root mass showed a tendency to decrease with increasing nutrient solution concentration which could have been associated with nutrient toxicity. On the other hand, both leaf area and fresh leaf mass tended to increase with an increase in EC levels. EC level did not influence the flavor or taste preference of lettuce sampled by evaluators. EC level, however, significantly increased the chlorophyll content in lettuce samples which is also linked to quality.

CONCLUSIONS

The results indicated that nutrient concentration did not significantly increase yield and quality, although it showed some tendencies to improve yield especially with regard to leaf area and fresh leaf mass. Although not significantly different from the other treatments, nutrient concentration of 2 mS/cm was the most promising with regard to improving lettuce yield.

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Keywords: chlorophyll content, elecrtical conductivity, gravel culture hydroponics, nutrient solution, sensory evaluation

EFFECT OF GENOTYPE AND ENVIRONMENT INTERACTION ON THE SELECTION OF OPEN POLLINATED MAIZE (*Zea mays* L.) VARIETIES FOR SELECTED ENVIRONMENTS OF THE EASTERN CAPE PROVINCE, SOUTH AFRICA

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INTRODUCTION

Maize production in Eastern Cape (EC) Province is characterized by low yields due to variation in climatic conditions, low access to capital and numerous abiotic and biotic constraints. This has necessitates a shifted from the use of hybrid seed to improved, stress tolerant Open Pollinated Varieties (OPVs) for sustainability. Before farmers can adopt OPVs, multi-locational trials must be done to target these varieties into their respective environments. However, existence of Genotype by Environment Interactions (GEI) makes variety recommendations difficult. Therefore, the objective of this study was to identify improved, stress tolerant OPVs that are suitable for selected environments in the EC Province of South Africa.

MATERIALS AND METHODS

On-farm trials were conducted in nine different environments across the Amathole and O.R. Tambo districts. Sites in the former district were supplied with supplementary irrigation due to low rainfall, while sites in O.R. Tambo were rainfed. Varieties that were evaluated were nine promising stress-tolerant OPVs obtained from International Maize and Wheat Improvement Center (CIMMYT) and International Institute of Tropical Agriculture (IITA). Locally grown varieties were used as checks. These included a hybrid (PAN 6479) and three OPVs (Okavango, AFRIC 1 and Nelsons choice). All trials were set up in a randomized complete block design (RCBD), replicated thrice. Yield data was statistically analyzed with Additive Mean Multiplicative Interaction (AMMI) model using GENSTAT 4.2. Variety stability was calculated with AMMI Stability Values (ASV).

RESULTS AND DISCUSSION

Pan 6479, ZM 525, Afric 1, high yielding varieties, and Obatanpa, a low yielding variety, showed high interactive responses to high and low potential environments, respectively. Afric 1 and ZM 525 outperformed the hybrid in low potential environments. However, yield of ZM 525 was not significantly different from that of Pan 6479. Obatanpa was more suited to environments with low yielding potentials as improvement of environmental conditions did not improve yield. ZM 305, BR993 and Nelsons choice performed poorly in environments with high soil acidity. However, Okavango had higher yield rankings in these environments suggesting it was better adapted to high soil acidic. ZM 423, the most stable variety based on ASV, did not give a significant yield increment (0.91%) when recommended throughout the environments. On the other hand, ZM 525, a variety identified as unstable by the ASV, had a 9.85% yield increment.

CONCLUSIONS

There were differences in yield performance and stability for the varieties and this was due to the presence of GEI. Stability alone cannot be used as selection parameter as most of the stable varieties did not give a good yield improvement. Though, ZM 525 was an unstable variety, it could substitute hybrid seeds in high potential environments. Obatanpa should be recommended to low potentials environments while Okavango to should be recommended to environments with high soil acidic.

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Keywords: Open Pollinated Varieties, Genotype by Environment Interactions (GEI), Stability, Additive Mean Multiplicative Interaction (AMMI) model, AMMI Stability Values (ASV)

THE FORMATION AND STABILITY OF SECONDARY CU MINERAL PHASES IN THE SOILS OF THE O'KIEP COPPER DISTRICT

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INTRODUCTION

The historic mining area of O'kiep suffers from acute soil contamination caused by over one hundred years of mining practices in the region with little or no regard for environmental impacts. This has led to the surrounding soils being exposed to extremely high metal (mainly Cu) and salt contaminant loads. The aridity of the area ensures evaporation is a dominant hydrologic process. Evaporation of highly saline, metal contaminated pore waters can lead to the formation of rare metal containing evaporite type minerals. Due to the high solubility of these evaporite minerals they are usually the first to dissolve in a sudden rainfall event which can result in a front of metal laden water percolating down the soil profile. This study looks at the geochemical controls on Cu mobility in the arid soils of the O'kiep Copper District.

MATERIALS AND METHODS

Soil samples were collected from a profile directly down slope of a tailings dam. The chemical and mineralogical composition of the samples was determined using XRF and XRD, respectively. Soil solution modelling was conducted, using PHREEQC, on saturated paste extracts from the soils. Sequential extraction techniques were used to determine phases controlling the mobility of Cu within the soils.

RESULTS AND DISCUSSION

The soils down slope of the tailings are highly contaminated and contain up to 2% Cu in places. Two secondary Cu hydroxyl chloride minerals have been identified within the soil, atacamite [$Cu_2(OH)_3Cl$] and clinoactacamite (polymorph of atacamite). The sulfate equivalent brochanitite has not been identified despite high sulfate concentrations present in the soil. The occurrence of atacamite minerals in soils is rare, with the minerals usually occurring in oxidised ore bodies exposed to saline waters and clinoactacamite (polymorph of atacamite). The sulfate equivalent brochanitite has not been identified despite high sulfate concentrations present in the soil. The occurrence of atacamite minerals in soils is rare, with the minerals usually occurring in oxidised ore bodies exposed to saline waters (Cameron et al., 2007). The presence of atacamite over brochantite is a likely consequence of chemical divides during evaporation of porewaters.

The sequential extraction results show that a large proportion of the Cu is sitting in a labile phase. This labile phase is likely to include the secondary minerals atacamite and clinoatacamite. These minerals are stable in high chloride, high pH conditions. Changes in these chemical conditions through continuous additions of acidic mine drainage or through the addition of meteoric water during sporadic high rainfall events may cause considerable redistribution of contaminants in the soils.

CONCLUSIONS

The O'kiep soils show extreme levels of Cu contamination. The main Cu containing secondary phases include the minerals atacamite and clinoatacamite, which are labile under acidic, low chloride conditions.

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Keywords: Chemical divides, Hardie-Eugster, Spektakel

CROP MODELLING POTENTIAL FOR AGRICULTURE STUDIES: WHAT CAN WE DO TO BENEFIT SOUTHERN AFRICA?

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Temperatures, rainfall and radiation are determinant factors of crop growth. These climatological parameters are changing in the long term and will impact cropping systems. Depending on the location these changes can either harm or benefit agriculture, in any case systems will need to be adapted in order to cope or take advantage of these changing conditions. Crop models provide the opportunity to experiment a large amount of cropping conditions, subject to expected future climate. Though these models have limitations, their evaluation capacity allow to study climate change impacts on agriculture and adaptation alternatives that are likely to benefit or cope with those impacts. Numerous studies over the world showed that crop modeling is a useful tool for short (months), medium (years) and long term (decades) crop studies. Spatialisation is also possible and allows modeling of plot scale, districts, river basins, regions, countries or even continents, with related modelisation constraints.

Southern Africa is highly relying on agriculture, and southern African scientists already use crop models (APSIM, DSSAT, AgroMetShell, AquaCrop, etc.). What ever crop model is concerned, studies relying on simulations usually require (1) data collection and model set up; (2) model validation; (3) model simulation/exploitation and (4) careful interpretation of the outcomes. As soon as a crop model is used, the quality of the concerned studies strongly relies on the accurate realisation of the previous steps.

We do believe that a stronger regional network concerned with crop modeling over southern Africa would be beneficial to all users. Among others, it would help (1) identify data resources and African specific settings; (2) strengthen model validation on the count of former studies; (3) expend simulation/exploitation techniques horizon and (4) increase expertise for outcome interpretation. We would like to incite such a network. The first step is now : seeking for interested academics and institutions in order to start a contact collection on a Google group like accessible to all. This would ease contacts in between members and will likely provide new opportunities to build project proposals as well as strengthen regional studies and related scientific publications (even provide valuable material for a journal special issue for example). It will allow the organisation of more efficiently training, schools and workshops that deal with crop models and would benefit the whole network. At a long term perspective it can also help improve crop models with African specific cropping actions such as micro fertilisation that are still hardly represented in major crop models. We are convince that there would be interest in such a network. We would be glad to start building it with you!

Keywords: crop model, agriculture, climate change, southern Africa, network

AGRICULTURAL ADAPTATION IN A CHANGING CLIMATE REGARDING MULTIPLE OBJECTIVES

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INTRODUCTION

Temperature, rainfall and radiation are determinant factors of crop growth. These climatological parameters are changing in the long term and will impact cropping systems. Depending on the location these changes can either harm or benefit agriculture, and systems will need to be adapted in order to cope or take advantage of these changing conditions. We propose to use crop models to look for adaptation alternatives simulated under uncertain climate scenarios and evaluated with regard to multiple objectives.

MATERIAL AND METHODS

Crop models' ability to simulate crop responses to specific management strategies and differing climatic conditions make them valuable tools with which to study climate change impacts on cropping systems. Once the crop model has been calibrated locally and validated with historical data, it can be used to evaluate current/innovative management strategies under likely future climatic conditions. This study aims at exploring adaptation alternatives by looking for optimal simulation outcomes that will highlight the most efficient decision options. Decisions include any modeled crop action that can be controlled such as sowing, irrigating, fertilising, etc. The challenge of the study is to look beyond economic value only, and propose alternatives that take into consideration environmental perspectives.

RESULTS

As a first step toward the simulation of multiple locations in the Berg river and the Olifant river basins (Western Cape), we present the early stage simulation results for a wheat farm in the Swartland (Berg River basin). The strategies that maximise harvest yield and minimise nitrogen losses would be most desirable. Each decision option is simulated subject to various (climatically different) years from downscaled GCMs. This allows each option to be evaluated through multiple simulations within the model. These evaluations are compared from a multicriteria perspective in order to determine the multiobjective optima as well as the corresponding efficient decisions. These optima would range from only-environmental to only-economic concerns and highlight the various costs and benefits to each, as well as the sensitivity of each decision to climate variability or climate change uncertainty.

CONLUSION

The proposed range of alternatives is expected to benefit decision makers by providing new perspectives on the adaptation alternatives. It includes the potential achievements along multiple antagonist objectives and their sensitivity to weather variability and/or climate uncertainty.

Keywords: Crop Decisions, Climate Change, Adaptation Alternatives, Multiple Objectives, Uncertainty

RENOSTERVELD: A TOOL TO MANAGE DRYLAND SALINITY IN THE WESTERN CAPE

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The Renosterveld of the Western Cape region is often seen as a natural occurring veld type that will very easily re-establish itself wherever land is left unattended. In this study it was firstly noted that, where wheatlands of the Berg River catchment (BRC) are left bare for a number of years, the renosterbos as a pioneer plant is slow in its re-growth response and when re-establishment occurs, certain patches in the landscape exhibit improved growth. This study therefore firstly focussed on the soil restrictions that widely determined the positions in the Berg River landscape where the renosterbos will become re-established. Secondly we needed to know whether some of the soil restrictions encountered could be alleviated and was possibly following cultivation of this land. Aerial observation indicated a general patchiness in the naturally occurring Renosterveld of the Voëlvlei area and hill tops of the region, and was described by others as the true nature of this veld type. Closer investigation of the soils in the Voëlvlei reserve showed that soil type played a major role in the patchiness found there.

The most common soil restriction was higher soil density of the deeper horizons. Any soil form restricting root access to the perched water table (about 15m depth) could not support the renosterbos vegetation. Additionally we investigated the impact of land-use change on the soil water balance and soil salinity by comparing a mature re-established stand of Renosterveld with an adjacent wheatfield. From the results, large differences in salinity and soil water behaviour were detected between the Renosterveld and wheatfield. Modelling of soil and plant water relations was done and the results correlated well with field observations.

It is therefore of great importance that the negative effect of the removal of deep rooted native vegetation on soil water resources is understood to the benefit of long term sustainability and productivity.

It is however our belief that soil could be prepared for the re-growth of renosterbos and through this action and henceforth renosterbos could also be used to alleviate the salinity problems found in this region. The research confirmed that the renosterbos through its deep root system is crucial in the conservation of other species found in the Renosterveld resulting from its ability to keep the water table down and with that the salts that is so often a problem in this area. The Renosterbos can also be associated with the translocation of nutrients to the soil surface from deeper nutrient sources.

Keywords: Renosterveld, Dryland, Salinity

MOLECULAR MARKER-ASSISTED BREEDING OF LOW PHYTIC ACID MAIZE GERMPLASM LINES AT THE UNIVERSITY OF KWAZULU-NATAL

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INTRODUCTION:

Breeding for the low-phytic acid (LPA) trait in African maize varieties offers potential for improving mineral bioavailability in maize-based diets. Consumption of LPA grain by the monogastric humans and pigs would also reduce eutrophication because less phosphorus is released into the environment. Therefore research was undertaken to breed new LPA inbred maize lines with the low phytic acid gene (lpa1-1). The lpa1-1 is due to a single recessive mutation which is available in a temperate background.

MATERIALS AND METHODS

Molecular marker-assisted selection was used to identify recombinant F_5 lines with lpa1-1 gene after four cycles of conventional pedigree selection to enhance adaptive traits. An F_2 base population was developed from the cross CM32 (LPA parent) x CZL00023 (adapted parent). The 168 $F_{2:5}$ derived lines were evaluated for agronomic traits resulting in selection of 73 F_5 progenies. Plant tissues were sampled from this set and the parents and DNA was extracted. To detect the lpa1-1 gene, the Rotor-Gene 6000 real time rotary analyser was used for the PCR amplification and high resolution melt (HRM) analysis. The CZL00023 was used as the wildtype standard (homozygous dominant) and CM32 as the lpa1-1 homozygous recessive standard genotype. The F_5 lines and their testcrosses were evaluated for yield and agronomic traits at two sites.

RESULTS AND DISCUSSION

The parental lines both produced 150 bp PCR products after amplification with the lpa1-1 SNP markers which were then subjected to HRM analysis to differentiate the parental lines due to their definitive melting profiles. The lpa1-1 SNP marker is co-dominant and could therefore be used to detect homozygous dominant, homozygous recessive due to the melting profiles and heterozygous genotypes according to different plots using HRM analysis. Results revealed the three groups of progeny genotypes comprising 13 wild-type (homozygous dominant), 47 LPA (homozygous recessive) and 13 heterozygote lines. The homozygous recessive lines are desired as the LPA trait is already fixed. There is still an opportunity to recover extra lines from the heterozygous group which will be considered after careful scrutiny of yield and agronomic data.

CONCLUSION

The 47 LPA germplasm lines are highly valuable for use in breeding LPA varieties for deployment in Africa.

ACKNOWLEGEMENTS

This study was funded by the FAO/Global Partnership Initiative for Plant Breeding Capacity (GIPB).

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

WINTER COVER CROP EFFECTS ON ACCUMULATION AND DISTRIBUTION OF SOIL PHOSPHORUS UNDER NO TILL

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INTRODUCTION

Under no till, fertilizers and crop residues are usually not mixed into the soil, but spread on the soil surface, resulting in possible stratification of some non mobile nutrients such as phosphorus (P) in the top soil. The inclusion of winter cover crops in rotation with the main summer crop could facilitate the efficient cycling of P in no till systems. We therefore conducted a four year study to test the effects of winter sown cover crops on the amounts and distribution of P in the rooting zone under a no till irrigated maize system.

MATERIALS AND METHODS

The experiment was conducted under the Alice-Jozini Ecotope in the Eastern Cape..In winter 2007, oats (*Avena Sativa* cv. Serderberg) and grazing vetch (*Vicia dasycarpa* cv. Max) cover crops were planted with and without fertilizer. The fertilizer rate for oats was 15 kg N, 22.5 kg P, 30 kg K ha^{-1} applied as a compound (2:3:4 [30]) at planting and 30 kg ha^{-1} N applied as LAN (28%) six weeks after planting. Vetch received 10 kg P, 7kg N and 14 kg ha^{-1} K applied as a compound (2:3:4 [30]) at planting, including inoculation with *Rhizobium legunominosarium*. Control plots were included where weeds were left to grow. In the summer season, all 5 treatments were split and maize planted, with and without fertilizer. The fertilized maize received 60 kg N ha^{-1}, with a third of the fertilizer applied as a compound (2:3:4 [30]) at planting. This gave a 5 x 2 factorial arranged in a randomized complete block design, replicated three times. Soil samples were taken at the end of the fourth cropping cycle from 0-5, 5-20, 20-50 and 50-80 cm depths for the analysis of plant available P and total P. Other measurements taken were soil organic carbon, pH and EC.

RESULTS AND DISCUSSION

There were significant differences in the total P and plant available P across the treatments and sampling depths. The top (0 – 5 cm) had higher total P measurements than the lower depths across all treatments except where no P fertilizer was applied. Plant available P measurements of < 0.2 mg l^{-1} were obtained from the non fertilized weedy fallow and oats treatments, suggesting P deficiency in these treatments. The highest concentrations of plant available P were obtained in the fertilized oats and vetch treatments. There were also significantly higher concentrations of organic carbon on the vetch and fertilized oat cover crop treatments. The results suggest that vetch cover crop has the ability to increase plant available P in the top soil. Higher values of plant available P in the top soil were related to higher soil organic matter content.

CONCLUSIONS

The repeated applications of P fertilizer to cover crops and the maize crop increased plant available P in the top soil. The inclusion of vetch and fertilized oat winter cover crops resulted in better distribution of P in the rooting zone compared to weedy winter fallows.

ACKNOWLEDGEMENTS

The National Research Fund.

Keywords: cover crops, no till, phosphorus

WINTER COVER CROP EFFECTS ON SOIL SEED BANK COMPOSITION AND WEED EMERGENCE UNDER NO TILL

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INTRODUCTION

There are increasing calls upon farmers in South Africa to adopt no till farming out of the need to reduce soil degradation, fuel costs and improve sustainability of farming. Tillage has long been recognized as an important weed control tool and its abandonment towards no till poses a risk of increased weed problems, especially for resource poor farmers who cannot afford herbicides. However, high biomass yielding cover crops in no till maize systems may provide conditions that encourage rapid depletion of weed seed banks and non recruitment of new seeds, towards reduced weed problems. A study was therefore conducted to test the effects of winter sown cover crops on the seed bank composition as well as emergence patterns of problematic weeds in a no till irrigated maize system under the Alice-Jozini Ecotope in the Eastern Cape.

MATERIALS AND METHODS

In winter 2007, oats (*Avena sativa* cv. serderberg) and grazing vetch (*Vicia dasycarpa* cv. Max) cover crops were planted. Control plots were included where weeds were left to grow. The cover crops and weeds were terminated by rolling and spraying with glyphosate. All treatments were split and maize planted using no till (jab) planters in summer. No weed control was carried out during maize growth. At the end of the third cropping cycle, the seedling germination method was used for evaluating the weed seed bank (Clements *et al.,* 1996). Shannon's diversity index (*H*'), was used to provide an overall assessment of weed diversity and Shannon's *E* for weed species richness. The emergence patterns of the summer weeds in maize were also recorded.

RESULTS AND DISCUSSION

Cover cropping had no significant effect on depletion of some problematic weeds namely *Cyperus esculentus, Paspalum dilatum, Datura stramonium* and *Amaranthus viridis* from the seed bank. Although cover cropping significantly reduced the number of emerged weeds early in the season, it had no significant effect on narrow leafed weeds such as *Cyperus esculentus* as they had the ability to emerge from under vetch and oat cover crop mulch. The broadleaf weeds such as *Amaranthus viridis* appeared after cover crop residue decomposition in later maize growth stages.

CONCLUSIONS

Winter cover crops promote rapid depletion of weed seed banks towards reduced weed pressure in maize compared to weedy fallows. However, the effects are dependent on weed species. Oat and vetch cover crops may not be an effective control measure for grass weeds and *Cyperus esculentus.*

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ACKNOWLEDGEMENTS

The National Research Foundation.

Keywords: cover crops, no till, weeds

ALLELOPATHIC ROOT LEACHATE EFFECTS OF *Lolium multiflorum* x *perenne* ON CROPS AND THE CONCOMITANT CHANGES IN METABOLIC POTENTIAL OF THE SOIL MICROBIAL COMMUNITY AS INDICATED BY THE BIOLOG ECOPLATE™

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INTRODUCTION

Plant roots serve a multitude of functions including anchorage, provision of nutrients and water, as well as production of exudates with growth regulatory properties. Some root exudate components may act as allelochemicals and mediate interactions between plants and other organisms in the rhizosphere (Bertin *et al.,* 2003). The aim of this study was to test the appropriateness of Biolog EcoPlates™ as a quick and relatively cheap method of establishing the presence of microbe interactions mediated by allelopathic root leachates from either rotational crops or *L. multiflorum x perenne* (weedy rye grass hybrid).

MATERIALS AND METHODS

Biolog EcoPlates™ were used to indicate the effect of root leachates from six different donor plants on the soil microbial populations associated with the same species serving as acceptor plants, grown in pots with soil from the same origin in both sets of pots. Soil samples from acceptor pots were used to inoculate Biolog EcoPlates™ and the carbon utilisation patterns were compared to the pattern obtained for the soil microbial populations before treatment commenced.

RESULTS AND DISCUSSION

Results imply that soil microbial populations are affected differently by the compounds released by the different plant types and the composition of plant root exudates and soil type are important factors governing plant-plant and plant-microbe interactions. Thus, chemical interference from crop allelopathy in crop rotational systems may occur not only in weeds, but also in soil microbes and *vice versa.*

CONCLUSIONS

The Biolog EcoPlate™ could be used as an indicator of the allelopathic activity of crop or weed species, in particular allelopathic impacts on microbial populations.

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ACKNOWLEDGEMENTS

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Keywords: Biolog EcoPlate™ *L. multiflorum* x *perenne*, micro-organisms, root leachates, allelochemicals

IMPROVING RESOURCE USE EFFICIENCY THROUGH ADAPTIVE NITROGEN AND IRRIGATION MANAGEMENT: A CASE STUDY USING ANNUAL RYEGRASS

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INTRODUCTION

Nitrogen is often poorly managed in irrigated pastures and excessive applications are common. This can reduce pasture quality through toxic levels of nitrate, excessive protein content, increased non-protein nitrogen and reduced metabolisable energy. Application of variable rates of N according to the pasture requirement can be a solution for alleviating these problems. The objective of the study was to test whether adaptive nitrogen and irrigation management approaches could improve the current N recommendations derived from empirical studies, using ryegrass as a case study.

MATERIALS AND METHODS

Experiments were conducted at Cedara in the KwaZulu-Natal Midlands in 2007 and 2008 seasons. Italian ryegrass was planted in early autumn. Three treatments in 2007 and seven treatments in 2008 were set up in a randomised block design with three replications. In 2007, the experiment included three fixed N rate applications over eight growth cycles; representing high (60 kg N ha^{-1} $cycle^{-1}$), and medium (30 kg N ha^{-1} $cycle^{-1}$) forage target yields and a control with zero N. In 2008, treatments included four fixed N rates (0, 20, 40 and 60 kg N ha^{-1} $cycle^{-1}$) and one treatment based on N mass balance (N_{MB}) calculations. There were also two adaptive treatments, the first reducing N input and the second reducing irrigation input, based on nitrate measurements from wetting front detectors (WFD) at different soil depths. Forage biomass and forage N concentrations were determined at each harvest.

RESULTS

There were no significant differences in total seasonal forage yields among the two adaptive N treatments, N_{MB} and the fixed N rates of 40 and 60 kg N ha^{-1} $cycle^{-1}$. Adaptive management strategies based on the depth and concentration of nitrate reduced fertiliser N application by 28%, reduced residual soil N, and improved forage quality without reduction in forage yield as compared to the current recommendation

CONCLUSIONS

The results showed that the N savings from intensive monitoring could be achieved through a much simpler adaptive approach based on simple thresholds. These thresholds can be improved as more experience is gained.

ACKNOWLEDGMENTS

The authors are thankful to the WRC and NRF for funding.

Keywords: Adaptive strategy, Soil solution nitrate, Threshold soil nitrate, Wetting front detector

DOES COMBINED APPLICATION OF CROP RESIDUE AND INORGANIC N FERTILISER INFLUENCE N_2O EMISSIONS FROM TROPICAL SOILS?

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Emissions of N_2O were measured following addition of ^{15}N-labelled residues of *Vigna unguiculata* (cowpea), *Mucuna pruriens* and *Leucaena leucocephala)* to a Ferric Luvisol from Ghana at a rate of 100 mg N kg^{-1} soil under controlled environment conditions. Residues were also applied in different ratio combinations with inorganic N fertiliser, each combination applied at a total rate of 100 mg N kg^{-1} soil. N_2O emissions were increased after addition of residues, and further increased with combined applications of residues and inorganic N fertiliser. However, ^{15}N-N_2O production was low and short-lived in all treatments, suggesting that most of the measured N_2O-N was derived from the applied fertiliser or native soil mineral N pools. There was no consistent trend in magnitude of emissions with increasing proportion of inorganic fertiliser in the application. The positive interactive effect between residue- and fertiliser-N sources was most pronounced in the 25:75 *Leucena*:fertiliser treatment where 22.5 g N_2O-N m^{-2} kg $biomass^{-1}$ was emitted over 30 days. N_2O (log_e) emission over the 30 day experiment from all residue amended treatments was positively correlated with residue C:N ratio (r = 0.63; P<0.05), and negatively correlated with residue polyphenol content (r = -0.59; P<0.05), polyphenol:N ratio (r = -0.61; P<0.05) and (lignin+polyphenol):N ratio (r = -0.61; P<0.05), indicating the role of residue chemical composition, or quality, in regulating emissions even when combined with inorganic fertiliser. Under our controlled experimental conditions the 75:25 residue: fertiliser ratio appeared to offer the best compromise between release of N and management of N_2O emission, but the positive interactive effect even in this treatment means that it is unlikely that combined applications of residues and inorganic fertiliser can lower N_2O emissions, unless the residue is of very low quality promoting strong immobilisation of soil mineral N.

Keywords: Nitrogen, tropical soil, crop residue, inorganic N fertiliser, Nitrous oxide, nitrification

INTERACTIVE EFFECT OF LEGUMINOUS TROPICAL CROP RESIDUES AND INORGANIC N FERTILISER ON N RELEASE AND N_2O EMISSION

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INTRODUCTION

The integrated nutrient management paradigm (INM), which involves the use of both organic and inorganic sources of plant nutrient have been suggested as a sustainable option for soil fertility management in low input tropical agricultural systems. Aside from crop productivity improvement the INM strategy must also be environmentally-friendly.

MATERIALS AND METHODS

In laboratory incubations we examined the interactive effect of simultaneous application of N fertiliser (NH_4NO_3) and crop residues of differing chemical composition: *Mucuna pruriens*, *Vigna unguiculate* and *Leucena leucecepahala*, all applied at 100mg Nkg^{-1} based on the percentage N content of inorganic fertiliser or crop residue respectively, on N release and N_2O production in a highly-weathered, low nutrient tropical Ferric acrisol. Labelled crop residues: Leucena (4.6 15N atom %), and Cowpea (4.9 15N atom %) and Mucuna (4.415N atom %) were incorporated in 200g soil for 30 days either solely or in combination with unlabelled NH_4NO_3.

RESULTS AND DISCUSSION

15N labelling of crop residues enabled the determination of the 15N contribution of the crop residue applied solely or in combination with Inorganic N fertiliser. Mineral N concentration increased after application of the throughout the 30 day incubation period. In the study a positive interactive effect of combined application of crop residues and N fertiliser on N_2O emission was observed with the 75:25 leucena:fertiliser treatment offering the potential to increase soil N availability without increasing N_2O emission compared to the sole leucena amendment.

CONCLUSION

The study amply demonstrated an interactive effect between crop residues applied in combination with inorganic N fertiliser on N_2O emissions, but the magnitude of emissions varied with the chemical composition of the residues incorporated with the fertiliser. Thus, application of a ratio of leucena having a high polyphenol content (>4.6%) at a ratio of 75:25 residue: fertiliser offer the best compromise to improve soil N concentration without a significant increase in N_2O emissions.

REFERENCE

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Keywords: Nitrous oxide, crop residue, denitrification, inorganic N fertiliser, nitrification

FUNCTIONAL EVALUATION OF THE ROLE OF A GROUP 5 "LATE EMBRYOGENESIS ABUNDANT" PROTEIN DURING PLANT WATER DEFICIT

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INTRODUCTION

Improving a crop's drought tolerance through breeding necessitates an integrated strategy, including candidate gene identification and transfer. Cowpea (*Vigna unguiculata* (L.) Walp) was used as a source of candidate drought responsive genes, since it is a highly drought tolerant legume crop. Suppression Subtractive Hybridisation (SSH), combined with DNA microarrays, was employed to identify genes responding to drought stress [1,2]. A group 5 late embryogenesis abundant protein (*LEA5*) gene was selected as drought responsive gene for further characterisation. LEA proteins play an important protective role during desiccation and other abiotic stresses of plants. Currently, not much functional information is available in the literature regarding the group 5 LEA proteins, which are hydrophobic and, therefore, atypical compared to the more studied groups [3].

MATERIALS AND METHODS

The cowpea *LEA5* gene was over-expressed in the model plant *Arabidopsis thaliana*. Homozygous progeny were selected from independent transgenic lines. *In vitro* germination assays and seedling stress tests were performed in the presence of osmotic agents. Soil-grown plants were stressed with water deficit, and physiological responses such as absolute water content and chlorophyll content compared to non-transgenic controls.

RESULTS AND DISCUSSION

Nine transgenic *LEA5 Arabidopsis* lines were generated and confirmed with PCR. The response of *LEA5* transgenic *Arabidopsis* plants during water deficit, compared to the wild-type, were variable and dependant on the individual plant's level of dehydration before rewatering. *In vitro* osmotic stress experiments also did not yield a conclusive improvement in tolerance that can be ascribed to the group 5 cowpea LEA proteins.

CONCLUSIONS

It is hoped that the LEA5 gene will confer drought tolerance in the transgenic *A. thaliana* plants. There is evidence in literature of other plant group 5 LEAs that play a role during plant water deficit. However, so far the results does not support the conclusion that group 5 LEA proteins play a positive role during plant water deficit of transgenic *A. thaliana* lines.

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Keywords: Cowpea, drought, LEA5, SSH

ESTIMATING WATER USE OF *Moringa oleifera* WITH SAP FLOW MEASUREMENTS

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INTRODUCTION

Moringa is a fast growing, drought tolerant multipurpose tree. It is valued for its nutritional benefits for humans and fodder for animals and has many medicinal uses. It is one of the trees that has a good potential for biodiesel production. Considering the possibility of large scale cultivation of moringa for its multiple uses in general and for biodiesel production in particular, it is very important to study the impact of this plant on resources, particularly water.

MATERIALS AND METHODS

The experiment was carried out at the Hatfield Experimental Farm, University of Pretoria. Water use was estimated using the heat ratio method (HRM) developed by Burgess *et al*. (2001). Three probe sets were radially inserted to different depths into the sapwood of each tree and measurements were recorded every hour. All estimates of sap velocity were corrected for probe implantation effects (Swanson & Whitfield, 1981) and converted to sap flow. Data obtained from point sampling were scaled up to whole tree water use.

RESULTS AND DISCUSSIONS

Sap flow rate was measured over a period of one year from June 2009 to May 2010. The daily and annual course of water use was very variable, showing seasonal trends, owing to changing weather conditions and canopy cover. It was higher in summer than in winter. Average daily water use was about 0.79 mm. Sap flow rate in July and August was zero. This was associated with leaf fall caused by the low winter temperatures. Water use in September was less than 1 mm for the whole month, indicating that tree physiological activity was very low. Water use showed a more than nine time increase in October compared to September and a further more than 5 times increase in November compared to October. Water use remained high throughout the summer and reached highest levels in February. Close to 80% of total annual water use took place between November and March. This was related to the warm weather and increased water availability, coupled with maximum physiological activity (leaf, flower and pod production) of the plant.

CONCLUSIONS

Water use of moringa remained less than 3.5 mm day^{-1} even during the warm and wet season of summer. Water use over the growing season varied substantially, depending on the prevailing weather conditions, water availability in the soil and the growth stage of the plant.

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ACKNOWLEDGEMENTS

WRC and NRF for funding.

Keywords: Heat ratio method, Sap flow, Sapwood

THE VALUE OF DNA FINGERPRINTING FOR USE IN IDENTIFYING POTATO CULTIVARS

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INTRODUCTION

It is important for potato producers to know that they are producing the correct cultivar while producing seed and table potatoes, or for the processing industry. Morphological traits are traditionally used to identify potato lines or cultivars and entail characteristics such as tuber shape, leaf type, flower colour and sprout appearance. Identifying cultivars according to phenotypic appearance becomes more difficult when dealing with *in vitro* plants. A large number of cultivars are currently commercially available, and many of them were developed from a small genetic base. This resulted in closely related cultivars which are difficult to identify when using traditional methods. The utilization of DNA fingerprinting is presented as a fast, simple and reliable method for cultivar identification. A large number of polymerase chain reaction (PCR)-based techniques can be used to detect genetic differences (polymorphisms) in plants. Specific landmarks or markers have been developed to detect very specific polymorphisms. For their wide-scale usage in germplasm characterization and breeding, it is important that these marker technologies be exchangeable between different laboratories, which in turn require that they need to be standardized to yield reproducible results, so that comparison of the data is possible

MATERIALS AND METHODS

The Agricultural Research Council Vegetable and Ornamental Plant Institute (ARC-VOPI) uses Single Sequence Repeats (SSR) as a DNA fingerprinting technique. In order to perform SSRs, DNA is isolated from the plant material to be tested. Plant material may be *in vitro* plants, greenhouse plants or any fresh material. Polymerase chain reaction (PCR) is performed in order to amplify the DNA using specific SSR primers. The PCR products are separated using gel electrophoresis, followed by staining of the gel to visualise the PCR products, where after the DNA fragments are scored. Scoring determines the unique pattern or fingerprint for each cultivar for its own unique identification.

RESULTS AND DISCUSSION

SSRs have been developed for various important crops, including maize, soybean, wheat, barley and potato. Results showed that the use of SSRs is a very effective, accurate and reproducible method for discriminating between different cultivars and assigning a unique DNA fingerprint to each. ARC-VOPI has compiled a SSR DNA fingerprint database for 71 potato cultivars/lines using only five SSR primer pairs (Provan *et.al*., 1996). This technique is recommended for commercial potato growers, as well as for crops such as avocados, tomatoes, melons and many more.

CONCLUSIONS

DNA fingerprinting is a quick and very effective way to test the trueness to type of cultivars, and it can be done at a very early stage of plant development. For crops such as potatoes even the tubers can be used for DNA fingerprinting.

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Keywords: DNA fingerprinting, Single sequence repeats

COMPARING THREE CARBON ANALYSIS METHODS FOR WETLAND SOILS IN NORTH-EASTERN KWAZULU-NATAL

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INTRODUCTION

A research project is being conducted to understand the regional processes that control the different wetland types and distribution on the Maputaland Coastal Aquifer, also known as the Maputaland Coastal Plain (MCP), in north-eastern KwaZulu-Natal. One of the project objectives is to test and refine soil organic carbon (SOC) as an indicator of hydro-period in order to delineate and classify permanent, seasonal and temporal wetlands on sandy coastal aquifers. The aim of the present study is to evaluate the appropriateness of various SOC analysis methods with regard to characterizing wetland soils on the MCP.

MATERIALS AND METHODS

Soil samples were taken on 15-17 December 2008 and 27-28 April 2009 from six wetland sites: two on the southern transect (Eastern Shores) and four on the northern transect (Tembe Elephant Park to Kosi Bay). Three carbon analysis methods were compared, namely: loss on ignition (LOI = total C), dry combustion (total C) and rapid oxidation [SOC - Walkley-Black (W-B)].

RESULTS AND DISCUSSION

In this study it was found that linear responses of dry combustion (C) and LOI total C to changes in W-B soil organic C were highly significant. Likewise, the response of LOI total C was highly significant to changes in dry combustion total C. The linear relationships, as depicted by the correlation coefficients, were highly significant for the three comparisons. Furthermore, the W-B method could account for almost all of the variability of the LOI and dry combustion methods. The almost 1:1 relationship between SOC (from the W-B method) and total C (dry combustion method) indicated that the latter method could also be regarded as an appropriate estimator of SOC for this particular study area. Although it was the cheapest method, LOI tended to overestimate SOC.

CONCLUSION

It can be concluded that the W-B method is the most suitable in terms of simplicity and cost considerations to measure soil organic carbon to determine the hydro-period for wetlands on sandy coastal aquifers. Should cost not be a factor, the dry combustion method can also be considered as an alternative.

ACKNOWLEDGEMENTS

The Water Research Commission for financial support of the project.
Prof. Cornie van Huyssteen, University of the Free State assisted to interpret the analyses.
The iSimangaliso Wetland Park, Ezemvelo, KZN Wildlife and the Tembe Tribal Authority for project support and logistics.

Keywords: Coastal plains, Wetlands, Sandy soils, Carbon analysis methods

SOIL MICROBIAL POPULATION DYNAMICS IN THE ZEEKOEGAT CONSERVATION AGRICULTURE TRIAL, ROODEPLAAT

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INTRODUCTION

Increasing demand exists to quantify the impact of agricultural management practices on physical, chemical and biological soil properties to ensure recommended practices sustain soil health / fertility and maximize farmers' profitability. While agricultural practices are known to have significant effects on soil physico-chemical properties, less is known of the associated changes on soil biological properties. Microbial biodiversity is an integral part of soil quality and crucial to maintain ecosystem function. Monitoring the effect of management practices on microbial diversity and activities in soil will enable researchers to develop biological indicators for sustainable crop production.

MATERIALS AND METHODS

Composite soil samples were collected from specific treatments at the Zeekoegat Conservation Agriculture Trial, Roodeplaat, during October 2008 and October 2009. Soil samples were prepared for microbial population functional diversity analyses and enzymatic activity. A portion of the soil samples were inoculated into Biolog EcoPlates™ (Biolog® Inc.). Functional diversity of soil microbial populations was determined using the amount and equitability of carbon substrates metabolized as indicators of richness and evenness. Soil microbial population's ability to obtain carbon, phosphorus and nitrogen, was assayed by measuring ß-glucosidase, alkaline phosphatase, acid phosphatase, and urease activities in the soil. Data was analysed using STATISTICA 6 (StatSoft, Inc ©). Biodiversity was determined using the Shannon-Weaver and evenness diversity indices.

RESULTS AND DISCUSSION

Despite changes in soil microbial diversity under different agricultural practices during the course of the season, insignificant variation in microbial diversity under maize monoculture and maize/delayed intercropping was observed. Visible variation could be observed under maize/legume rotations. Diversity indices demonstrated increased microbial diversity under reduced tillage practices. Soil enzymatic activities were influenced by different agricultural practices. Preliminary results indicate slightly higher enzyme activities under reduced tillage than conventional tillage.

CONCLUSIONS

Agricultural practices influence sensitive soil biological properties as indicators of soil health / fertility. At this initial stage of the project, reduced tillage practice has a seemingly favourable effect on soil microbial diversity and enzymatic activity. Stimulation of soil microbial populations with the correct agricultural systems could promote availability of carbon sources for microbial utilisation. This impacts enzymatic activity and soil microbial diversity; ultimately resulting in increased mineralisation rates and faster nutrient recycling. In due course, these factors could eventually result in increased soil quality and fertility, resulting in a significantly beneficial effect on the sustainability of agricultural management practices.

Keywords: BIOLOG, enzymatic activity, soil health, soil microbial communities

THE EFFECT OF ETHYL METHYL SULFONATE CONCENTRATION, TREATMENT TEMPERATURE AND DURATION ON MUTAGENESIS OF SELECTED VERNONIA LINES

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INTRODUCTION

Chemical mutagenesis using ethyl methyl sulfonate (EMS) is a powerful tool in inducing random useful genetic mutations in crop plants (Kim et al., 2005). Mutations of a single or few genes possessing target traits are invaluable in crop improvement programs. This study was conducted to determine the optimum EMS concentration, treatment temperature and duration that would enable 50-60% germination and minimum days to seedling emergence in inducing mutations in vernonia (Vernonia galamensis var. ethiopica), a potentially novel industrial oilseed crop rich in naturally epoxidised oil (Shimelis et al., 2008).

MATERIALS AND METHODS

Seeds of four selected lines of vernonia (Vge-1, Vge-4, Vge-7 and Vge-10) were treated in two replicates using three EMS concentrations (0.372, 0.744 and 1.1%), three temperature regimes (30, 32.5 and 35°C) and four time durations (0.5, 1, 1.5 and 2 hours). The treated seeds were planted in seedling trays and germinated in a tunnel at a Controlled Enviroment Facility (CEF) of the University of KwaZulu-Natal. Days to 50% emergence and germination percentages were recorded for each variety and treatment combinations.

RESULTS AND DISCUSSION

There existed significant interactions ($P<0.001$) between EMS, variety, time and temperature for both germination and days to emergence. Optimal seed germination at 50-58.33% and relatively early emergence of 10-12 days was achieved for Vge-1, -7 and -10 when treated with 0.372% EMS at 35°C and an hour treatment duration. The ideal treatment combination for Vge-4 was 0.372% EMS at 32.5°C for 2 hours that provided 53.33% of seed germination and early emergence at 9 days after planting.

CONCLUSION

he treatment combinations that yielded optimum results in the tested lines will be utilized to induce large scale mutation in V. galamensis to select target mutants.

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ACKNOWLEDGEMENTS

The National Research Foundation is acknowledged for financial assistance of the study.

Keywords: ethyl methyl sulfonate, epoxy oil, mutation, vernonia

ESTABLISHMENT OF METHODS OF REDUCING IN VITRO PHENOLIC OXIDATION AND INCREASING MULTIPLICATION RATES IN THE ABB-TYPE BANANA, 'PISANG AWAK'

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INTRODUCTION

Bananas are amongst the most important food crops in the world. 'Pisang Awak' has traditionally been grown by small scale farmers for local consumption as a dessert fruit. However, it also has potential for value-adding as a juicing banana and can be processed into a high-fibre flour which can substitute wheat flour. The availability of planting material of the ABB-type banana 'Pisang Awak' is limited due to insufficient supply of good-quality planting material. Proliferation of banana is highly dependent on genotype. Micro-propagation of 'A'-genome banana cultivars is generally more efficient than selections containing the 'B'-genome, which appears to negatively affect multiplication (Hirimburegama and Hamage, 1997; Arinatwe *et al*., 2000). Propagation by suckers and conventional tissue culture is highly inefficient and is plagued by excessive browning of the plant tissues by phenolic compounds (Ko *et al.*, 2008). This study investigated the reduction of explant browning and increasing multiplication rate through the use of various methods including drying, anti-phenolics, liquid vs solid culture, manipulation of subculture interval and removal of apical dominance.

MATERIALS AND METHODS

The study had two focal areas:
In vitro plantlets were subjected to various treatments to reduce browning. These included explant drying before culture, addition of 3 $g.L^{-1}$ activated charcoal to the culture medium, addition of 0.5 $g.L^{-1}$ ascorbic and citric acids in the culture medium, reduced subculture interval and liquid culture medium.
Furthermore, *in vitro* plantlets were subjected to various treatments to improve the proliferation rate. These included longitudinal sectioning ('half' explants) of *in vitro* plantlets and cultured on liquid or solid medium containing 1 $mg.L^{-1}$ benzylaminopurine (BAP), 2 $mg.L^{-1}$ BAP or 4 $mg.L^{-1}$ BAP.

RESULTS AND DISCUSSION

Reduction of browning due to phenolics was most satisfactorily achieved using liquid culture medium (less than 20% browning). Eighty percent of explants were still affected by explant browning during drying, addition of activated charcoal, the addition of anti-oxidants and reduced culture interval. Proliferation rates of 3.0 when half explants were used at higher BAP concentration (2 and 4 $mg.L^{-1}$) were obtained. The proliferation rate did not exceed 1.5 when whole explants were used, for all BAP concentrations. Plant quality did not appear to be affected by the explant type or the higher BAP concentration. Proliferation rate was significantly higher in liquid medium than solid medium supplemented with 2 $mg.L^{-1}$ BAP.

CONCLUSIONS

The best methods included a combination of explant drying followed by a period of liquid culture using shorter subculture intervals to reduce explant browning and longitudinal sectioning to eliminate apical dominance.

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Keywords: Piesang awak, micropropagation, phenolics, proliferation

SOUTHERN AFRICAN PLANT INVADERS ATLAS (SAPIA) PHASE II AND EMERGING INVASIVE ALIEN PLANTS

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INTRODUCTION

The Southern African Plant Invaders Atlas (SAPIA) is a mapping project, launched in 1994, to collate information on the distribution, abundance and habitat types of invasive alien plants (IAPs) in southern Africa. The focus of the SAPIA phase II project, launched in 2005, is on emerging invasive alien species and from 2010 the project will be aligned with, and provide support for, the South African National Biodiversity Institute (SANBI)'s Early Detection and Rapid Response of emerging invasive alien plants programme (ED&RR).

MATERIALS AND METHODS

The SAPIA database is a computerized catalogue of some 70 000 locality records of more than 600 naturalized alien plant species. The database incorporates records gathered by about 560 participants since 1994 and from roadside surveys conducted by the author since 1979 (Henderson 2007). SAPIA phase II aims to make all SAPIA information available to the public at the Weeds and Invasive Plants website (WIP) (www.agis.agric.za/wip). Electronic SAPIA newsletters are sent out at three-monthly intervals.

RESULTS AND DISCUSSION

Since April 2005, more than 13 000 records have been added to the SAPIA database (12 000 from roadside surveys and 1 000 from the public). One hundred and six species, with 83 newly recorded or emerging species were added to the SAPIA database bringing the total to ± 660. Most emerging species are ornamentals and were located close to habitation and in disturbed sites. Some parts of the country were re-surveyed after almost 20 years revealing large increases in the number of IAPs. A major discovery was made of a submerged aquatic weed, hydrilla (*Hydrilla verticillata*), at the Pongolapoort Dam in KwaZulu-Natal. Torch cactus (*Echinopsis spachiana*) could become as much of a pest as the prickly pear in the 1900s if urgent steps are not taken to control it. More attention should be paid to invasive grasses particularly in the W Cape where they are invading Fynbos and succulent Karoo. A new generation of IAPs in Fynbos, such as bottlebrushes (*Callistemon* spp.), threaten to replace the older generation IAPs, many of which have been successfully controlled biologically. Pompom weed (*Campuloclinium macrocephalum*) continues to spread at an alarming rate.

CONCLUSIONS

Urgent steps are needed to prevent further invasions and to target emerging species.

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ACKNOWLEDGEMENTS

Financial support for the SAPIA project has been provided by the Department of Water Affairs' Working for Water Programme since 2005.

Keywords: Emerging invasive alien plants, mapping project, southern Africa

POSSIBLE ALTERNATIVE METHODS OF OYSTER MUSHROOM SUBSTRATE DISINFECTION

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INTRODUCTION

Proper disinfection of mushroom growth medium is the most important step in the production of oyster mushrooms (*Pleurotus ostreatus*) (Stamets, 2000). Conventional hot water bath treatment or steam pasteurisation is costly. In rural South Africa electricity or wood needed for the mentioned treatments are not readily available and are unaffordable for small-scale oyster mushroom farmers. Even water is a scarce resource. The objective of this pilot study was to screen the possible alternative disinfection methods.

MATERIALS AND METHODS

Maize stalks were put through a hammer mill and the chopped straw was divided into 5 kg batches. These batches were subsequently subjected to eight different treatments. The treatments were as follows: one hour in 70 °C water bath, respectively four, five and six days yeast fermentation, four, five and six days cold fermentation as well as a two hour submersion in a 5 g potassium permanganate/1000 ml water solution. The treated substrate was spawned at a rate of 5% per wet weight and then subdivided per treatment into 10 bags of 2 kg each. The inoculated bags were incubated in a growth room. Colonization was regularly monitored and fruiting recorded. The bags were completely randomised within the growth room.

RESULTS AND DISCUSSION

Compared to the hot water bath control, results show that most of the treatments have potential as an alternative treatment of substrate. The potential treatments need to be refined to ensure optimal production.

CONCLUSIONS

The results showed that both yeast and cold water fermentation have the potential to substitute hot water bath or steam pasteurization in small-scale oyster mushroom production.

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Keywords: Disinfection, substrate, oyster mushroom, pasteurisation

EFFECT OF CHLOROACETAMIDE HERBICIDE DAMAGE ON THE PHYSIOLOGY AND YIELD OF MAIZE

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INTRODUCTION

Herbicide damage due to the use of chloroacetamide herbicides or mixtures thereof has been found in many crops worldwide. The aim of this study was to elucidate the effect of chloroacetamide herbicides on different soil types and to determine crop yield loss where chloroacetamide herbicides are applied alone or in combination with other herbicides.

MATERIALS AND METHODS

Two field trials were conducted at two localities during 2007/2008 and 2008/2009 with clay content of 35% and 16%. Six chloroacetamide herbicides were tested on four maize cultivars. Herbicides were applied at the standard registered dosage rates and double this dosage rate one day after planting. Control plots for each cultivar were included and were kept free from weeds by hand. Plant height (cm) and dry mass (g) of above-ground plant parts were recorded over time at both localities. Yield was determined by hand harvesting the middle two rows of each plot and yields were corrected to 15% moisture content.

RESULTS AND DISCUSSION

Herbicide treatments had a significant effect on plant height on both soil types for the 2007/08 season 23 DAP. Cultivars had a significant effect on plant height on both soil types and seasons 23 DAP. The herbicide treatment x cultivar interaction was only significant for plant height, 23 DAP on clay soil. Plant height was significantly reduced in the acteochlor/atrazine/terbuthylazine+safener and acteochlor+safener treatments for both dosage rates on clay soil. All the herbicide treatments reduced plant height significantly (>10%) on sandy soil during the 2007/08 season, but only the acetochlor/atrazine/terbuthylazine+safener and acetochlor+safener treatments reduced plant height significantly during the 2008/09 season on sandy soil. PHB30H05 was significantly less tolerant to herbicide treatments on both clay and sandy soil during the 2007/08 season, whereas LS8053 was less tolerant on sandy soil during 2008/09. Acetochlor and most likely other chloroacetamide herbicides are more readily metabolized in tolerant than in susceptible hybrids. CRN3505, PAN6966 and PHB30H05 outgrew stunting effects of herbicide treatments completely. Cultivars and the interaction of herbicide treatment x cultivars had a significant effect on yield where maize was planted on clay soil. PHB30H05 was the only cultivar that had a yield loss of 27% where acetochlor/atrazine/terbuthylazine+safener was applied at the registered dosage rate. Yield loss for CRN3505 was significantly reduced at both dosage rates where acetochlor+safener was applied on sandy soil. LS8053 showed yield loss of >20% where acetochlor/atrazine/terbuthylazine+safener was applied on sandy soil at double the registered dosage rate and at both dosage rates where Atrazine/S-metolachlor/terbuthylazine was applied. Yield loss of >20% was recorded for PHB30H05 where acetochlor/atrazine /terbuthylazine+safener was applied at the registered dosage rate and for acteochlor+safener, applied at double the dosage rate. Only the herbicide treatment x cultivar interaction had a significant effect on maize yield during the 2008/09 season on sandy soil.

CONCLUSION

Significant yield losses were recorded especially for acetochlor+safener treatments but maize cultivars showed different sensitivity towards the various herbicide treatments.

Keywords: acetochlor, maize, phytotoxicity, yield loss, atrazine

INCREASING ROOTING OF EUCALYPTUS AND AVOCADO CLONES IN SOUTH AFRICA

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INTRODUCTION

Rooting percentage of eucalyptus clones and avocado rootstocks is very poor. The most common factors affecting commercial nurseries are the high chemical, labour, time and cost inputs as well as algae, fungal disease, pests and weeds (Lombard, 2004; Zhou *et al.*, 2008).

AIM

The primary aim of the investigation was to increase the rooting percentage of eucalyptus and avocado clonal material under optimal greenhouse conditions. Secondly, the relationship between various greenhouse parameters and endogenous rooting hormones as well as the effects of seasonal changes on these compounds were determined; ultimately the intention was to decrease cutting production costs and time.

MATERIALS AND METHODS

Three eucalypt clones of the eucalyptus hybrids *E. grandis x E. nitens, E. grandis x E. camaldulensis and E. grandis x E. urophylla,* were grown under standard commercial greenhouse conditions with a sanitation treatment applied. . Avocado rootstock cuttings were prepared in the same manner as eucalypt cuttings. Rooting percentage was recorded as well as disease incidence.

RESULTS AND DISCUSSION

Rooting percentage of all eucalypt clones was increased by more than 20% by applying the sanitation treatment when compared with commercial rooting percentages. *E. grandis x E. nitens* (hard to root variety) rooting percentage was increased by more than 50%. Seasonal changes showed marked variation in rooting ability. Treated trays were free from algae, weeds and fungal growth while control trays showed a high incidence of such problems. By decreasing the amount of algae and fungal growth in trays, the cuttings may be able to utilize oxygen and nutrients, and this in turn results in a higher rooting rate. The results show that by simple, affordable changes to commercial methods, rooting percentages can be greatly increased while the time to rooting can be decreased.

CONCLUSION

Rooting percentage can be increased significantly by simple, affordable treatments which can be adapted for commercial greenhouse methods.

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Keywords: Auxin, Avocado, Eucalyptus, Calcium, Clones, Rooting

THE USE OF A SOIL WATER BALANCE MODEL TO SELECT THE IDEAL RAINWATER HARVESTING STRATEGY IN SEMI-ARID AREAS

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INTRODUCTION

Rainfall in semi-arid areas is generally insufficient to meet crop water requirements, and above all is erratic in distribution. This leads to crop yield fluctuation, which drastically affects food security. Rainwater harvesting technologies, which involve the collection and concentration of runoff for productive purposes, have been implemented in these areas in order to mitigate the effect of perennial droughts. The successful adoption of these technologies can contribute to poverty alleviation, and therefore improve the livelihood of resource-poor subsistence farmers. Field trials for testing different rainwater harvesting scenarios in order to identify the best strategy for a particular semi-arid area and season are very expensive, time consuming and laborious. As a result, crop models must be used to help study these systems, and thereby make prudent water harvesting design choices for specific situations. The aim of this study is to select the ideal rainwater harvesting strategy in semi-arid areas with the help of a soil water balance model.

MATERIALS AND METHODS

A simple, one-dimensional soil water balance model (Soil Water Balance-SWB) was modified by incorporating linear runoff estimation models and calibrated in order to predict the soil water balance and crop yield under different rainwater harvesting design scenarios and to select the design most likely to succeed in a particular locality. Various rainwater harvesting design scenarios were run for two different semi-arid areas, on different soil types to illustrate the application of the SWB model as a tool to help design the most appropriate rainwater harvesting strategy, taking into account whether arable land is limiting or not limiting for crop production.

RESULTS AND DISCUSSION

Simulation results reveal that in drier years bigger design ratios (cropping area: runoff area) of the in-field rainwater harvesting technique (IRWH) are most likely to be successful, while in wetter years smaller design ratios of the IRWH technique or even simpler rainwater harvesting strategies such as the tied ridge and the conventional tillage techniques can harvest sufficient rainfall for maximum crop production. Results from field trials conducted in Pretoria, on sandy clay loam soils, confirmed that, in a wet season, maize yield is maximized by a smaller IRWH design ratio (1:1) with a bare runoff area.

CONCLUSIONS

The SWB model can be used as a tool to help select the most appropriate rainwater harvesting strategy under specific conditions with acceptable accuracy and minimum input requirements.

Keywords: rainwater harvesting, SWB model, semi-arid areas, in-field rainwater harvesting, Soil Water Balance, design ratios

INTEGRATING STRUCTURAL DEVELOPMENT AND EXPANSIVE GROWTH WITH THE CARBON BALANCE IN THE CANEGRO SUGARCANE MODEL

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INTRODUCTION

Crop simulation models can be used as tools to assist plant breeding, by predicting phenotypes based on genetic and environmental information. Such models must be able to predict complex traits (e.g. yield) by simulating interactions between simple genetic traits (e.g. leaf elongation rate) and environmental factors. The Canegro model [1,2] simulates canopy development at shoot and leaf level; light interception, photosynthesis, growth and maintenance respiration, and partitioning of assimilated carbon (C) to different plant components at whole-crop level. Although photosynthesis is influenced by the size of the canopy, shoot and leaf development is not affected by carbon availability (source strength), which is unrealistic. The objective of this study was to modify Canegro to mechanistically (rather than descriptively) simulate shoot and leaf development and growth, taking into account carbon and light availability. This will provide indications of the feasibility of using the improved model to support sugarcane genetic improvement programs.

MODEL DEVELOPMENT

New model attributes include: (a) Primary shoot appearance depends on bud density and planting depth, in addition to temperature; (b) Secondary shoot appearance and senescence is governed by intra-row light interception and carbon availability, as well as temperature; (c) leaf appearance is governed by temperature and leaf senescence by carbon availability; (d) interception of light is calculated in layers and photosynthesis determined for each leaf; (e) expansive growth, sugar accumulation and the carbon balance are simulated separately for each phytomer (leaf and internode) on every shoot; (f) expansive growth is determined by temperature and water stress as in Canegro, but is now also regulated by carbon availability; (g) carbon requirements (sinks) to support stalk volume and leaf area expansion are determined from internode density and specific leaf area; (h) stalk hexose is determined from fibre growth rate; (i) the remaining carbon is stored as sucrose in the internode which can be re-mobilised to support growth and respiration on that shoot; (j) respiration rates are calculated separately for each phytomer component (leaf, internode fibre, hexose and sucrose).

RESULTS AND DISCUSSION

A sensitivity analysis was performed, and the model responded appropriately to changes in simple genetic traits. Further calibration work remains before the new model is ready for operational use. The phytomer-level integration of structural development and expansive growth with the carbon balance opens up new opportunities for model-assisted breeding.

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Keywords: GxE, simulation, source-sink, phytomer

HONEYBUSH TEA INDUSTRY

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Contrary to what the word may suggest, honeybush tea is not tea that is mixed with honey. Rather, honeybush tea is made from a plant (*Cyclopia spp*) that is endemic to the Western and Eastern Cape Provinces of South Africa. This plant occurs naturally in the fynbos area from the West Coast to Port Elizabeth in the east. It is used as a herbal tea with health promoting properties and is low in tannin, caffeine-free and contains high levels of antioxidant.

The honeybush industry is one of the newest industries in South Africa. Previously, honeybush was harvested in the wild and fermented in heaps. The quality of the taste varied remarkably and ranged from tea with no taste to fairly good taste. It was therefore important to investigate alternative methods of processing and product development for effective marketing.

There are 23 species of honeybush, of which three are currently grown commercially. One of these species is mostly harvested in the wild, with the risk of damage to natural populations due to unsustainable harvesting. To establish a viable industry with growth potential, it is important to establish commercial plantations. During the early nineties when the need to establish plantations was expressed, no information was available on the cultivation of honeybush and thus research was required. Since then research has been conducted on rhizobium for honeybush, soil preparation and the evaluation of the best plants for commercial production.

The South African Honeybush Tea Association (SAHTA) was formed in 1999 to co-ordinate the activities of wild harvesters, producers, processors, nurserymen and marketers. Ten years later, this association was registered as a section 21 company. Meetings were held to identify strategies for the development of SAHTA and the main strategies will be discussed.

Currently the industry still has very low tonnage that is marketed each year. Most of the honeybush tea is exported to Europe, the UK and the USA. Local use of honeybush is very low, as the product is fairly unknown to local consumers. Promotion is of utmost importance. In addition, another problem is that the demand for this tea by far exceeds the supply thereof. Production is still very low and needs to increase, but cultivation practices are lacking due to limited funds being available for research into production protocols.

For more information visit: *www.arc.agric.za/home.asp?pid=4045* or *sahoneybush.co.za* or *sahoneybush.co.za*

Keywords: Cyclopia, honeybush, industry, production

EFFECT OF SOIL SURFACE MANAGEMENT ON GROWTH AND YIELD OF PINK LADY APPLE TREES

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INTRODUCTION

During the 1990s, organic farming became one of the fastest growing segments of American and European agriculture. In South Africa there was also an interest in organic fruit production. However, organic fruit production guidelines are limited and not always supported by scientific data. The aim of this project was to compare organic soil management practices with soil management practices currently applied within the framework of integrated production to supply guidelines for sustainable organic fruit production.

MATERIALS AND METHODS

This study was done on Pink Lady apple trees during period 2003 – 2011 on the Elgin Experiment Farm in the Western Cape region. The following treatments were applied:
Chemical weed control in tree row from bud break till autumn, weeds slashed in work row from bud break till autumn (T1);
Cover crop established in work row during winter, combined with full surface chemical control from bud break (T2);
Mulch applied to tree row, cover crop in work row during winter, full surface chemical control from bud break (T3) ;
Mulch applied to tree row, cover crop in work row during winter, slash weeds in work row and hand weed tree row from bud break (T4) and
Mulch applied to tree row, slash weeds in working row and hand weed tree row from bud break (T5).

RESULTS AND DISCUSSIONS

Vegetative growth of the trees was vigorous in all the treatments from 2003 to 2010, but 25% less vigorous in T1 and T2 compared to T3, T4 and T5. Continuous release of nutrients from the compost (T3-T5) may have caused the vigorous growth of the trees. The yield of T1 and T2 was on average 65% more than that of the mulched plots (T3-T5) as measured from 2008 to 2010. Soil surface management in the work row did not have a significant effect on growth and yield of the trees.

CONCLUSIONS

Compost contributed to vigorous growth of the trees and low yield. When compost is applied, care should be taken to balance the growth and yield of the trees. At the end of the project articles on guidelines on sustainable organic as well as integrated management practices of apple production will be published.

ACKNOWLEDGEMENTS

ARC
DFPT

Keywords: mulches, apple, growth, yeild, organic

MANIPULATING OF KENAF GROWTH AND BIOMASS BY THE MEANS OF NITROGEN AND WATER

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INTRODUCTION

Kenaf is a tropical annual crop, attracting considerable attention as multipurpose plant. It has a great potential for energy, feedstock, building materials and paper production. Growth parameters and biomass production of kenaf seem to be influenced by nitrogen fertilization and water availability. Kenaf response to nitrogen fertilization depends on various factors including climatic conditions, soil type, soil fertility, and agrotechnical practices.The aim of the study was to investigate the effect of Nitrogen and water on growth, physiological parameters and biomass yields of kenaf "Tainung 2" cultivar

MATERIALS AND METHODS

Two field trials, one irrigated and one rain-fed, were established at the University of Pretoria, Hatfield Experimental farm, Pretoria on a Hutton soil type. Four nitrogen levels (N_0=0, N_1=50, N_2= 100 and N_3=150 kg.ha^{-1}) were applied for both rain-fed and irrigated trials. Irrigated plots were filled to field capacity every week. All plots received a basal dressing of 0 or 50 kg N ha^{-1} at planting and 0, 50 or 100 kg N ha^{-1} after thinning out (35 days after planting: DAP). Each plot also received 30 kg P and 100 kg K ha^{-1} at planting. The plots for both two experiments were laid out in a completely randomized block design (CRBD). Growth, physiological parameters, and biomass yield were measured in subsequent harvests throughout the growing period.

RESULTS AND DISCUSSION

Overall, increasing N enhanced both yield and growth parameters. It was evident that the irrigated crop performed better than the rain-fed throughout the season except at 58 DAP. At final harvest, the contribution of stem to the total aboveground dry biomass ranged between 75 and 79% for both trials. At final harvest N_0 irrigated plants were taller than all the rain-fed plants. In addition, this component did not respond to nitrogen under irrigation as the rain-fed crops did. The basal stem diameter at the final harvest responded positively to nitrogen, though there was not difference between the irrigated and rain-fed crops. Unlike rain-fed treatments, the bark percentage, the bark-core ratio as well the nitrogen use efficiency of irrigated kenaf responded to N application. Nitrogen use efficiency of the irrigated plants was higher than the rain-fed ones. The N treatments had no effect on germination in both trials.

CONCLUSIONS

Managing water and nitrogen seems to be the important keys for optimizing growth parameters as well biomass production of kenaf. The data strongly suggest that increasing nitrogen can increase not only the stem yield, but the total harvestable bark under irrigation conditions. Interestingly, the maximum bark percentage was observed with the N_0 rain-fed crops. We have identified the need for further research on the response of kenaf to N application.

ACKNOWLEDGEMENTS

Sustainable Fibre Solution (Pty Ltd) for funding and Mr JH Marneweck for technical assistance.

Keywords: Kenaf, Multipurpose crop, Growth characteristics, Biomass production, Nitrogen, Water

SUPPORTING MICROBIAL COMMUNITIES IN THE SOIL AND THE EFFECT ON APPLE PRODUCTION IN THE CAPE REGION

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INTRODUCTION

As scientists unravel the complex interaction between plant roots and the microbial communities that surround them, growers are becoming increasingly aware of the benefit of having a well populated and microbially diverse soil. There are a number of approaches one can follow to achieve this and this trial investigated the benefit of applying FUNGIMAX™ and/or ORGANOBOOST™, mixtures of organic compounds, to soils in apple orchards.

MATERIALS AND METHODS

The trial was laid out as a statistical strip trial with 21 treated strips paired with 21 control strips in three districts across the Western Cape (Piketberg, Grabouw, Langkloof). The apple cultivars comprised 'Sundowner', 'Granny Smith', 'Golden Delicious' and 'Royal Gala'. FUNGIMAX™ and/or ORGANOBOOST™ were applied on three occasions according to the outcome of an analysis using bacterial and fungal counts to evaluate microbial populations. At harvest, fruit from each strip were classed and weighed. Ten fruit were selected, five from each side of the tree and individual fruit mass and size measured.

RESULTS AND DISCUSSION

Overall a significant yield increase was achieved of 4.061t ha^{-1} ($P = 0.06$), with increases being recorded on 17 of the 21 strips. The average yield of the control was 38.85t ha^{-1}. The increase was derived from an increase in Class 1 and 2 apples with no change in apples classed as sap.

Increases were also recorded in individual fruit mass, the treated fruit weighing on average 16 g more ($P<0.01$) than the control. The average fruit mass of the treated fruit was 142 g and for the control, 126 g. Fruit size was also positively affected and fruit diameter increased by 3 mm ($P<0.01$). The average fruit size of the treated fruit was 70 mm and that of the control 67 mm.

Microbial samples were taken at three intervals and fungal counts were found to be higher on the treated strips for each interval. Bacterial responses were variable and the levels of probability attached to the results were low.

CONCLUSION

Supplementing the specific nutritional requirements of microbial communities has been shown to improve production in apple orchards. The benefit was achieved over a wide geographical area, a variety of soil types, cultivars and orchards that differed in age and vigour.

Keywords: Apples, Production, Quality, Carbon cycling, Rhizosphere, Soil microorganisms

NUTRIENT AND WATER UPTAKE BY HYDROPONICALLY GROWN TOMATO PLANTS AS AFFECTED BY NUTRIENT SOLUTION CONCENTRATION AND COMPOSITION.

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INTRODUCTION

Intensive agricultural practises are often characterized by low water and fertiliser use efficiency and high risks of pollution of soil and water resources due to over fertilization (Baligar *et al*., 2001). Hydroponically grown crops under protection is an environmentally friendly technology with a high water and nutrient use efficiency, which can be increased even further by re-using the drained fertigation water. To enable producers to adopt a closed hydroponic system, nutrient solution compositions should be better aligned to the water and nutrient requirements of plants and the changes in ion ratios experienced with nutrient solution recycling as certain ions will start accumulating in the nutrient solution when it is recirculated (Carmassi *et al.,* 2002). This study examined the water and macronutrient uptake for greenhouse tomatoes under optimal nutrient supply.

METHODS AND MATERIALS

Trials were performed using tomato plants grown hydroponically, using a deep water technique to determine water and nutrient uptake without any effects of growing media. The effect of a standard nutrient solution for tomatoes at four different starting concentrations (ECs of 0.7, 1.4, 2.1 and 2.8, $mS.cm^{-1}$) levels and two different light intensity, temperature combinations on two cultivars differing in salinity tolerance was evaluated in randomized block design. Trials were conducted in a temperature controlled glasshouse at the University of Stellenbosch during 2009 - 2010. Water uptake, EC and pH were measured and water and plant nutrient content analysed for macro nutrients. Analysis of variance was performed and treatments were compared with LSD ($P \leq 0.05$).

RESULTS AND DISCUSSION

There was no correlation between the nutrient solution concentration and the water use of the plants although plants growing at an EC of 0.7 $mS.cm^{-1}$ showed a 30% reduction in water use. Uptake ratios of K:Ca and K:Mg increased with an increased nutrient solution concentration and also during fruit development. Starting EC values did not affect yield although total dry weights as well as the dry matter percentage of the fruit increased with an increase in nutrient solution concentration. Cation and anion ratios increased with re-use time especially under higher light intensity and temperature conditions and at higher ECs but remained more stable at lower ECs. At the higher ECs Ca^{2+} and $SO4^{2-}$ levels accumulated to unacceptable high values.

CONCLUSION

Determining the water and macronutrient uptake for greenhouse tomatoes under optimal nutrient supply will enable us to adapt nutrient solutions for recirculating hydroponic systems to maintain optimal ion ratios without negatively affecting crop growth and yield.

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Keywords: Hydroponic, tomatoes, nutrient uptake, nutrient ratios, water use

THE EFFECTIVE BIOLOGICAL CONTROL OF THE INVASIVE CACTUS, CHAIN-FRUIT CHOLLA, IN SOUTH AFRICA

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INTRODUCTION

Chain-fruit cholla, *Cylindropuntia fulgida* var. *fulgida* (Engelmann) F.M. Knuth, native to USA and Mexico, has invaded the arid parts of South Africa and Zimbabwe. It harms domestic animals, small mammals and birds. A biotype of the cochineal insect, *Dactylopius tomentosus* (Lamarck), from *Cyl. cholla* in Mexico, was proven sufficiently host-specific and damaging to *Cyl. fulgida* for release as a biocontrol agent (Mathenge *et al.* 2009). It was released near Douglas, Northern Cape and near Musina, Limpopo Province, during 2008.

METHODS

The effect of the cochineal to the target weed was monitored 18 months after release at both sites. At Musina, one transect, 30 m x 2 m, was monitored by counting large plants, small plants and detached cladodes, distinguishing between live (without cochineal), live (infested with cochineal), and dead individuals. At Douglas, four such transects were monitored. In addition, at Musina, the effect of a previous chemical clearing action was evaluated by counting live (without cochineal), live (with cochineal) and dead cladodes in 40 treated cactus clumps.

RESULTS AND DISCUSSION

At Musina, the cochineal had infested all the target weeds and killed the majority. By killing most of the detached cladodes, the cochineal had significantly reduced the invasive potential of the cactus. In the chemical clearing sites, regrowth of detached cladodes had caused a ten-fold increase in the cactus populations. However, virtually all of these had become infected with cochineal, and most are now dead.

At Douglas, the cochineal was present throughout the cactus infestation, and had killed almost all detached cladodes and small plants. However, most of the large plants were still alive and were regrowing, following heavy rain, although the regrowth was already infested with cochineal. The superior performance of the cochineal at Musina compared to Douglas can be ascribed to the higher winter temperatures and lower rainfall in Musina.

CONCLUSIONS

Biological control is effective at Musina, but at Douglas the woody stems might have to be felled after two years' damage by the cochineal, to prevent regrowth.

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ACKNOWLEDGEMENTS

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Keywords: Invasive cactus, biological control, *Cylindropuntia fulgida, Dactylopius tomentosus*

EVALUATION OF *Ornithogalum* LINES FOR CUT FLOWER POTENTIAL

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INTRODUCTION

Ornithogalum is a flower bulb that is sold on international floriculture markets either as a cut flower or pot plant. The Agricultural Research Council (ARC) has been involved in the breeding of indigenous *Ornithogalum* species for many years. An old yellow flowering ARC cultivar was irradiated to induce mutations for the development of new products for the international market. Several mutants with larger flowers were obtained. The objective of the study was to evaluate the different mutant lines against the control cultivar to identify the best lines for the production of cut flowers.

MATERIALS AND METHODS

Fifteen mutant lines, together with the original cultivar as control were evaluated. Bulbs were established in March 2009 and flower stems were cut when the first floret of the inflorescence showed color (Oct-Nov). Twenty flower stems (5 stems x 4 repetitions) of each line were brought inside and placed in vases under artificial lighting in the laboratory at 20 to 25^0C in a complete randomized block design. Data was collected on stem length, flower number, and vase life quality. A standard analysis of variance was conducted on the parameters using Statistical Analysis Software (SAS).

RESULTS AND DISCUSSION

Stem length is an important criterion for cut flower production with longer stems obtaining premium prices on flower markets. Two lines produced significantly longer stems than the control cultivar. The number of florets in an inflorescence has an influence on the acceptability of the product on the market. Fuller stems with many florets will have a higher value. None of the mutant lines produced significantly less flowers than the control. The most important criterion for good quality cut flowers is acceptable vase life duration. None of the lines evaluated had a significant increase in vase life quality compared to the control, but a number of lines had reduced vase life quality. These lines will thus be discarded.

CONCLUSIONS

Each of the three parameters discussed above were ranked from best to worst and a total score was calculated statistically to indicate overall performance of the different lines. One line performed statistically better than the control and can be recommended for commercial evaluation.

Keywords: Cut flower, keeping quality, *Ornithogalum*

ULTRA LOW TEMPERATURE SHIPPING AND COLD CHAIN MANAGEMENT OF 'HASS' AVOCADOS: INVESTIGATION INTO REDUCING SHIPPING COSTS

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INTRODUCTION

With the South African avocado industry being largely export-orientated, new and effective technologies are vital to improve quality and shelf life. The 'Hass' cultivar comprises 50% of the South African avocado exports. Current technologies to delay ripening, such as 1-MCP and CA, are costly and have disadvantages (Maré *et al.*, 2002). It has been shown that breaks in the cold chain are highly detrimental to fruit quality, even if the fruit recover to normal physiological functioning (Undurraga *et al*., 2007). This study examined whether storage at 1°C is comparable to 1-MCP during simulated shipping, and to ascertain the physiological effects of cold chain breaks and the ultra low temperature of 1°C on the final fruit quality of 'Hass' avocados.

MATERIAL AND METHODS

'Hass' avocado fruit for early (72% MC), mid (66% MC), and late (60% MC) season were subjected to treatments of temperature (1°C / 5.5°C), 1-MCP (treated / untreated), waxing (waxed / non-waxed) and cold chain breaks (28 days no break, 24 hour delay, break at day 14, 56 days no break). The 24 treatment combinations (10 fruit each) were placed into simulated shipping for 28 days, while 8 treatment combinations were placed in simulated shipping for 56 days. Fruit weight, softness, water content, ethylene, and days to ripening were measured / recorded. Statistical analysis was conducted in the form of a factorial design in order to determine significant differences between the treatments used.

RESULTS AND DISCUSSION

The effect of ripening when fruit was stored at 1°C was comparable to the use of 1-MCP, although 1-MCP extended the time to ripening slightly. There were signs that the occurrence of cold chain breaks did reduce the quality and ripening period, with a 24 hour delay before storage being highly detrimental. There was evidence that the 1°C treatment suppressed the effects of cold chain breaks to some extent. Overall the mid season fruit were the most sound in terms of quality and ripening. The 56 day control showed that the 1°C treatment may cause external chilling injury. The 5.5°C treatment in combination with 1-MCP indicated that extended periods of storage may be a possible alternative if required.

CONCLUSIONS

It is possible that 1°C could be used more regularly in export shipments of 'Hass' avocados due to the advantageous effects. This temperature regime may not entirely match the performance of 1-MCP, but it may be a viable economic alternative. The effects of cold chain breaks are also reduced at this temperature, although the physiological processes still require investigation in this trial before recommendations can be made.

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Keywords: Ultra low temperature shipping, 1-MCP, cold chain breaks

EFFECTS OF MULCHING WITH EMPHASIS ON FACTORS INFLUENCING SOIL FERTILITY, PLANT NUTRITION AND FRUIT QUALITY

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INTRODUCTION

Organic mulches showed effective results in reducing evaporative water loss (Forge et al., 2003) and increasing microbial activity, available soil minerals and root development (Neilsen et al., 2004). In some cases, these had a positive effect on the on growth and yield in apples (Neilsen et al., 2004).

MATERIALS AND METHODS

A field trial was conducted to investigate the yield, fruit quality and plant responses of Cripps` Pink apple trees to mulching in terms of changes in the soils' physical, chemical and biological properties. Treatments consisted of one inorganic (geotextile fabric) and three organic (compost, wood chips, and vermi- compost topped with wood chips) mulches that were compared to a commercial control (no mulching) on a sandy loam soil. Both leaf and fruit mineral analyses were done by a commercial laboratory (Bemlab Pty Ltd, Strand, South Africa).

RESULTS AND DISCUSSION

The vermi-compost and wood chip treatments significantly increased some soil minerals, however, these did not always correlate with increased mineral elements in fruit or leaves. The total number of roots were increased by the wood chips and geotextile treatments. The vermi-compost and wood chip mulches showed a decrease in the percentage of pathogenic nematodes, whilst the compost and geotextile treatments increased the percentage of pathogenic nematodes. The high level of pathogenic nematodes in the compost treatment could partially explain the smaller root system. All mulches significantly increased mycorrhizal colonization compared to the control treatment. The wood chips significantly increased fruit calcium, which correlated well with the finding that these trees had the biggest root system, as root growth is a prerequisite to calcium uptake. Leaf mineral uptake was significantly increased as follows: compost and geotextile treatments (manganese), control treatment (iron), compost treatment (zinc) and vermi-compost, wood chips and geotextile (boron).

CONCLUSION

The wood chips and vermi-compost treatments showed the most promising result to increase plant nutrition.

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Keywords: Compost, Mychorrhiza, Nematodes, Polytex Geotextile, Wood chips

THE EFFECT OF PREVIOUS CROP AND DIFFERENTIAL NITROGEN FERTILISER APPLICATION ON SOIL NITROGEN MINERALISATION AND AVAILABILITY TO WHEAT GROWN UNDER DRYLAND CONDITIONS IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

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INTRODUCTION

Seasonal variation in climatic conditions, the previous crop and the resultant effect on N mineralisation may influence the supply of soil nitrogen to a wheat crop. This supply (quantity and timing of the N mineralised) may affect the fertiliser N requirements of the wheat crop. The aim of this study is to quantify N mineralisation as influenced by previous crop and to evaluate the availability of soil N (mineralised and fertiliser N) during the growing season of the wheat crop.

MATERIALS AND METHODS

A trial was laid out at the Langgewens Research Farm near Moorreesburg to evaluate the effect of previous crop and differential nitrogen applications on soil nitrogen levels and availability for crop uptake. Previous crop (wheat, canola or medic) was allocated to main plots and N treatments to sub-plots. Nitrogen fertiliser treatments included were, either 0 or 30 kg N ha^{-1} at planting followed by various combinations of 0, 30 or 60 kg N ha^{-1}, 30 and 60 days after emergence. Fallow plots were included to monitor nitrogen mineralisation. Soil and plant samples were collected at two weekly intervals during the growing season.

RESULTS AND DISCUSSION

Nitrogen mineralisation measured in the fallow treatments during both the 2008 and 2009 production seasons shows a distinct pattern of mineral nitrogen levels decreasing as season progresses until late July. During the 2008 season the soil nitrogen levels remained relatively constant during the rest of the season. During 2009 however nitrogen levels gradually increased until mid September, remained relatively constant between late September and the first week in October followed by a steady decrease towards the end of October. Nitrogen mineralisation during 2008 in the wheat after medic and wheat after canola rotations tends to result in higher levels of mineral N compared to the wheat monoculture system during the first 4 to 6 weeks after planting. During 2009 nitrogen mineralisation in the wheat after medic and wheat after canola rotations tends to result in lower levels of mineral nitrogen compared to the wheat monoculture system during the entire production season, an observation that needs further investigation.

CONCLUSIONS

Soil nitrogen content as a result of mineralisation differs between systems and years. During 2008 the initial soil nitrogen tends to be higher in the systems where wheat follows medics or canola than in the wheat monoculture.

Keywords: nitrogen mineralisation, cropping systems, wheat

THE INFLUENCE OF SOIL TILLAGE AND CROP ROTATION ON THE PRODUCTION POTENTIAL OF WHEAT AND CANOLA ON SHALE DERIVED SOILS OF THE WESTERN CAPE

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INTRODUCTION

Tillage practice and crop sequence can be regarded as two very important factors that influence sustainability of crop production on the shale derived soils of the Western Cape. The aim of this study was to quantify the effect of tillage practice and crop sequence on wheat and canola productivity within a long-term soil tillage/crop rotation trial. In addition to yield, the effect of the treatment combinations on selected quality parameters was recorded.

MATERIALS AND METHODS

Three crop sequences, continuous wheat (W W W W), wheat/medic/wheat/medic (W M W M) and wheat/canola/wheat/lupin (W C W L) were allocated to main plots replicated four times. Each main plot was subdivided into four sub-plots allocated to four tillage treatments namely zero-till – soil left undisturbed (planter places seed with minimal soil disturbance), no-till – soil left undisturbed until planting and then planted with a tined planter, minimum till – soil scarified late March/early April and then planted with the no-till planter and conventional tillage – soil scarified late March/early April, then ploughed and planted with the no-till planter.

RESULTS AND DISCUSSION

The zero-till treatments recorded the lowest (2409.3 kg ha^{-1}) and the no-till the higest (2952.4 kg ha^{-1}) grain yields at the Tygerhoek Research Farm (Riviersonderend). The same response was noted for the Langgewens Research Farm (between Malmesbury and Moorreesburg) with the zero and no-till treatments producing 1746.3 and 2858.0 $kgha^{-1}$ respectively. Tillage practice did not influence hectolitre mass or protein content of wheat at Langgewens. Except for the zero-till treatment at Tygerhoek that resulted in a lower ($P \leq 0.05$) grain protein content, no differences were found between the tillage treatments tested. No trend regarding the effect of tillage treatment on hectolitre mass was recorded for the Tygerhoek site. A relatively low mean canola yield of 1418.3 kg ha^{-1} was recorded at Tygerhoek. A significantly lower ($P \leq 0.05$) canola seed yield was recorded on the zero till treatments. Seed protein content did not differ ($P > 0.05$) between the tillage treatments. The oil content of the zero till treatments was lower ($P \leq 0.05$) than the no-till and conventional tillage treatments.

CONCLUSIONS

The zero-till treatment resulted in the lowest wheat and canola yields at both sites included in the study. In contrast, the highest yields were recorded under the no-till treatment. No definite trend regarding the effect of tillage and crop sequence was noted.

Keywords: canola, crop rotation, soil tillage, wheat

WHAT BIOTYPE…? FINDING EVIDENCE FOR THE EXISTENCE OF RWASA2 (*Diuraphis noxia*) IN DRYLAND WHEAT

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INTRODUCTION

Large-scale yield losses in commercial wheat varieties after discovery of RWASA2 in 2005 have not materialized to date. This trend is difficult to explain and often questions the effect of RWASA2 on farm level. A partial objective of field trials conducted at ARC-Small Grain Institute (2008 and 2009), Seotlong, Qwa-Qwa (2008) and Welverdiend, Reitz (2009) is monitoring of damage levels of RWA in commercial wheat varieties with *Dn-1* resistance.

MATERIAL AND METHODS

Field trials were planted with Matlabas, PAN 3144, SST 399 and Scheepers 69. Scheepers 69 was used to monitor RWA infestation frequency at each locality by determining percentage infestation through calculation of the fraction of infested tillers from total number of counted tillers. The effect of RWA on grain yield, hectolitre mass and protein content and falling number was determined by comparing RWA-free and RWA-infested plots for each variety. Additive Main-Effects and Multiplicative-Interaction (AMMI) analysis over 2008 and 2009 were done.

RESULTS AND DISCUSSION

Low to medium RWA infestation occurred on untreated Scheepers 69, ranging between 4.8% (2008) and 22.2% (2009) for ARC-SGI and 30.7% at Seotlong in 2008 and 36.1% for Welverdiend, Reitz in 2009. Analysis of Variance (ANOVA) for AMMI indicates chemical control of RWA as the primary contributor to variation in yield (46%), hectolitre mass (35%), protein (43%) and falling number (35%). This contribution is significantly larger than for environment (season and locality) or genotype (cultivar) and indicates that although the effect of failing *Dn-1* resistance on farm-level is not very apparent, subtle decreases of production components from RWASA2 are occurring under experimental conditions. Integrated Principal Component Analysis 1 (IPCA 1), explaining 73% of the variation occurring in yield, indicates seed treatment to result in more stable yields compared to higher but less stable yields from seed treatment followed by application of foliar insecticides.

CONCLUSION

AMMI indicates that chemical control of RWA in *Dn-1* resistant varieties was the major contributor to variation over the 2008 and 2009 seasons at all localities. This trend illustrates that an important response, interpreted as the effect of insecticides on failing host plant resistance is occurring. Conditions for wheat production during 2008 and 2009 were favourable but under more adverse conditions conducive for RWA population development, RWASA2 may yet still result in a major catastrophe by inflicting large-scale yield loss.

ACKNOWLEDGEMENTS

The Winter Cereal Trust and ARC-SGI management are thanked for supporting and funding of the project.

Keywords: Wheat, RWA, Control strategies

INFLUENCE OF TEMPERATURE ON CANOLA YIELD IN THE WESTERN CAPE

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INTRODUCTION

Canola (*Brassica napus*) is an important oil seed crop and component in crop rotation systems programs of the rain-fed winter grain production areas of the Western Cape. Vegetative and reproductive growth of the plant is dependent on favourable temperatures and exposure to a cold period, i.e. vernalisation, respectively. With the predicted weather changes due to global warming, the focus of this study is to examine the relationship between temperature and the performance of canola in terms seed yield (Si & Walton, 2004 and Aksouh-Harradj *et al.* 2006).

MATERIALS AND METHODS

The study is based on correlation analyses of canola cultivar performance (yield) and corresponding data over a five year period at two sites, one in the Swartland and the other in the southern Cape. Maximum, minimum and mean temperature was analysed to determine the impact during the first 60 days following 50% flowering on yield. The performance of cultivars was also evaluated on the basis of (1) genotype groupings, i.e., conventional (conv.), triazine-tolerant (TT) and imidazolinone-tolerant (Clearfield$^{(R)}$) and (2) period to flower, i.e. early and medium, respectively. The local study was executed under rain-fed conditions with no control over the timing of rainfall or temperatures.

RESULTS AND DISCUSSION

Results revealed that seed yield was significantly affected (early conv. $R^2 = 0.61$; medium conv. $R^2 = 0.43$; medium TT $R^2 = 0.35$; early Cl $R^2 = 0.24$ and medium Cl $R^2 = 0.49$) by daily minimum temperature in the Swartland while no such relationship was found in the southern Cape. The impact of minimum temperature varied among genotypes, early TT showed no significant response. Previously under rain-fed conditions was found that data will scatter along the line due to timing of heat- and water stress (Si and Walton, 2004). No distinctive results were obtained from analyses of the mean and maximum temperature at both locations. A yield decline of 18.2% ha^{-1} was observed for every 1°C increase in the minimum temperature over the period. The local study was executed under rain-fed conditions with no control over the timing of rainfall or temperatures.

CONCLUSION

The risk of reduced canola yields due to increased minimum temperatures during the 60 day period following 50% flower will be greater in the Swartland than in the southern Cape. This will put immense pressure, with global warming predictions in mind, on an already small industry.

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Keywords: canola, yield, temperature, production risk

ROBUST PREDICTION MODELS FOR QUALITY PARAMETERS IN JAPANESE PLUMS (*Prunus salicina* L.) USING NIR SPECTROSCOPY

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INTRODUCTION

Japanese plums (*Prunus salicina* L.*)* are successfully cultivated in South Africa with more than nine million cartons of 35 different cultivars exported annually. Currently all the quality parameters are determined using destructive measures making it impossible to test every unit of fruit. Near infrared (NIR) spectroscopy can possibly serve as a non-invasive technique to determine quality in plums as it interacts with molecular groups associated with quality parameters (Nicolaï et al., 2007). NIR spectroscopy will produce an absorption pattern of the chemicals present in the fruit in a rapid and non-destructive way and using multivariate data analysis techniques prediction models can be developed for each parameter. This study aims to determine if NIR spectroscopy can be used for the accurate prediction of quality parameters in three plum cultivars.

MATERIALS AND METHODS

Fourier-transformed near infrared (FT-NIR) reflectance spectroscopy was used over a spectral rage of 800-2700nm to develop multivariate prediction models for total soluble solid (TSS), total acidity (TA), sugar-to-acid ratio, firmness and weight in three plum cultivars (Pioneer, Laetitia and Angeleno) and a multi-cultivar model. Samples were collected for seven weeks throughout the ripening period and repeated over two seasons. Robustness of the models was testing in terms of seasonality, range and cultivar.

RESULTS AND DISCUSSION

The validation results had mixed success with TSS (R^2 = 0.817-0.955; RMSEP= 0.453-0.610 % Brix), TA (R^2 =0.608-0.830; RMSEP=0.110-0.194% malic acid), sugar-to-acid ratio (R^2 = 0.718-0.896; RMSEP= 0.608-1.590), firmness (R^2 = 0.623-0.791; RMSEP= 12.459-22.760 N) and weight (R^2 = 0.577-0.817; RMSEP= 7.700-12.800g). The cultivar-specific models of ‘Pioneer’ and ‘Laetitia’ had a better predictability capacity than the ‘Angeleno’ model on all parameters. Although the multi-cultivar model often outperformed the single cultivar models on R^2 values, it had higher prediction errors. The robustness of all the TSS, TA and firmness models is high in terms of seasonality, range and cultivar.

CONCLUSIONS

NIR spectroscopy produced accurate, robust prediction models in the plum cultivars tested and can be used as a non-destructive tool to determine quality parameters, especially TSS.

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ACKNOWLEDGEMENTS

This study was sponsored by SASPA (South African Stone Fruit Producers’ Association).

Keywords: firmness, Near infrared spectroscopy, robustness, prediction models, TA, TSS

AN INVESTIGATION INTO LOW TEMPERATURE SHIPPING AND COLD CHAIN MANAGEMENT OF FUERTE AVOCADOS

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INTRODUCTION

'Fuerte' makes up 25% of the avocados exported from South Africa to the European markets and requires shipping periods of up to 30 days. A temperature of 5.5°C and expensive CA and MA treatments are currently used to delay ripening; however, fruit still appear on the European market showing signs of softening and physiological disorders. Previous work by Bower and Magwaza (2004) showed that it is possible to ship greenskins at 2ªC. Recent work by Lutge (2009), on 'Fuerte' avocados, showed that 2ªC storage resulted in improved internal quality, while cold chain breaks caused increased fruit softening, water loss and susceptibility to external cold damage, especially a break or delay early in the cold chain. The objective of the study is to determine the potential for shipping 'Fuerte' avocados at temperatures of 2°C, as well as determining the effects of cold chain breaks on fruit quality throughout the growing season.

MATERIAL AND METHODS

'Fuerte' avocado fruit were subjected to treatments of temperature (2°C and 5.5°C), 1-MCP (treated and untreated), waxing (waxed and non-waxed) and cold chain breaks (no break, 24 hour delay and break at 14 days) for 28 days as well as an additional trial of 56 days. Data were collected for 10 fruit (replications) for each treatment combination and analysed with respect to fruit softening, weight loss, ethylene production, days-to-ripening, ripening consistency, external quality and internal quality as well as cellulase activity, antioxidant levels and total sugar levels. A factorial design was used for the statistical analysis.

RESULTS AND DISCUSSION

The storage temperature of 2°C provided good internal quality as well as reduced weight loss (mainly water loss) and fruit softening. The 2°C storage temperature did cause a notably higher occurrence of external chilling injury than 5.5°C but extended days-to-ripening. Waxing significantly reduced the external damage on fruit stored at 2°C. Initial results indicate that fruit stored for 56 days ripen erratically and 2°C appears to cause a greater degree of external damage than for 28 days, while internal quality over this extended period is better when stored at 2°C than 5.5°C.

CONCLUSIONS

Storage at 2°C can improve the internal quality over a storage period of 28 days. Further, waxed fruit stored at 2°C could eliminate the need for 1-MCP in terms of delivering the required shelf-life and quality. However, the external damage at a storage temperature of 2°C is unacceptable, suggesting that at present 1-MCP and 5.5°C storage may still be required for greenskins.

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Keywords: low temperature shipping, 1-MCP, cold chain breaks

EVALUATING THE STREIF INDEX AGAINST COMMERCIAL SUBJECTIVE PREDICTIONS TO DETERMINE HARVEST DATE OF APPLES IN SOUTH AFRICA

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INTRODUCTION

During the 1970's, research was done locally to determine the optimum harvest maturity for apples for long term storage. In Europe, a different, more objective system has been developed by Streif, the Streif Index (SI), to reduce the subjectivity of the interpretation. The SI formula was applied to local conditions to compare the accuracy of the different approaches to determine optimum harvest time of apples.

MATERIALS AND METHODS

Historical maturity indexing information for Golden Delicious and Starking apples was obtained from a commercial laboratory at DuToit-Vrugte together with the release date that was based on a subjective evaluation of all maturity indexing data for that particular season. Concurrently, for the SI model, the change over time was plotted to determine the optimum harvest date in weeks. This data was then correlated with the predicted release date as supplied by the laboratory to determine the accuracy of the SI per site and per season. A multi-linear regression was also performed on all maturity data as second model.

RESULTS AND DISCUSSION

The correlations between the predicted release dates obtained with the SI and subjective methods were statistically significant when all data was considered. This indicated that the SI value of 0.1 was suitable for the initial model. Non-significant correlations occurred during specific years and were attributed to initial differences in starch break down. A significant correlation was obtained between the actual release date and the predicted date, when a multi-linear regression was performed on all relevant maturity data. The accuracy of this model was influenced by season and individual sites, similarly to those influencing the performance of the SI.

CONCLUSIONS

During seasons where apples exhibit a very low initial starch conversion rate, the SI alone may not be sufficient to accurately predict the release date for harvesting.

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Keywords: Golden Delicious, percentage starch break down, total soluble solids

YIELD RESPONSE OF SELECTED TARO (*Colocasia esculenta*) LANDRACES TO WATER STRESS

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INTRODUCTION

Taro (*Amadumbe*) is an underutilised crop in South Africa. Little information is available on the responses of taro to water stress. The aim was to gain insight into and to characterise the responses of taro to water stress as well as collect data for preliminary parameterisation of AquaCrop. AquaCrop is FAO's crop model for simulating yield response to water.

MATERIALS AND METHODS

Taro landraces were collected from Umbumbulu, KwaNgwanase and Jozini rural areas across KwaZulu-Natal. Corms were selected for uniform size. Trials were conducted in 25 l pots in tunnels at the University of KwaZulu-Natal, Pietermaritzburg. The experimental layout was a completely randomized design with two treatment factors: landrace type (3 levels) and water stress (no stress, intermittent stress and terminal stress), replicated six times. For the no stress treatment, soil water content (SWC) was maintained at 75% of field capacity (FC). Intermittent stress involved watering pots to 75% of FC during crop establishment, and allowing SWC to deplete to 30% of FC during the vegetative stage and refilling the soil to 75% of FC upon tuber initiation. Terminal stress involved maintaining SWC at 30% of FC for the growing period. SWC was measured gravimetrically and using a Theta probe every seven to fourteen days. Measurements of plant height, leaf number and area, phenology and stomatal conductance (SC) were determined weekly. Field trials are being conducted under lysimetry and rain shelters at ARC-Roodeplaat, Ukulinga, Baynesfield and Umbumbulu to calibrate and validate AquaCrop.

RESULTS AND DISCUSSION

There were highly significant differences ($P<0.001$) between varieties, treatments and the interaction between the two, with respect to emergence, plant height, leaf number and area, as well as SC. All landraces, showed a decrease in growth and development, in response to water stress. Only KwaNgwanase achieved 100% emergence in all treatments. The latter had the tallest plants (212 cm) with the most number of leaves (3) and highest leaf area (218 cm^2). SC was shown to be sensitive to water stress ($P<0.001$). SC, canopy growth and tuber initiation data will contribute towards parameterisation of AquaCrop.

CONCLUSIONS

Results show that emergence, growth, development and physiology of taro landraces are sensitive to water stress. Data from the lysimeters, rain shelters and field trials will serve to calibrate and validate AquaCrop. The calibrated model will be used to evaluate production options and water-use of taro for different soils and weather conditions in South Africa.

ACKNOWLEDGEMENTS

Water Research Commission is gratefully acknowledged for funding.

Keywords: AquaCrop, Taro landraces, Water stress, Yield

EVALUATION OF FOUR TOMATO CULTIVARS IN TEMPERATURE-CONTROLLED VS. NON-TEMPERATURE CONTROLLED TUNNELS

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INTRODUCTION

Tomato production in tunnels has gained popularity in South Africa due to improved plant growth as well as yield and quality. The majority of tunnel production in South Africa is still carried out in non-temperature-controlled tunnels while utilisation of temperature-controlled tunnels is continuously increasing. Farmers prefer non-temperature-controlled facilities due to their low cost and simplicity by relying on natural ventilation in order to reduce temperature in the tunnels. Most tomato cultivars are imported into and distributed by seed companies in South Africa. Therefore optimal growing conditions for specific cultivars need to be determined, as wrong cultivar choices may lead to great financial losses. The objective of the study was to compare the performance of four fresh market tomato cultivars grown in temperature-controlled and non-temperature-controlled tunnels.

MATERIAL AND METHODS

Two experiments were conducted using a temperature-controlled tunnel and a non-temperature-controlled tunnel at the ARC-VOPI. The temperature-controlled tunnel was equipped with a wet-wall (1.7m x 8m) and two extraction fans (1.1 Kw, 1300 mm diameter), whereas the non-temperature-controlled tunnel relied on natural ventilation by means of a flap and door that could be opened on opposite sides. In each tunnel four indeterminate tomato cultivars (FiveOFive, Miramar, Malory and FA593) were grown hydroponically using sawdust as a growing medium. A randomised complete block design with four replicates was used for both conditions. Data was subjected to analysis of variance (ANOVA) using *GenStat* (2003). Treatment means were separated using Fisher's protected T-test least significant differences (LSD) at the 5% level of significance (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

The cultivars 'Miramar' and 'FiveOFive' produced a significantly higher fruit number and marketable yield as well as the lowest unmarketable yield under both structures as compared with the cultivars 'Malory' and 'FA593'. The average marketable yield was 88% and 59% of the total yield in the temperature-controlled and non-temperature-controlled tunnel, respectively. All cultivars produced a higher marketable yield in the temperature-controlled than in the non-temperature-controlled tunnel. This lower marketable yield in the standard tunnel was caused by the higher number of fruit exhibiting cracks. Poor yield in the non temperature-controlled tunnel was due to high temperature which predisposed fruit to cracking. In both structures, fruit cracking was found to be directly correlated with fruit size with the cultivars 'Malory' and 'FA593' being more susceptible to cracking than the other two cultivars.

CONCLUSION

Results emphasize the importance of cultivar selection while illustrating that temperature control can improve yield and quality of tomatoes produced in tunnels. Under temperature-controlled and non-temperature-controlled tunnel, 'Miramar' and 'FiveOFive' were the most promising cultivars with regard to yield and quality.

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Keywords: fruit cracking, marketable yield, plastic tunnels, temperature, Tomato cultivars

EFFICACY OF INSECTICIDES AGAINST THE THREE COMMON POTATO APHIDS (*Myzus persicae, Macrosiphum euphorbiae* and *Aphis gossypii*)

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INTRODUCTION

Aphids are common pests of potatoes, transmitting viruses that significantly affect the production of potatoes. *Myzus persicae, Macrosiphum euphorbia* and *Aphis gossypii* are frequent pests of seed potato plantings and important vectors of potato leaf roll virus (PLRV) and potato virus Y (PVY). Farmers complain that the incidence of virus infections increase on a yearly basis despite the use of aphicides. This study was undertaken to determine the efficacy of the registered aphicides on potato.

MATERIALS AND METHODS

The three aphid species were reared in a glasshouse on potato, green pepper and brinjal plants. A detached-leaf bioassay technique was used to determine the efficacy of all aphicides at the registered field dosages. Individual aphids were placed on treated potato leaves (dipped in insecticide solutions for 30 seconds) and their mortality examined after 48 hours.

RESULTS AND DISCUSSION

All the aphicides that were evaluated were effective against the three common potato aphids using field recommended dosages. Very high mortalities (above 90%) were found in all tests after feeding on treated leaves for 48 hours When the dosages of each aphicide were lowered from the field recommended dosage, some aphicides even produced reasonable results at half dosages. The systemic insecticides used in the glass house and in two field trials showed high mortality (all above 86%).

CONCLUSIONS

It can be concluded that the registered insecticides against aphids on potatoes are still effective. Other factors need therefore be investigated to find the reason for the high incidence of potato viruses plaguing the seed industry.

Keywords: bio-assay technique, insecticides, aphids, potatoes, viruses, aphicides

MULCHING DECREASES WHILE MOISTURE STRESS INCREASES SUNBURN DEVELOPMENT IN APPLE

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INTRODUCTION

Apples on trees under moisture stress are considered to be more prone to develop sunburn (Schrader et al., 2003). We investigated the effect of mulching and moisture stress on plant water relations and subsequent sunburn development in 'Cripps' Pink' apples.

MATERIALS AND METHODS

Mulching treatments, viz. woodchips, plant compost, vermicompost, a geotextile black polystyrene plastic and a no mulch control were applied after full bloom in 2008/09 and 2009/10 seasons in two orchards, the one on a sandy loam and the other on a clay loamy soil. In 2009/10, irrigation was manipulated in a concurrent moisture stress trial to ascertain the role of moisture stress in sunburn development. Normal irrigation, half irrigation and no irrigation treatments were applied for 14 days starting on 15 March 2010. Plant water potential, fruit surface temperature (FST), sunburn incidence (SI) and sunburn severity (SS) were measured in both trials. Stomatal conductance (SC), transpiration and net CO2 assimilation rate (NCAR) were measured to determine tree performance for the mulching trial. The sunburn type, viz browning, necrosis or bleaching, was recorded in the moisture stress trial. In the second season, fruit were tagged for progressive SI and SS assessments in both trials and stem water potential (SWP) was measured instead of leaf water potential (LWP).

RESULTS AND DISCUSSION

Mulching did not appear to have a significant effect on plant water status, but enhanced photochemical performance. Vermicompost in particular, consistently reduced FST and sunburn compared to the control. Trees in loamy clay generally performed better than those in sandy loamy. SWP decreased while FST, SI and SS increased linearly with irrigation level in the moisture stress trial. Sunburn browning was more prominent under normal and half irrigation while necrosis increased with increasing moisture stress.

CONCLUSIONS

Mulching, vermicompost in particular, enhanced tree performance and decreased sunburn despite the absence of a notable effect on plant water status. However, when water status was manipulated by means of irrigation level, moisture stress increased fruit surface temperatures, possibly by decreasing evaporation from the fruit surface, thereby aggravating sunburn development.

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Keywords: Apples, sunburn, mulching, moisture stress, water potential, transpiration

EVALUATION OF PRE- AND POST EMERGENCE HERBICIDES FOR USE IN KENAF IN SOUTH AFRICA

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INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is a fibre crop, recently re-introduced in South Africa by Sustainable Fibre Solutions Pty Ltd. Their aim is to promote the production of natural fibres for use in a variety of products. Due to it's novelty in South Africa, no herbicides have yet been registered. The focus of this study was to identify pre- and post-emergence herbicides for further testing in the field.

MATERIALS AND METHODS

Pre- and post-emergence herbicides were evaluated in a glasshouse study at the University of Pretoria. Pre-emergence herbicides were: S-dimethenamid, imazethapyr, fluometuron/prometryn, pendimethalin, S- metolachlor and the post-emergence herbicides were: bentazone, 2,4-DB, monosodium methanearsonate and pyrithiobac sodium. Each herbicide was applied at 1x, 2x and 3x the recommended rate and compared to an untreated control. Seeds were planted six per pot filled with a soil with 22% clay and fertigated twice a week with Supafeed. The trials lasted 40 days to allow for maximum damage development on the kenaf seedlings. A fully randomized design with four replications was used. The data were analysed with SAS to determine LSD's of the treatments at the 5% level of probability.

RESULTS AND DISCUSSION

Kenaf seedling emergence, plant height, kenaf injury and kenaf biomass (above-ground mass and roots separately) were recorded. None of the treatments had a negative effect on seedling emergence.

The pre-emergence herbicides Imazethapyr and pendimethalin, as well as a combination of imazethapyr and S-metolachlor caused no negative effects to root and above-ground biomass at the recommended rate. S-dimethenamid and fluometuron/prometryn seem to have a number of negative impacts on the crop itself at all of the application rates.

Post-emergence herbicides: despite having the highest injury rating at all the application rates, it seems as if the crop were able to outgrow the effect of pyrithiobac sodium (PS) as the root and above-ground biomass of kenaf determined at 40 days after planting were even higher than that of the control. The other post-emergence herbicides also caused damage, however, lower than that of PS. From this group 2.4-DB and monosodium methanearsonate did not have a negative impact on the biomass and roots while the same cannot be said about bentazone.

CONCLUSIONS

We recommend imazethapyr, pendimethalin and a mixture of imazethapyr and S-metolachlor (pre-emergence herbicides) as well as pyrithiobac sodium, 2,4-DB and monosodium methanearsonate (post-emergence herbicide) for further field trial testing.

ACKNOWLEDGEMENTS

Sustainable Fibre Solutions

Keywords: Hibiscus cannabinus, imazethapyr, pendimethalin, S-metolachlor, pyrithiobac sodium

DISTRIBUTION OF TOTAL PHENOLICS AND ANTIOXIDANT ACTIVITY IN FRUIT, LEAF, STEM AND ROOT OF *Monsonia burkeana*

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INTRODUCTION

Monsonia burkeana, widely used as a 'special tea', is harvested unsustainably due to insufficient information on the ability of its organs to accumulate secondary metabolites. Using phenolics and antioxidants as focus chemical compounds, an investigation was carried out to determine (1) the distribution of phenolic and antioxidant compoundsin *M. burkeana* organs, and (2) whether phenolic acids and antioxidants in *M. burkeana* had density-dependent relationship patterns.

MATERIALS AND METHODS Fresh plant materials were sampled from Chuenespoort, Limpopo Province, South Africa during fruiting. Plots of 10 m × 10 m were arranged in a randomised complete block design with three replicates, where blocking was done for gradient. Ten plants within each plot were randomly sampled by collecting the entire plant and transported in cooler boxes to the Horticultural Skills Centre of the University of Limpopo, Turfloop Campus. Whole plants were dried in air-forced ovens at 52°C for 48 hours (Makkar, 1999). Fruit, leaves, stems and roots were individually ground. The four organs were quantified for phenolic and antioxidant components using the Folin Ciocalteau method and the Trolox Equivalent Antioxidant Capacity assay, respectively.

RESULTS AND DISCUSSION Generally, reproductive and vegetative organs had high levels of phenolic and antioxidant compounds when compared to roots. The ability of organs to accumulate essential nutrient elements and secondary metabolites followed the density-dependent pattern, which is expounded by the saturation factor model (Salisbury & Ross, 1992). The saturation factor suggested that more than 90% of the antioxidants present were derivatives of phenolic compounds. Optimum antioxidant activities were attained at 5.39, 5.49, 4.36 and 4.13 mg/ 100 g total phenols in fruit, leaf, stem and root tissues, respectively.

CONCLUSIONS

The vegetative and reproductive organs are good sources of phenolic and antioxidant compounds in *M. burkeana* and therefore could serve as harvestable material.

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ACKNOWLEDGEMENTS

The authors are grateful for the financial support from the National Research Foundation, National Department of Agriculture, Forestry and Fisheries through its Young Professional Development Programme and the Department of Science and Technology.

Keywords: Antioxidant, phenolic, optimum, saturation factor

SPATIAL VARIABILITY OF SOIL PH, ELECTRICAL CONDUCTIVITY AND SELECTED MACRONUTRIENTS AT ZANYOKWE IRRIGATION SCHEME, EASTERN CAPE

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INTRODUCTION

Sustainable management of soil fertility in smallholder agriculture is often been made difficult by high degrees of variability of many soil attributes. Understanding spatial variability is particularly important in irrigation schemes where cropping intensity in higher and nutrients are mined through harvests and limited fertilizer application. A study was undertaken to determine and map variability of soil pH, electrical conductivity, available phosphorus and basic cations at Zanyokwe Irrigation Scheme.

MATERIALS AND METHODS

Seven hundred and eighty three (783) soil samples were collected from grid points measuring 50 X 50 m and co-ordinates taken using a GPS. The soil samples were analysed for soil pH, electrical conductivity, phosphorus and basic cations (Ca, Mg, K and Na). A spreadsheet consisting of GPS co-ordinates and their corresponding soil parameter values was exported to TNTmips Version 7.3 and kriged to produce continuous raster surfaces for each parameter. The raster surfaces were then reclassed using prescribed limits to produce soil fertility maps. Data compression and variability analysis was done using Principal Components Analysis.

RESULTS AND DISCUSSION

Calcium was sufficient in 85% of the scheme and with highest concentrations on upslope positions of dolerite derived soils and lower slope positions on alluvial parent material. Mg was sufficient in 100% of the soils and showed very little spatial variability. Potassium was sufficient in 97% of the soils on all slope positions, variable over short distances, on variable parent material and management practices. Nutrient ratios showed an inverse Ca: Mg ratio in 20% of soils at Burnshill. Mg: K ratio was below limits at 60% and 5% of Lenye and Burnshill soils, respectively. Sodium Adsorption Ratio was undesirable with 62% of Lenye and 50% of Burnshill above acceptable limits. There was no clear pattern in spatial variability of SAR with variability seemingly influenced by parent material. Phosphorus was the most deficient element and showed the least spatial variability at Burnshill. However, at Lenye P levels and spatial variability were higher across the block.

CONCLUSION

Potassium and SAR exhibited the greatest spatial variability while Mg and P showed the least spatial variability.

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Keywords: available P, bases, maps, soil fertility, soil pH, variability

USE OF 1-NAA TO IMPROVE THE GROWTH, YIELD AND SHELF-LIFE OF OYSTER MUSHROOMS (*Pleurotus ostreatus*)

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INTRODUCTORY BACKGROUND

Auxins are chemical regulators which have been noted to produce a great variety of responses in plants (Wittwer, 1983). These responses include epinastic behaviours in roots and stems, induction of rooting in cuttings, flower sex modification, fruit setting, changes in vegetative growth and plant architecture, hastening of fruit ripening and storage behaviour.

MATERIALS AND METHODS

The study was carried out in a Huthouse growth chamber at the ARC-ITSC. Oyster mushrooms were propagated using 1-NAA, a plant growth hormone. The experiment was a randomized complete block design with 6 treatments (0, 0.1, 0.5, 1, 1.5 and 2 mmol 1-NAA) replicated 4 times. Treatment solutions were applied on spawn (1000 g) planted in industrial plastic bags (410 mm x 750 mm x 45 µm). Wheat straw was used as a growing medium. After planting, colonization and contamination percentages, number of harvestings, number of flushes, number of caps and mass were recorded. At harvesting, 50 g of mushrooms from each treatment were packed in FT11 containers with and without covers and stored under three different temperatures (room, 2^{o}C or 5^{o}C) in order to evaluate the shelf-life. During storage, mass, physiological disorders, and colour of the mushrooms were assessed and recorded.

RESULTS AND DISCUSSION

There was a sharp increase in colonization percentage between Day 0 and Day 1 in all treatments except for 1.5 mmol 1-NAA. There was a steady increase in colonization percentage between Day 1 and Day 9 in all the treatments. From Day 10 until Day 15, colonization percentage remained constant. There was a significant effect of 1.5 mmol 1-NAA on contamination, whereas both the control and 2 mmol 1-NAA had no significant effect. A 1 mmol level of 1-NAA application had a significantly positive effect on mass, number of caps and number of flushes of mushrooms. Covered containers played a major role by reducing mass loss, reducing evaporation rates, and maintaining colour of mushrooms compared to the uncovered containers.

CONCLUSIONS

The experiment demonstrated that 0 mmol and 2 mmol 1-NAA were ideal for reducing contamination, whereas, 1 mmol 1-NAA increased number of flushes, caps and mass at harvest. Covered FT11 containers maintained quality of mushrooms for longer during storage.

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ACKNOWLEDGEMENTS

ARC – ITSC and AgriSETA for financial assistance of this study.

Keywords: Auxin, Colonization percentage, Contamination percentage, Spawn, Wheat straw, Mushroom quality

HYPERSPECTRAL CHARACTERIZATION OF SALT-AFFECTED SOILS IN THE SANDSPRUIT CATCHMENT

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INTRODUCTION

Owing to their low spectral resolution, multispectral sensors have limited value for detecting soil properties (Tamas & Lenart, 2006). In contrast, hyperspectral remote sensing provides near-laboratory quality reflectance spectra, thus allowing for the subtle discrimination of materials (Campbell, 2007).

MATERIALS AND METHODS

In this study, topsoil samples were collected from within the Sandspruit Catchment near Cape Town, South Africa. Electrical conductivity (EC), pH, anions and cations were analyzed in the laboratory. An Analytical Spectral Devices (ASD) field spectrometer was used to measure the spectral reflectance of the soil samples on a clear sky day. Similar measurements were taken of saturated pastes, and of dried soil sample residues after soluble salts were washed out. Correlation analyses of EC, anions and cations with untransformed and derivative reflectance were conducted. Spectral signatures of the soil samples before and after the soluble salts were washed out were analyzed.

RESULTS AND DISCUSSION

Quadratic predictive models of individual bands using first derivative reflectance yielded higher calibration r^2 values (equal to 0.85, 0.65, 0.84, 0.68, 0.79, 0.81, 0.79, and 0.57 for EC, Ca, Mg, K, Cl, NO_3, PO_4, and SO_4, respectively). The spectral reflectance of the soils in the Sandspruit Catchment increased in all the bands when soluble salts were removed. The correlograms of EC, Na, and Cl with spectral reflectance were similar in all the bands. These results are applicable to dry soils.

CONCLUSIONS

The results show that salt-affected soils in the Sandspruit Catchment can be spectrally characterized and therefore possibly mapped by remote sensing techniques. Na and Cl appear to be major contributors to the spectral reflectance of salt-affected soils. The first derivative reflectance improved the detection of EC, cations and anions.

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ACKNOWLEDGEMENTS

The Water Research Commission is thanked for funding the study. Richard Tswai and Leonard Adams are thanked for assisting in spectral and soil sample data collection, respectively. Mat Gordon is thanked for conducting chemical analysis.

Keywords: Hyperspectral remote sensing, salinization, salt-affected soils, spectroscopy

EFFECT OF HOT WATER AND MOLYBDENUM DIPS ON ENDOGENOUS POLYAMINES IN LEMON FLAVEDO AND THEIR ABILITY TO ALLEVIATE CHILLING INJURY DURING COLD STORAGE

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INTRODUCTION

Cold sterilization of citrus fruit against fruit fly has been well-established as a phytosanitary standard for most high paying and competitive markets. However, lemons, like any other citrus fruit, are chilling susceptibility which can result in great economic losses, as the fruit's marketability is reduced. Polyamines (PAs), putrescine (Put), spermidine (Spd) and spermine (Spm) have been shown to be involved in mitigating stress by improving membrane stability through their antioxidant function (Kuznetsov and Sheyakava, 2007). The effect of hot water and molybdenum postharvest dips on endogenous free, soluble-conjugated and membrane- conjugated polyamines in 'Eureka' lemon flavedo and their involvement in alleviation of chilling injury (CI) were investigated.

MATERIALS AND METHODS

Fruits were obtained from two sources and hot water dipped (HWD) for 2 min at 47°C or 53°C in combination with a subsequent 1 or 10µM $Na_2MoO_4.2H_20$ soak for 30 min. Fruit were subsequently stored at -0.5°C for 7, 14, 21 or 28 days and thereafter evaluated weekly for CI. Flavedo samples were taken on removal from cold storage and specific polyamines analyzed by HPLC.

RESULTS AND DISCUSSION

Chilled fruit sourced from Sun Valley Estates were high in free, soluble and membrane conjugated polyamines, an indicator of response to chilling stress and susceptibility. The decrease in soluble and membrane-bound PAs further accounted for chilling susceptibility of Sun Valley Estates fruit during cold storage. Moreover, HWD at 53°C with Mo also reduced CI by increasing PAs. Furthermore, the chilling susceptibility of lemon was affected by locality which also influenced endogenous PAs.

CONCLUSIONS

Putrescine was the dominant polyamine in lemon flavedo and soluble conjugated polyamines were found to be high in chilling susceptible lemon due to chilling stress. HWD plus Mo increased Put concentrations resulting in an increased antioxidant capacity and therefore a reduced chilling injury during cold storage.

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Keywords: chilling injury, hot water, molybdenum, polyamine, cold storage

THE POTENTIAL OF HOT WATER AND MOLYBDENUM DIPS TO INDUCE A SYNERGISTIC SUGAR-ASCORBIC ACID INTERACTION IN LEMON RIND DURING COLD STORAGE

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INTRODUCTION

Lemon fruits are sensitive to low temperatures during storage, resulting in potential chilling injury. This is particularly so where cold sterilization is required for phytosanitary purposes. It has been reported that ethanol soluble sugars in the rind may play a role in stabilizing proteins and membranes under chilling conditions, while ascorbic acid has been found to be a major antioxidant during cold storage (Abeysinghe *et al*., 2007) and can be converted from ethanol soluble sugars (Smirnoff, 2000). Previous work has shown that a combination of hot water (HWD) and molybdenum dips (Mo) have potential to mitigate chilling injury. The purpose of this work was to investigate if alcohol soluble sugars and ascorbic acid concentration can be altered by such treatments, and whether there is a synergistic interaction between sugars and ascorbic acid during cold storage as a mechanism to enhance chilling resistance.

MATERIALS AND METHODS

Fruits were obtained from two sources and treated with a 2 min HWD at 47°C or 53°C in combination with a subsequent 1 or 10µM $Na_2MoO_4.2H_20$ soak for 30 min. Fruits were subsequently stored at -0.5°C for 7, 14, 21 or 28 days and thereafter evaluated weekly for chilling injury. Ethanol soluble sugars and ascorbic acid were extracted and analyzed by HPLC.

RESULTS AND DISCUSSION

The dominant soluble sugar found was glucose, which was high in fruits without chilling symptoms. Hot water dips at 53^{0}C plus 1µM Mo decreased chilling injury in susceptible fruit, and increased ascorbic acid concentration. It is suggested that glucose is the precursor for ascorbic acid (Loewus, 1999) and the conversion is enhanced by the treatment. Results also implied a synergistic relationship between glucose and ascorbic acid. Fruit origin also influenced ascorbic acid concentration, and hence susceptibility to chilling injury.

CONCLUSION

High glucose and ascorbic acid concentrations in lemon rind appear to regulate chilling injury resistance. Hot water dips at 53ºC combined with 1µM Mo dips may enhance the conversion of glucose to ascorbic acid which then acts as a potent antioxidant during cold storage. Fruit with higher rind glucose at harvest had enhanced potential for chilling resistance.

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Keywords: Citrus, Chilling injury, Hot water, Molybdenum, Sugars, Cold storage

MAIZE/PIGEONPEA INTERCROPPING SYSTEMS IN MPUMALANGA: RESIDUAL EFFECT OF PIGEONPEA

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INTRODUCTION

Pigeonpea (*Cajanus cajan* L. Millspaugh) is rarely grown as a field crop in South Africa, although its yield potential has been established and outstanding varieties have been identified for South Africa (Mathews & Saxena, 2005). However, studies on the nitrogen contribution by these varieties have not been undertaken in local environments. The main objective of the study was to assess the N-benefit of the long-duration pigeonpea (cv. ICEAP00040) on the yield of the subsequent maize crop.

MATERIALS AND METHODS

The study was carried out at Nelspruit (25° 26' 25" S, 30° 58' 57"E and 676 m.a.s.l.) during 2007-09 and 2008-2010 cropping seasons. An intercropping trial was planted in the 2007 cropping season with three spatial arrangements (same, alternate and paired- rows) and sole crops of pigeonpea and maize. The trial was arranged in a RCB design with five replications. In 2008, after harvesting the trial, all the above ground parts of the plants in the intercropping trial were incorporated into their respective plots and planted to maize. Each plot was sub-divided and received four super-imposed nitrogen treatments (0, 40, 80 and 120 kg N ha^{-1}). Thus, the trial in the 2nd season was laid out as a randomized-split plot with five replications keeping the cropping systems of 2007 as the major and N levels as minor treatments. The trials were repeated in 2008-10 seasons. Data collected on growth and yield parameters were analyzed using MSTAT-C statistical package.

RESULTS AND DISCUSSION

A combined anlalysis of the results over two seasons (2007-09 and 2008-10) indicated that the major treatment (cropping systems) effect was highly significant ($p \leq 0.001$). Relative to maize following sole maize, increases in grain yield ranging between 4 and 26% were obtained when maize followed treatments that contained pigeonpea across N levels. In both seasons, the yield was greatest when maize was planted subsequent to sole pigeonpea and it did not differ significantly from paired-row planting. Highly significant ($p=0.01$) yield increases were observed with increasing N levels across all cropping systems. The yield increase was up to 47% in plots that received N @120 kg ha^{-1}over the no-nitrogen plots.

CONCLUSION

Pigeonpea had a significant positive effect on residual N, especially when grown as a sole-crop. The residual benefit of pigeonpea to subsequent maize crop was estimated to range between 40 and 80kg N ha^{-1}.

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Keywords: paired-row, sole-cropping, N-content

MAIZE/PIGEONPEA INTERCROPPING SYSTEMS IN MPUMALANGA: EFFECT ON GROWTH AND YIELD OF COMPONENT CROPS

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INTRODUCTION

Smallholder farmers in the Mpumalanga province produce maize under marginal conditions characterized by low and erratic rainfall and soils with low plant-available N, and reduced organic matter (Mathews & Beck, 1994). Under these circumstances, inclusion of N_2-fixing legumes can improve soil N-fertility and organic matter accumulation in cropping systems. The main objective of this study was to assess the biological and economic potential of pigeonpea (*Cajanus cajan* L. Millspaugh) intercropping systems for sustainable crop production by resource-poor farmers in Mpumalanga.

MATERIALS AND METHODS

The study was carried out at Nelspruit (25° 26' 25" S, 30° 58' 57"E and 676 m.a.s.l.) for three seasons (2007-2010) with three intercropping and two sole-cropped treatments. The trial was laid out using RCB design with five replications. The spatial arrangements included pigeonpea (cv. ICEAP00040) and maize (cv. ZM521) in same, alternate and paired rows. The plant populations were kept at sole cropping levels. Leaf area index (LAI) was recorded from 45 days after planting (DAP) to harvest, using a LAI ceptometer (AccuPAR LP-80). Leaf drop was recorded from two $1m^2$ quadrates per plot. Growth and biomass were recorded using sample plants at four crop physiological stages viz. maize tasseling and harvest, and pigeonpea flowering and harvest. Data collected were analyzed using MSTAT-C statistical package.

RESULTS AND DISCUSSION

Intercropping systems significantly (p=0.05) affected growth parameters in pigeonpea with sole-cropping giving larger biomass. Cropping systems had no significant effect on growth of maize plants and grain yields in both component crops. Peak level of LAI was recorded under pigeonpea sole copping, and the lowest in same-row planting during flowering to pod formation. Leaf drop was significantly greater (p=0.05) under pigeonpea sole cropping followed by paired-row planting, and lowest in same–row planting. The average land equivalent ratio (LER) over two seasons varied from 1.68 in the alternate–row planting to 1.81 in paired-row planting.

CONCLUSION

Pigeonpea when intercropped did not interfere with the growth of component maize crop to cause any significant reduction in its yield and produced higher LER value, indicating its sustainability.

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Keywords: LER, LAI paired-row

HOST-SUITABILITY AND HOST-SENSITIVITY OF *Vernonia galamensis* ACCESSION 17, 18 AND 19 TO *Meloidogyne incognita* RACE 2 UNDER GREENHOUSE CONDITIONS

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INTRODUCTION

Vernonia galamensis, a potential alternative oilseed crop in Limpopo Province, South Africa; is greatly valued for its seed oil enriched with vernolic fatty acid (Shimelis *et al*., 2008), which is important in the reduction of greenhouse gases and the removal of carcinogenetic acrylic formulations in the manufacturing of various industrial products. The objectives of the study were to determine the host-suitability and host-sensitivity of *V. galamensis* accession 17, 18 and 19 to *Meloidogyne incognita* race 2 under greenhouse conditions.

MATERIALS AND METHOD

Five nematode inoculums, 0, 500, 1000, 1500 and 2000 were dispensed into the root systems of accession 17, 18 and 19 arranged in a randomised complete block design with five replicates in 2009, and repeated in 2010 with four replicates under greenhouse conditions at the Plant Protection Skills Centre, University of Limpopo (23°53'10"S, 29°44'15"E), Republic of South Africa.

RESULTS AND DISCUSSION

Sixty-two days after inoculation, the reproductive factors (Pf/Pi) of *M. incognita* race 2 were less than one at all nematode (Pi) level, and the roots of the tested accessions had no galls. The nematode level had no effect on the plant variables except shoot weight. The results support the concept of root-pruning effects in fibrous root systems infected with *M. incognita* nematode that breaks the rootlets during the initiation of giant cells, which subsequently reduces root biomass.

CONCLUSION

Results of the study suggested that the three accessions tested were resistant to *M. incognita* race 2, and the accessions are suitable for use in crop rotation systems.

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ACKNOWLEDGEMENTS

The authors are indebted to the NRF for financial support and Edward Mathebula for his technical assistance.

Keywords: Asteraceae, epoxidised fatty acid, ironweed, oilseed crop, reproductive factor

THE EFFECT OF POST-HARVEST FERTILIZER APPLICATION AND AGE OF PLANTING MATERIAL ON PLANT ESTABLISHMENT AND YIELD OF QUEEN PINEAPPLE, *Ananas comosus*

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INTRODUCTION

Queen Pineapple plant mortality as well as poor growth and development are some of the major problems facing the Hluhluwe pineapple producers. The Queen pineapple is planted at a density of 100 000 – 120 000 plants per hectare. The number of fruit harvested is much less than expected at these populations and ranges from 72 000 – 78 000 fruit per hectare. Rejected fruit contribute 3-5% of the loss. Therefore approximately 20% of the plants do not produce fruit, due to mortality or poor growth. The causes of poor growth are not clear, but the plants die back or develop very slow after planting, ending up being too small to produce fruit at the time of flower induction with consequent yield reduction and lower returns to farmers. Quality of planting material is one of the important factors affecting pineapple plant growth.

MATERIALS AND METOHDS

Two pineapple blocks (0.5 ha) harvested in August 2008 were treated 1 month after harvest with three different application rates of fertilizer namely: Control (no ammonium sulphate applied), 0.5 ton ammonium sulphate and 1 ton ammonium sulphate. The planting material obtained from the above mentioned block was used in the trials. Three blocks were planted with sucker sizes 2, 3, 4 and 5 at three different planting dates namely: 6 (Block A, 03/2009), 8 (Block B, 05/2009) and 10 (Block C, 08/2009) months after applying the post-harvest fertilizer. Assessments were done on plant growth and development, mortality symptoms, leaf analysis (at 6 months and at flowering), flower percentage, pest infestation and yield.

RESULTS AND DISCUSSION

Post harvest fertilizer treatment influenced plant growth and development; the 1 ton treatment produced bigger plants, followed by the 0.5 ton treatment and the smallest plants were in the control treatment. Plant mortality was higher in 03/2009 planting, while less in 05/2009 and 08/2009 planting. Plant size, age and fertilizer treatment influence the recovery of plants with mortality symptoms. Leaf analysis (at flowering) only differed in 08/2009 planting (older planting material) with 1 ton treatment having a higher nitrogen percentage in the leaves. More than half of the plants that did not flower had mortality symptoms. Yield is influenced by age of planting material, plant size and fertilizer treatment. Higher yields were obtained from the bigger plants. The effect of the fertilizer treatment on yield was more prominent in 05/2009 and 08/2009 planting (older planting material). Plant size, plant age and fertilizer treatment had no influence on insect infestation.

CONCLUSION

Post harvest fertilizer application, as well as age and size of planting material are important factors influencing pineapple yield.

Keywords: Fertilizer, plant mortality, plant size, Queen pineapple, *Ananas comosus*, plant age

THE POTENTIAL OF POSTHARVEST SILICON DIPS TO REGULATE PHENOLICS IN CITRUS PEEL AS A METHOD TO MITIGATE CHILLING INJURY IN LEMONS

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INTRODUCTION

South African citrus fruit is shipped at -0.6°C to meet the quarantine requirements for certain high paying markets. However, tropical and subtropical fruit suffer from chilling injury when held at temperatures below 12°C. Physiologically, chilling injury is induced by oxidative stress caused by reactive oxygen species (ROS) (Sala & Lafuente, 2000). One of the most effective anti-oxidants to scavenge these ROS and subsequently mitigate chilling injury is phenolics. Silicon (Si) has been proved to induce stress resistance in plants (Liang *et al*., 2008) and has been reported to increase phenolic concentration in tissue (Ma & Yamaji, 2006). The objective of this study was to evaluate the potential of Si dips to regulate phenolics capacity, thereby preventing chilling injury.

MATERIALS AND METHODS

Lemons (cv. Eureka) were obtained in July 2010 from the UKZN Research Farm, Ukulinga. Fruit were transported to the laboratory and treated with various concentrations (50, 150 and 250 ml/L) of K_2SiO_3 dips for 30 minutes. Fruit were left at room temperature to dry and subsequently stored at -0.5°C or 2°C for up to 7, 14, 21 and 28 days. Samples for phenolics evaluation were taken out of cold storage and stored for 5 days at room temperature. Phenolic compounds were determined spectrophotometrically according to Abeysinghe *et al*. (2007).

RESULTS AND DISCUSSION

Ukulinga lemon showed no chilling symptoms, neither at -0.5 nor at 2ºC, after 28 days of cold storage plus five days shelf life. Silicon postharvest dips had no significant effect on fruit weight loss compared with untreated fruit; however, fruit weight loss was accelerated post cold storage (Schirra & D'Hallewin, 1997). Electrolyte leakage indicated the highest membrane damage at 7 and 21 days cold storage; at 7 days electrolyte leakage was significantly reduced by the 150ml/L K_2SiO_3 dip. High amounts of free phenolics seem to have been aligned to chilling resistance of lemon fruit stored at -0.5 or 2ºC.

CONCLUSIONS

Si dips seem to have a potential to mitigate chilling injury in lemons.

ACKNOWLEDGEMENTS

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Keywords: citrus, phenolics, silicon

USE OF SILICON AND PHOSPHORUS ACID TO ENHANCE NATURAL RESISTANCE TO PENICILLIUM ROT IN CITRUS FRUIT

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INTRODUCTION

Although technological advances have greatly improved the storage life and quality of citrus, postharvest decay is still a major problem (Ladaniya, 2008). *Penicillium digitatum* (green mould) and *P. italicum* (blue mould) are the most economically important postharvest pathogens (Brown, 1985). Over the years, fungicides belonging to the benzimidazole, thiabendazole (TBZ) and benomyl and imidazol (IMZ) groups have been used extensively to control these diseases but the development of fungicide-resistant strains, together with the withdrawal of effective chemicals from the market, has led to the search for more integrated methods of disease control (Kinay *et al*, 2007). Silicon and phosphorus acid appear to trigger a systemic response that enhances the fruit's resistance to pathogen attack. The aim of this research is to ascertain the changes in fruit biochemical composition after the application of these two chemicals in order to improve the understanding of the mechanisms involved and, therefore, how they can be manipulated to improve the level of control.

MATERIAL AND METHODS

Valencia and Navel oranges as well as one lemon cultivar, Eureka, harvested from Ukulinga farm, were treated both pre- and post-harvest with three different silicon concentrations (3.35ml/l, 10.7ml/l and 21.4ml/l) and one concentration (5ml/l) of phosphorus acid. As pre-harvest treatment, individual trees were drenched around the base of the tree trunk with 5l solutions of the different treatment concentration. The fruit were left on the trees for 21 days after treatment to allow for uptake and transport of the silicon and phosphorous acid to the fruit, and were then harvested thereafter. As a postharvest treatment, fruit were immersed in the treatment solutions and then air dried. After treatment, fruit were inoculated with a 1 x 10^{-4} spore suspension of *Penicillium.* Control fruit and trees were treated with water. The fruit were sampled three times over a period of 30 days (once every 10 days) for biochemical analysis. Petroleum jelly was used to cover the surface where the peels were removed in order to prevent fruit desiccation and shrinkage. Disease progress was monitored throughout the 30 days and AUDPC was used to analyse data.

RESULTS AND DISCUSSION

Different levels of *Penicillium* control were achieved with the different treatments used. Petroleum jelly applied onto the surface of the fruit was able to provide sufficient cover to prevent fruit shrinkage and thus allow for continuous sampling over the 30 day period. Although some treatment combinations did not seem to have a synergistic effect on disease suppression they did appear to delay disease onset.

CONCLUSION

Further research is necessary to fully understand the biochemical changes induced by silicon and phosphoric acid.

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Keywords: Penicillium decay, Host resistance, Silicon

IMPOSING WATER STRESS DURING SEED GERMINATION ALLOWS DETERMINATION OF SEED QUALITY

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INTRODUCTION

Since plant response to environmental restrictions is regulated by physiological and biochemical processes (Naidu *et al.*, 1990), it is important that studies of water stress on plants take into consideration changes in metabolism and cell composition as early as the germination stage. The objective of this study was to determine the response of seeds to water stress during germination in an effort to relate seed performance to plant performance under water stress.

MATERIALS AND METHODS

Leakage of substances during imbibition of cowpea, water melon and bambara seeds was determined according to the international rules for seed testing (Modi and Asanzi, 2008). Changes in seed water activity were determined over a period of 48 hours of water absorption during imbibition. Water stress conditions during seed germination were mimicked by suspending seeds over respective relative humidities in equilibrium with saturated solutions of $LiCl.H_2O$ (12.4% RH), NaCl (75.5% RH) and KNO_3 (93.2% RH) at 20 ^{0}C (Das *et al.,* 1990). Seed germination capacity and seedling size (total, shoot and root) were used to determine seed performance.

RESULTS AND DISCUSSION

There were significant differences ($P < 0.05$) between species with respect to seed quality and response to water stress during germination. Water melon was most sensitive to water stress and cowpea was most resistant. A negative correlation between proline accumulation and water stress was established for all species. High seedling vigour was associated with resistance to water tress.

CONCLUSIONS

Rate of germination and seedling size, more so root size, were used to predict species performance under water stress during plant growth under field conditions. Field studies are in progress.

ACKNOWLEDGEMENTS

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Keywords: conductivity, proline, water activity

EFFECT OF FERTILIZER APPLICATION ON YIELD, MINERAL COMPOSITION, VITAMIN C AND FIBRE CONTENT OF *Brassica rapa*

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INTRODUCTION

Brassica rapa has been an essential source of food for years, providing vital nutrients (iron: 2.6 mg, fibre 0.7g) and vitamins (Vitamin A:2305 µg carotene, Vitamin C:53 mg) in South African rural communities. However, this vegetable has been neglected as poor mans crop and production systems using fertilization have not been studied. Recently, the importance of this vegetable in the survival of the rural people has been widely recognized. Considering the role of this vegetable in disadvantaged rural households, proper fertilization management and nutrient requirements of this vegetable need to be determined.

MATERIALS AND METHODS

Brassica rapa trials were conducted during the 2009 and 2010 winter seasons at the ARC-Roodeplaat Research Station. The trials were laid out in a complete randomized block design, with four replicates. Soil nutrient status before applying fertilizers was 27 mg P kg^{-1}; 64 mg K kg^{-1}; 210 mg Ca kg^{-1}; 93 mg Mg kg^{-1} in 2009 and 34.4 mg P kg^{-1}; 39 mg K kg; 177.16 mg Ca kg^{-1}; 63.16 mg Mg kg^{-1} in 2010. The fertilizer treatments applied based on soil analysis were: No fertilizer application 100: 20:150 kg N: P: K ha^{-1}; 0: 20:150 kg N: P: K ha^{-1}; 100:20:0 kg N: P: K ha^{-1}; 100:0:150 kg N: P: K ha^{-1} and 50:10: 75 kg N: P: K ha^{-1}. Seedlings of *B. rapa* were transplanted in May at a spacing of 40 X 40cm. Harvesting was done in the middle of the season to determine the vitamin A, vitamin C, fibre, iron, and zinc contents.

RESULTS AND DISCUSSION

Fertilizer application particularly nitrogen (100:20:150 kg N: P: K ha^{-1} and 50:10:75 kg N: P: K ha^{-1}) increased yield of *B. rapa.* Although there was no clear trend on the iron, zinc and vitamin C content of the leaves, some indications of increase onthe iron and Zinc and reduction of vitamin C content was observed with the high nitrogen (100:20:150 kg N: P: K ha) application. Fibre content was not negatively affected by fertilizer application. Vitamin A content of B.rapa was not detected.

CONCLUSIONS

Nitrogen application had a beneficial effect of on the yield of B. rapa. There were indications that high nitrogen increased iron and zinc and decreased vitamin C while fibre content was not affected.

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ACKNOWLEDGEMENT

The Department of Agriculture and Rural Development for funding the project.

Keywords: Brassica, Fertilization, Yield, Nutritional value

GERMINATION RESPONSES OF SEEDS OF DIFFERENT SOUTH AFRICAN MEDICINAL PLANTS TO VARYING TEMPERATURES AND TREATMENTS

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INTRODUCTION

The demand for medicinal plant material is currently satisfied from wild populations and this has caused great concern for conservation of medicinal plant species. Propagation of medicinal plant species of South Africa through seeds has proved to be difficult, with very low and very erratic germination percentages. The aim of the study was to find ways for mass propagation of highly utilized medicinal plants and those that are becoming extinct, and to investigate the optimum conditions required to obtain high germination percentages and uniform germination, in the shortest time possible. The species investigated were *Bowiea volubilis, Alepidea amatymbica, Dicoma anomala* and *Leonotis ocymifolia*.

MATERIALS AND METHODS

Percentage germination was determined by placing four replicates of 50 seeds each between moist paper towels which were rolled up and placed individually in polythene bags, held upright in plastic beakers. The four replicates of each treatment were kept in growth chambers (Labotec) at 10ºC, 15ºC, 20ºC, 25ºC and 30ºC, respectively. They were all kept at constant temperatures in darkness, unless when unrolled and counted in the light. The seeds were checked every seven days and the germinated seeds counted. Recording continued for three weeks for *L. ocymifolia*, six weeks for *B. volubilis* and 14 weeks for *A. amtymbica*, while germination for *D. anomala* was recorded for eight weeks. A seed primer paper disc, which contained a combination of natural substances from smoke, was used for smoke treatment of some seeds, while seeds of other species were “defluffed” between the thumb and forefinger. Untreated seeds were used as a control.

RESULTS AND DISCUSSION

A. amatymbica showed the highest germination of 10% at 25ºC with smoke treated seeds, while *D. anomala* showed increased germination after the removal of hair like structures, which could be the reminiscence of the flower. At 15ºC *D. anomala* reached the highest germination percentage of 68%. *L. ocymifolia* had a high germination percentage of 88% at 20ºC treatment of the seeds before germination. Untreated seeds of *B. volubilis* at 15ºC reached the highest germination percentage of 93%.

CONCLUSIONS

In general, each species differed in terms of germination conditions, but 15ºC to 20ºC seemed to be the most effective germination temperature for most of the species. Future research on germination of medicinal plant seeds will focus on species which can enter commercial production or facing extinction to develop less expensive but effective germination methods.

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Keywords: Seed germination, medicinal plants

LEAF CHLOROPHYLL READINGS AS AN INDICATOR OF NITROGEN STATUS AND YIELD OF SPINACH (*Spinacia oleracea* L) GROWN IN SOILS AMENDED WITH *Leucaena leucocephala* PRUNINGS

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INTRODUCTION

Biomass from leguminous trees can be used as a source of nitrogen in smallholder vegetable production systems. Biomass accumulation and the possibility of predicting nitrogen status of spinach (*Spinacia oleracea L.* cv. Swiss Chard) through the use of the SPAD-502 (Minolta, Japan) chlorophyll meter were investigated.

MATERIALS AND METHODS

Leaves of *Leucaena leucocephala,* (applied at a rate of 3, 5, 7 or 11 t ha^{-1}), were used to ameliorate soil used for the production of spinach. The experimental layout was a randomized complete block design replicated three times and the experiment was repeated over two seasons, March-May 2009 and December 2009-February 2010. A 'no fertilizer' 0 N and 150 kg N ha^{-1} were the control treatments. Total biomass, leaf number and size were measured following destructive sampling at 2, 4, 6, 8 and 9 weeks after transplanting. At each sampling, leaf SPAD-502 readings were recorded for the top six leaves. Nitrogen sufficiency indices were used to indicate the N status of plants in the various treatments.

RESULTS AND DISCUSSION

Application of *L. leucocephala* prunings increased spinach yields relative to the 0N treatment and yields increased with increasing rate of pruning application. This was corroborated by the different relative growth rates over the two seasons and the treatments ranked: 11 t > 150 N > 7 t > 5 t > 3 t > 0 N. Total N availability and nutrient recovery rates significantly affected chlorophyll meter readings. SPAD readings showed a linear increase with the increase in applied prunings/N. Preferential distribution of N to upper leaves resulted in the first fully expanded leaf having the highest SPAD reading and slightly lower values were recorded for subsequent leaves across treatments. The relationship between shoot N concentration and SPAD readings was linear and strongest for the top three leaves (r^2=0.84-0.91). Normalization of the SPAD readings for the top three leaves resulted in an even stronger relationship (r^2=0.86-0.92). Nitrogen deficiencies detected throughout the season for the 3 t and 0 N treatments resulted in greater yield loss relative to the 150 N treatment. Early N deficiency detected for the 5 t treatment prevented full recovery in terms of yield production.

CONCLUSION

The results indicate that chlorophyll meter readings may be suitable indicators of N status and yield of leafy vegetables grown using biomass transfer technology.

Keywords: chlorophyll meter readings, spinach, *Leucaena leucocephala* prunings

TEMPERATURE EFFECT ON SEED GERMINATION AND SEEDLING GROWTH OF *Moringa oleifera* Lam.

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INTRODUCTION

Moringa oleifera Lam. is a fast growing, drought tolerant tree with numerous beneficial uses, such as nutritious food, animal forage, green manure, water purification, traditional medicine and bio-fuel (Anwar *et al.*, 2007). From a commercial point of view, seed is the cheapest, easiest and most common plant propagation method. High germination percentages and rates, with relatively good uniformity, are thus important factors for successful commercial seedling production.

MATERIALS AND METHODS

Moringa oleifera seeds were planted into seedling trays and placed into three temperature-controlled greenhouses with fluctuating night/day temperatures regimes (TRS) namely; 10/20°C ± 2°C, 15/25°C ± 2°C and 20/30°C ± 2°C. Seedling trays were monitored daily over a period of 40 days to record differences in germination percentage, rate, uniformity and seedling growth.

Seed viability of those that did not germinate was tested using the tetrazolium viability test, according to the guidelines of the International Seed Testing Association (ISTA, 2006). Pre-moistened seeds were cut longitudinally without damaging the embryo and then submerged in a 0.1% solution of 2,3,5-triphenyl tetrazolium chloride for 20 hours prior to the assessment of the seeds.

RESULTS AND DISCUSSION

Seed at the high 20/30°C temperature regime (TR) exhibited a significantly ($P \leq 0.05$) higher germination rate and uniformity along with a lower mean germination time compared to the two lower TRS. The germination percentage however, was lowest at the 20/30°C TR with 74%, and differed from the 88% and 81% of the 10/20°C and 15/25°C TRS respectively. Seedling growth increased exponentially with an increase in TR. Viability testing of un-germinated seed revealed that although germination percentages increased with the decrease in TR, this was not as a result of uneven seed viability, but merely due to temperature differences.

CONCLUSION

Despite the higher germination percentage of the 10/20°C TR, 20/30°C was found to be the most favourable regime for both germination uniformity and seedling growth.

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Keywords: seed viability, germination percentage, mean germination time, growth rate

EFFECT OF FLOODING PATTERN AND NITROGEN APPLICATION ON YIELD OF RICE (*Oryza sativa* L.)

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INTRODUCTION

Worldwide approximately 75% of rice is cultivated using traditional methods which involve flooding the fields while or after setting the young seedlings. Although these flooded conditions impact on the availability and use of nutrients by the crop (Vlek and Byrnes, 1986), yields are potentially higher than rice produced under upland conditions. The unpredictable flooding patterns of these wetlands, however, have implications for nitrogen-use efficiency. The aim of this study was to examine the influence of various flooding patterns on nitrogen use and rice productivity under simulated wetland conditions.

MATERIALS AND METHODS

Rice (cv. Golden Mountain #1, RSA) was grown under glasshouse conditions (30/20°C day/night; 65% RH), and subjected to three nitrogen levels (0, 110 and 220 kg ha^{-1}) applied in three doses, and four water regimes namely: (1) well watered (aerobic) control, (2) continuous flooding, (3) early flooding at tillering, and (4) late flooding at post-tillering. Flood level was maintained at 5 cm above the soil surface in 4.8 L pots containing mineral soil (28% clay, 1.5% OM, 0.2% N). Tiller production from 28 DAS till heading, and grain yield at maturity were measured. Nitrogen use efficiency (NUE) was determined by the difference method (Moll *et al*., 1982) as N fertilizer recovery at heading and agronomic NUE at maturity.

RESULTS AND DISCUSSION

Continuous and early flooding increased tiller production and grain yield, compared to late flooding or aerobic conditions. Although the highest grain yields under the various flooding patterns were obtained with 220 kg N ha^{-1}, the combination of 110 kg N ha^{-1} and early flooding significantly increased tiller productivity, nitrogen recovery, and agronomic NUE, indicating the need to carefully regulate the supply of nitrogen and water resources if grain yield must be increased at minimal costs.

CONCLUSIONS

Compared to upland culture, rice production under wetland conditions can lead to increased productivity with N applied at the rate of 110 kg ha^{-1} for cultivars having yield potentials of 6-7 t ha^{-1}. Best results are obtained when flooding is limited to the early part of the season.

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Keywords: Flooding, Nitrogen, Rice, Tillering, Wetland

ACTUAL COSTS OF CROP PROTECTION FIELD TRIALS

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INTRODUCTION

In order to curb research costs, many crop protection companies resorted to out sourcing the registration field trials for Act 36 of 1949 (as amended), to independent research contractors. Principals were used to utilize farmers' fields for trials where crop production input expenses were waived. This becomes a contentious issue since this practice does not reflect a true picture of the actual costs of such trials.

MATERIALS AND METHODS

The trial protocol which contains all the trial elements viz. treatments, replications, number of applications, type and number of evaluations, plot size, is used as the basis for costing. Further, using good field practices (GFP) as a guideline, the major cost contributing factors were identified and valued, namely that of crop establishment, application, maintenance, evaluation and reporting. The trials are conducted by crop protection professionals (contractors) and time spent on spraying, evaluating and reporting and the costs, quantified.

RESULTS AND DISCUSSION

Using a maize field trial with ten treatments, four replications, one application as a basis, the measuring out of chemicals, mixing and spraying of a plot with a pressurized knapsack sprayer takes an average of 3,2 min/plot. The evaluation of disease or insect damage, as a percent damaged, takes 4,5 min/plot, whereas counting insects viz. thrips, diamondback moth or spider mites, takes 18 min/plot. A herbicide trial takes 4,5 min/plot on average to evaluate. The percentage cost implication on the 40 plot trial with one evaluation is 13,3 %; 14,6 %; 32,6 % and 39,3 % for crop establishment, application, evaluation and reporting, respectively, resulting in a cost of R11,795-00. Using the same trial but with three evaluations, 9,3 %; 10,4 %; 52,7 % and 27,6 % is attributed to crop establishment, application, evaluation and reporting, respectively, the cost being R 16,820-00. Additional costs would be for locating a trial site, travelling and destruction of the crop/plants when unregistered products were used.

CONCLUSION

Being aware of all the cost inputs in a crop protection field trial, should create a better understanding between principals and contractors in reaching an amicable price agreement.

Keywords: Spray costs, evaluation cost, field trial cost

GROWTH AND NUTRIENT UPTAKE BY MAIZE (*Zea mays* L.) GROWN IN A SOIL AMENDED WITH LEAF LITTER FROM THREE DOMINANT SUB-TROPICAL FRUIT TREES IN MPUMALANGA PROVINCE

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INTRODUCTION

The most commonly used method to supply nutrients to growing crops has been through chemical fertilizers. However, the majority of small scale farmers can not afford to buy chemical fertilizers and rely in organic materials to replenish soil nutrients. The sub-tropical climate of Nelspruit supports the growth of sub-tropical fruit trees that shed leaves throughout the year and thereby providing biomass with potential for managing soil nutrients. There is however, no quantitative evidence on the contribution of leaf litter from fruit trees to nutrients for crop uptake. The objective of this study was to quantify the nutrient uptake and growth of maize grown on soil amended with leaf litter from fruit trees commonly found in Mpumalanga Province.

MATERIALS AND METHODS

The study was carried out at the ARC-ITSC in Nelspruit. Maize hybrid (cv PAN 6671) was grown in pots containing soil amended with leaf litter collected from three fruit trees *viz*: avocado (*Persea americana*), mango (*Mangifera indica*) and litchi (*Litchi chinensis*). The treatments consisted of combinations of leaf litter types (avocado, mango, and litchi), application rates (0, 1.6, and 3.3 t ha^{-1}), and incubation periods (0, 6, and 12 months) laid in a randomized complete block design with five replicates. After 48 days of growth, plant height and dry matter yields (shoots and roots) of the maize seedligs in each pot were measured. The dry material was ground and analyzed for N, P, K, S, Ca, Mg, Zn, and Mn.

RESULTS AND DISCUSSION

Both leaf litter type and incubation period had a significant ($P<0.01$) effect on dry matter yields and plant height of the maize plants. Dry matter yields were significantly higher ($P<0.01$) in maize grown in soil amended with 3.3 t ha^{-1} of avocado leaf litter than in soil amended with mango leaf litter. The concentration of P, K, Ca, Mg and Zn were higher in the shoots than roots of maize while that of N, S and Mn shows the reverse trend. Increasing the application rate and incubation period of leaf litter resulted in higher concentration and uptake of nutrients. There was a significant higher concentration of N in the shoots of maize grown in soil that were incubated for 6 months prior to planting whereas P and K was higher in the shoots of maize plants grown in soil incubated for 12 months. Higher uptake of N, P, K, Ca, Mg and Zn was observed in maize plants grown in soil incubated for 12 months prior to planting. The low response by maize plants to mango and litchi leaf litter could be attributed to slow rate of mineralization due to the large C:N ratio (average 48:1) and high lignin content (average 39%). The concentration of nutrients in different parts of maize could be due to differences in the mobility of these nutrients within the plant parts. The results emphasize the importance of timing the application of litter in order to synchronise the release of nutrients with crop uptake and growth.

CONCLUSION

It was concluded that leaf litter from avocado had a superior effect on the dry matter and plant height of maize plants due to higher quality compared to the leaf litter from mango and litchi. Due to the relatively poor quality, this litter needs to be incubated for longer periods in order to allow for mineralization to take place.

ACKNOWLEDGEMENT

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Keywords: incubation period, leaf litter biomass, nutrient uptake, rates of litter application

THE EFFECTS OF GREYWATER ON VEGETABLE CROP QUALITY

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INTRODUCTION

There are reports indicating that greywater reuse for agricultural purposes increases crop yield due to finite concentrations of macro-nutrients such as nitrogen and phosphorus contained in greywater. Research on greywater irrigation has mainly focused attention on the re-use of greywater in relation to its quality and crop biomass but not on quality of the vegetable crop edible part.

MATERIAL AND METHODS

An experiment was established at the Umtata Dam Research Station where combinations of cabbage and onions followed by spinach and beetroot followed by carrot and lettuce were planted in three different planting seasons and irrigated with greywater (GW) derived from bathing and dishwashing, potable water (PW) and diluted greywater (DGW in a ratio of 1:1 GW:PW) using drip irrigation. In each season, before the trial initiation, greywater samples were collected from the Umtata Dam households, quantified and analyzed for pH and Electrical Conductivity (EC) using a portable pH/EC meter to check whether they meet acceptable irrigation quality according to (Baunder *et al*., 2007). All plots were mulched with grass.

RESULTS AND DISCUSSIONS

The results show a significant increase in yield, head mass and appeal when cabbages were irrigated with DGW than with PW. Onion yields were, however, significantly higher when using GW as compared to DGW and PW. Spinach also obtained significantly higher yield when irrigated with GW, however, many leaves from this treatment were infested by bacterial spot as compared to the other treatments. Bacterial spot on spinach leaves compromises the marketing quality but this did not reduce the total harvested quantity of spinach leaves from the GW irrigated plot. In beetroot none of the measured parameters were significantly affected by any irrigation water treatment. Carrots didn't have any significant difference on yield and root girth, however carrots irrigated with PW were more appealing and significantly longer than other treatments. There were no significant difference observed in all treatments on lettuce yield and on average head diameter. However, lettuce irrigated with DGW was significantly more appealing than other treatments.

CONCLUSION

Greywater increase vegetable crop yield but seems to compromise the aesthetic appeal which is very crucial to external quality in marketing of perishable fresh produce.

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Keywords: greywater, vegetables, yield

RESPONSES OF SELECTED WHEAT CULTIVARS TO ETHYL METHANE SULPHONATE CONCENTRATION, TREATMENT TEMPERATURE AND DURATION

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INTRODUCTION

Genetic variation could be enhanced through various techniques including the use of chemical mutagens such as ethyl methane sulphonate (EMS). Use of EMS has been reported in various major crops such as wheat, rice, barley, cotton, peanuts and beans (Ahloowalia and Maluszynski, 2001). The most important considerations for inducing mutation with EMS include concentration, temperature and duration of treatment. The objective of this study was to determine the optimum EMS concentration, treatment temperature and duration that would provide desired germination percentage and vigorous seedlings for effective mutagenesis in wheat (*Triticum aestivum* L.*)*.

MATERIAL AND METHODS

Seeds of four selected varieties of wheat (B936, B966, SST387 and SST875) were surface sterilized in sodium hypochlorite and ethanol and soaked in distilled water for 18 hours. The seeds were treated using three EMS concentrations (0.3, 0.5, and 0.7%), three temperature regimes (30, 32.5 and 35 °C) at four time durations (0.5, 1, 1.5 and 2 hrs). Two replicates were done. The treated seeds were planted in seedling trays and germinated in a tunnel at the Controlled Environment Facility (CEF) of the University of KwaZulu-Natal. Germination percentage and seedling heights were recorded for each variety and treatment combinations.

RESULTS AND DISCUSSION

Results showed significant interactions ($P<0.01$) among variety, EMS concentration, temperature and exposure time on germination percentage and seedling heights. B936 and SST387 had germination at 50.0%, B966 53.3% and SST875 56.65%. These results were observed at EMS level of 0.7%, 30 ^{0}C and 1.5 hours exposure time in B936; EMS at 0.5%, 35 ^{0}C and 1.5 hour (B966); and EMS at 0.5%, 32.5 ^{0}C and 2 hours in SST387. SST875 required EMS dose at 0.5%, 32.5 ^{0}C and 1 hour treatment time. Other treatment combinations rendered higher germination percentages ranging from 70 to 97% similar to untreated control or severely reduced germination and seedling heights. Seedling heights decreased with increase in EMS dose, temperature and exposure time.

CONCLUSION

The study established the requirement of variety specific EMS dose and treatment temperature and duration that could be used for inducing large scale mutation to select targeted mutant individuals in wheat.

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ACKNOWLEDGEMENTS

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

Keywords: ethyl methane sulphonate, mutagenesis, seed germination, *Triticum aestivicum*

EFFECT OF CROP ROTATION, CULTIVATION AND NITROGEN FERTILISATION ON THE YIELD OF MAIZE ON A HUTTON SOIL

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INTRODUCTION

Financial risk of crop production in the Highveld has increased in the past decade. Crop rotation has the potential to minimise risk of crop failure due to reduced pests and diseases, increased yields and reduced nitrogen fertilisation requirements. The aims of this project were to quantify the rotational effects of soybean and sunflower on maize under conventional and reduced cultivation practices, at two nitrogen fertilisation rates.

MATERIALS AND METHODS

A dryland field trial was conducted over a period of six years on a Hutton soil with a topsoil clay content of 19% at Bloekomspruit in the Heidelberg district. The trial was set out as a factorial design with split plots and two replications. Crop rotation and cultivation treatment combinations were allocated to main plots and nitrogen fertilisation treatments to split plots. Three rotation treatments were applied, namely (i) maize in monoculture, (ii) maize in rotation with sunflower, and (iii) maize in rotation with soybean. The two cultivation treatments consisted of mouldboard ploughing at approximately 200 mm depth and chisel-plough cultivation at approximately 150 mm depth. The two nitrogen fertilisation rates were 25 and 89 kg N ha^{-1}. Agronomical practices were according to best practice recommendations. Results were analysed through an analysis of variance.

RESULTS AND DISCUSSION

Maize yields were affected by nitrogen fertilisation, crop rotation and crop rotation x fertilisation interaction with no effect from cultivation. Average maize yield was 4655 kg ha^{-1}. Maize that received only 25 kg N ha^{-1} and preceded by a soybean crop, yielded 18% more than monocultured maize or maize preceded by sunflower, while at 89 kg N ha^{-1} the yield increase was only 7%. Considering the seasons individually, maize following maize ranked the highest in one season and the lowest in three. Maize following soybean ranked the highest during three of the six seasons and maize following sunflower ranked the highest in one and the lowest in two of the six seasons.

CONCLUSIONS

Chisel plough cultivation is preferable above mouldboard plough cultivation due to savings on energy costs.The yield benefit of maize in rotation with soybean confirms results from other localities. Maize yield was also influenced by a nitrogen fertilisation x rotation interaction. The implication is that nitrogen fertilisation levels of maize in rotation with soybean could be scaled down from that applied on maize in monoculture without sacrificing yield. In the long-term, sunflower as rotational crop did not influence the yield of subsequent maize.

ACKNOWLEDGMENTS

Financial support from the Maize Trust is acknowledged

Keywords: Crop rotation, cultivation, maize, nitrogen fertilisation, soyabean, sunflower

THE GEOGRAPHICAL OCCURRENCE OF RYEGRASS (*Lolium* SPP) RESISTANCE IN THE WESTERN CAPE

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INTRODUCTION

Lolium spp. (ryegrass) is a widespread weed that occurs throughout the small grain production areas of the Western Cape's. It is troublesome as it competes with small grains for light and nutrients and space. In this area, herbicides are commonly used to control ryegrass and consequently address the major weed challenges. Herbicides routinely used are bipyridyliums and glyphosate for pre-crop emergence control and diclofop-methyl and sulfonylureas for post-emergence control. Before 1993, when the first herbicide resistant ryegrass was reported, ryegrass control in crop fields was successfully achieved with these herbicides. However, ryegrass is a genetically highly variable, cross-pollinated species and herbicide over-reliance has resulted in the widespread occurrence of herbicide resistant weed populations. However, no information on the geographical extent of this phenomenon exists. A survey was thus conducted to determine the geographical occurrence of resistant ryegrass to herbicides from four different modes of action groups in the Western Cape.

MATERIAL AND METHODS

In the 2005 growing season, cropped fields were surveyed at crop maturity and 167 ryegrass samples were collected. Each sample was screened in the greenhouse for resistance to an ACCase-inhibitor (Topik®), an ALS-inhibitor (Cossack®), a glycine (Roundup®) and a bipyridylium (Skoffel®) herbicide. All greenhouse trials were conducted at Agricultural Research Council Small Grain Institute, Bethlehem. A randomized complete block design was used for all experiments. The experiments were evaluated after fourteen days by means of weighing fresh shoot mass and data was analysed using Genstats 11th ed (version 11.1.0.1575). Maps of the geographical occurrence of resistance to the four different modes of action groups were generated using ArcView (GIS) 9.3.

RESULTS AND DISCUSSION

Most samples were found to be resistant to the ALS-inhibitor (Cossack®) and the ACCase-inhibitor (Topik®), indicating multiple herbicide resistance. In contrast, the majority of the screened ryegrass samples were effectively controlled with Skoffel® and Roundup®. Maps of the survey indicate that ryegrass resistance is a substantial threat to small grain production in the Western Cape. However, a small number of samples did not show resistance to anyone of the four herbicides screened.

CONCLUSION

Ryegrass across the Western Cape now exhibits widespread resistance across many but not all herbicides, posing severe management and sustainability challenges to the small grain industry in this area. Farmers should always apply herbicides judiciously, accurately and according to management practices that will reduce the occurrence of herbicide resistance.

Keywords: herbicide resistance, *Lolium* spp., Survey, Western Cape

THE ROLE OF DIFFERENT TANK MIX PARTNERS WITH GLYPHOSATE IN MAIZE WEED CONTROL SYSTEMS IN THE EASTERN FREE STATE

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INTRODUCTION

The main objective of the study is to identify the best weed control system incorporating the herbicide tolerance biotechnology trait, i.e. Roundup Ready®, and other residual herbicides in the Eastern Free State. A longer residual activity after the first glyphosate application is required. Different situations in the applications of glyphosate tolerance systems resulted in the need for testing additional tank mix partners with glyphosate. The second glyphosate application is sometimes difficult due to the height of the maize plants. Extreme wet conditions after plant also affect the second application of glyphosate. The control of problem weeds can also be managed more effectively by combining glyphosate with different mixing partners with various modes of action. The adding of different mixing partners to lyphosate can give a longer period of residual weed control.

MATERIAL AND METHODS

The trial was planted in the Fouriesburg area, Eastern Free State. The trial is to be repeated for three years (Two years are completed, 2008/9, 2009/10). The trial design is a randomized complete block replicated three times. Eighteen treatments were conducted. Different combinations of pre- and post-emergence herbicides in combination with glyphosate were tested. The hybrid used is DKC80-40BR.

RESULTS AND DISCUSSION

The percentage weed control was evaluated in all treatments for the next dominant weed species: *Cyperes esculentus, Amaranthus hybridus, Eleusine indica, Chenopodium album* and *Tagetes minuta.* The treatments with the highest efficacy for both seasons included pre-emergence herbicides followed by one or two applications of glyphosate. The application of glyphosate without pre-emergence herbicides and followed by post-emergence applications of either flumetsulam or mesotrione also gave excellent weed control.

CONCLUSION

The application of different post emergence residual herbicides in combination with glyphosate will definitively have a positive impact on successful weed control systems in the Eastern Free State.

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Keywords: Glyphosate, Mixing Partners

QUANTIFICATION OF THE EFFECTS OF SOIL AND CLIMATE ON WINE STYLE IN THE GRABOUW REGION

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INTRODUCTION

As the climate of the Grabouw region is regarded as favourable for the production of quality wine, wine grapes are increasingly being planted here in spite of little scientific information being available. The main objective of this study was to determine the effects of soil and climate on wine quality at some selected localities.

MATERIALS AND METHODS

The investigation was conducted using eight Sauvignon blanc and eight Merlot vineyards, established on five commercial estates. Weather stations were erected on each estate. Within each vineyard two contrasting soil types were identified. Soil water, leaf water potentials and viticultural parameters were monitored over a period of five years. Experimental wines were prepared annually in duplicate for each soil type according to standard winemaking procedures. Aroma characteristics were evaluated after 6 months of storage by an experienced wine tasting panel, using the terminology of Noble *et al*. (1987).

RESULTS AND DISCUSSION

Different meso-climates were identified within the study area, with maximum summer-temperatures differing by more than 2°C between the coolest and the warmest locality. At some localities different soil types induced significantly different levels of water stress within the same vineyard, especially towards the end of the season. However, the magnitude of the differences varied from season to season. Wine style differed between localities, not only on account of climatic differences, but also on account of different management practices. At some localities, within the same vineyard, soil-induced effects on wine style were detected. However, these differences were more pronounced during some seasons. This implied that the effect of soil type on wine style may vary in prominence, depending on the severity of climatic conditions.

CONCLUSIONS

In spite of relatively cool conditions in the Grabouw area, different soil types induced significant differences in water stress during some seasons. Thus wine style is not only affected by climatic conditions, but also by soil type.

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Keywords: climate, Merlot, Sauvignon blanc, soil, wine style

THE USE OF PALM MAT GEOTEXTILES IN SOIL EROSION CONTROL

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Geotextiles have been used for many years in different parts of the world to promote soil conservation and to combat erosion. Such geotextiles may be synthetic (usually some form of plastic, sometimes with wire), or natural (usually some form of fibrous material). Work carried out in the UK on the effectiveness of mats made from palm tree leaves sourced from Gambia, West Africa led to a project funded by the EU, which ran from 2005 to 2009, comprising the participation of four EU countries (UK, Belgium, Hungary and Lithuania) and six "developing" countries (Brazil, Gambia, South Africa, Thailand, China and Vietnam).

Research carried out in used mats made from the leaves of the Lala palm. These mats are easy to make, flexible, durable and completely bio-degradable. They cover approximately 40% of the surface, allowing space for vegetation to emerge, and add 1.3 kg of dry organic matter to each m^2 of soil. Furthermore, they have a water retention capacity of 1.8 l kg^{-1} m^{-2}, their N, K, S and P percentages are high, they have low sodium and aluminium values and a favourable C/N ratio. The palm mats have, generally speaking, the ideal chemical composition of organic mulch.

Trials were done on 20 soils and 10 mine tailings materials using a rainfall simulator. The soils varied considerably with respect to their textural, chemical and mineralogical properties as well as annual precipitation and geological origin. Erosion parameters varied greatly within, and to a much lesser extent between, the two different materials. Several significant correlations were obtained. Sediment load (SL) had the best correlation with kaolinite content and with fine sand content, while for runoff, the best correlation was with organic carbon content. When the samples were covered with palm mats, values for final infiltration rate (FI) percentage stable aggregates (SA) and inter-rill erodibility (K*i*) values were similar to those of bare materials and the amount of runoff was slightly higher. SL, however, was reduced by $\pm$65%.

The next stage was to carry out a range of field trials, using runoff plots. Plots at four localities (Bergville, Ladybrand, Roodeplaat and Mabula) were used. Results showed that average runoff under the palm mats decreased by between 38% and 70%, compared to bare soil. SL under the mats decreased by between 38% and 89%, using three combinations of slope, mat density and mesh size. Splash erosion at Roodeplaat decreased by between 62% and 68%, while re-vegetation at Ladybrand and Mabula increased by between 38% and 58%, with organic carbon content and topsoil accumulation also increasing under the mats. Various trials (using both the rainfall simulator and runoff plots) were carried out to evaluate the effects of reduced mat density and increased mesh size.

Results from the other participating countries (25% to 95% reduction in runoff) confirm that there is much potential to use organic, bio-degradable, easy to manufacture geotextiles such as palm leaf mats, especially to combine employment opportunities with enhanced environmental protection in many susceptible areas of South Africa.

Keywords: soil erosion, geotextiles, runoff

HARVEST AND POST-HARVEST FACTORS AFFECTING SHELF LIFE OF MACADAMIA KERNEL

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INTRODUCTION

Rapid growth in the macadamia industry has resulted in both pack-houses and buyers holding nut stocks for longer periods. As a consequence buyers are starting to request the inclusion of sell-by dates on individual consignments. Further, industry growth has also seen pack-house capacity exceeded at the peak of the season, with both growers and packers having to hold nut-in-shell (NIS) for longer periods. It is known that time of harvesting affects kernel shelf life, but there are no current guidelines as to a cut-off date for final harvesting and delivery to the packers. This study aims to determine the optimal harvest time, storage temperature and storage period for both NIS and kernel. The use of the Rancimat test as a predictor of shelf life, and for the determination of sell-by dates, is also investigated.

METHODS AND MATERIALS

Storage of kernel. Vacuum packed kernel (Styles 1 and 5) from a commercial pack-house was obtained at the start, middle and end of the 2009 season. Kernel was stored at either -5°C, 5°C, 15°C or ambient temperature for 6, 12, 18 or 24 months. Following storage, the kernel was exposed to ambient atmosphere and kept at ambient temperature for 5 months, with peroxide analysis being used to monitor rancidity. Oil samples for Rancimat analysis were extracted at the start of the storage trial from random kernel samples of each style and collection date.

Nut-in-shell storage. Nut-in-shell from a commercial 'Beaumont' orchard was dried to 10% moisture and stored either in a commercial drying bin or a cold room at 15°C for 0, 3, 6, 9 or 14 weeks. After storage nuts were dried and cracked and the kernel commercially packaged. Kernel was stored for a further 6, 12, 18 or 24 months at 15°C, following which the vacuum was broken and the kernel stored for a further 16 weeks, with regular monitoring for peroxide development.

Kernel stored for 18 or 24 months in both trials has yet to be analysed and only results for kernel stored up to 12 months will be discussed.

RESULTS AND DISCUSSION

Initial first season results indicate that the Rancimat test may be useful as a predictor of shelf life, with the kernel style having the shortest induction time (style 5) also being the first to show an increase in peroxide value. This test also showed that kernel harvested late in the season has a shorter induction time (and therefore potentially shorter shelf life) than that harvested early in the season. Peroxide analysis showed that style 5 commercial kernel at ambient temperatures develops rancidity after 4 months if harvested early in the season but this is shortened to 2 weeks if harvested at the end of the season. Very little rancidity was detected in any samples stored below ambient temperature. This indicates that small styles (chips) are more prone to oxidation, but this can be ameliorated by storage at 15°C or less. Kernel from the NIS trial showed the onset of rancidity within six weeks on the shelf when the original NIS samples were held at ambient temperature for more than 5 weeks.

CONCLUSIONS

The Rancimat test seems to offer a means of predicting shelf life, but requires refinement. Commercial kernel requires storage temperatures below 15°C and smaller styles are more prone to developing rancidity. NIS should not be held at ambient temperature for more than 5 weeks. More refined recommendations should be possible on completion of the trial.

Keywords: macadamia, quality, storage, shelf-life, peroxide, rancimat

COMPETITIVE INTERACTIONS BETWEEN FOUR WHEAT CULTIVARS AND WEEDS

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INTRODUCTION

The wide adoption of conservation tillage systems in the wheat producing areas of the Western Cape resulted in greater reliance on efficient chemical weed control practices and thus the development and evolution of herbicide resistance in weed species. Several weed species have developed resistance to a wide range of herbicides registered for their control. Under these conditions the implementation of integrated weed management (IWM) practices becomes crucial. One of the aspects of an IWM system is the use of more competitive crop cultivars. In this study, the interaction between weeds and four different wheat cultivars at three different localities in the Western Cape was investigated.

MATERIALS AND METHODS

The study was carried out on three.experimental farms at Stellenbosch, Caledon and Moorreesburg, respectively. Four wheat cultivars viz. SST 88, SST 27, Baviaans and Tankwa were planted and various weed control treatments aimed at resulting in a heavy, medium and light weed pressure was applied. The experimental design was a 4X3 factorial replicated four times.

During the second week of June 2010 two 30 cm X 30 cm subplots in each plot was sampled by pulling up all vegetation. The two subplots were combined, the vegetation was separated into wheat plants and weeds and the wet and dry mass of each fraction was determined. During the last week of August 2010 the sampling and measuring procedure as described above, was repeated.

RESULTS

No interactions between wheat cultivar and weed pressure was evident in the number of wheat plants per unit area or the number of weed plants per unit area. The same applies to the wheat dry mass per unit area and weed dry mass per unit area. Therefore it does not appear as if the cultivars reacted differently to weed pressure in terms of plant survival or vegetative biomass production. As was expected, high weed pressure resulted in significant losses in vegetative biomass produced by wheat plants. The effect of weed pressure on wheat yield will be determined at harvest.

CONCLUSION

These preliminary results give no indication that different wheat cultivars reacted differently to weed pressure in terms of plant survival and growth. The wheat yield results still have to be analysed but at this early stage there seems to be no difference between the response of selected wheat cultivars with perceived variation in competitive ability to varying weed pressure levels.

ACKNOWLEDGEMENTS

Financial support from the Winter Cereal Trust and the Protein Research Foundation is gratefully acknowledged.

Keywords: competitive ability, vegetative growth, weed pressure, wheat cultivars

SOIL COLOUR AS INDICATOR OF WETLAND BOUNDARIES ON THE MAPUTALAND COASTAL PLAIN

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INTRODUCTION

Sandy Coastal Aquifers such as the Maputaland Coastal Plain located in KwaZulu-Natal, are listed by the Department of Water Affairs' wetland delineation guideline as areas with problematic soils for wetland delineation. These soils typically exhibit grey profile colours not necessarily associated with hydromorphic soil forming processes. Conversely, wetland soils in this area usually lack the characteristic redoximorphic mottles. However, prolonged wetness may manifest in an accumulation of organic carbon in the topsoil of wetlands. The use of carbon as an additional indicator of wetland boundaries is thus proposed for the Maputaland Coastal Plain. The aim of this study was to test whether the colour of wetland soils on the Maputaland Coastal Plain, due to the accumulation of carbon, can be used as a visual indicator to aid wetland delineation.

MATERIALS AND METHODS

Thirteen wetlands, covering four wetland systems, occurring between the Tembe Elephant Park and Kosi Bay were sampled. In each wetland the permanent, seasonal and terrestrial zones were sampled. The colours of the soil were determined in their dry and wet state using a Munsell Soil Colour Chart. The wet and dry colours were used to calculate a delta value against which Soil Organic Carbon was correlated. Soil Organic Carbon was determined using the Walkley-Black method.

RESULTS AND DISCUSSION

A strong correlation was found between soil colour and Soil Organic Carbon. Black soil colours (10YR 2/1 and 2.5Y 2.5/1) were indicative of Carbon values varying between 2 – 27%. Other top soil colours varied from Hue 5YR to 5Y, Value 2.5 – 6 and Chroma 1 to 3, with most samples high in organic matter concentrated around 2.5Y 2.5/1.

CONCLUSION

A strong correlation was found between soil colour and organic carbon which can be used as a practical field procedure to differentiate the different wetland zones.

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Keywords: Soil Organic Carbon, Soil colour, Maputaland Coastal Plain, Wetlands

THE EFFECT OF APPLICATION RATE, FREQUENCY OF APPLICATION AND SPRAY VOLUME OF AVIGLYCINE ON THE INHIBITION OF NATURAL FLOWERING OF QUEEN PINEAPPLE (*Ananas comosus*) IN SOUTH AFRICA

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INTRODUCTION

The year-round production of pineapples destined for the fresh produce markets in South Africa and overseas can only be achieved by planting different plant sizes at specific times and artificial induction of flowering using plant growth regulators such as ethepon. Uncontrolled natural induction of flowering (precocious flowering) is a severe problem in the production of pineapples. Ninety percent of South Africa's fresh market pineapples are produced in Hluhluwe and consists of the Queen cultivar. Natural flowering is a severe problem during the winter months since flowering is induced by short days/long nights and low temperatures. Other factors such as extremes in water supply can also play a role. This results in an over-production of fruit in December/January with consequently lower market prices. Several methods of reducing natural flowering were investigated in the past and the best results were obtained with chemical control using [2-(m-chlorophenoxy), propionic acid] (Swelpine®). However, it had the adverse effect of plant stunting and reduced sucker growth, therefore reducing the available planting material from a treated land. Recent trials with Aviglycine (Retain®), an inhibitor of ethylene biosynthesis, has proved to control natural flowering successfully when applied weekly during the winter months (May to August) at 100 $mg.L^{-1}$ (ppm). It is however a very expensive chemical and therefore trials were carried out to determine the effect of application rate, frequency of application as well as spray volume on the efficacy of treatment. The critical minimum temperature, the effect of plant size and the period of treatment were also investigated.

MATERIALS AND METHODS

Six trials were carried out in which the frequency of application (weekly as well as 2 and 4 weeks apart), the application rate (30 to 180 $mg.L^{-1}$) and the effect of spray volume (500 to 3000 l/ha in 500l increments) were evaluated. The onset of application varied (May and June) and plants of different sizes were treated. The effect of tank mix adjuvants, such as surfactants, was also evaluated.

RESULTS AND DISCUSSION

In the first two trials, 100 $mg.L^{-1}$ (1000 mg aviglycine/1500 l water per ha) at a 7 day interval gave the best results (0.5% and 0% natural flowering), while 100 $mg.L^{-1}$ at a 14 day interval reduced natural flowering to 2% (control = 45% and 14%). By increasing spray volume to 2000 l/ha, dosage could be reduced to 400g/ha (30 $mg.L^{-1}$) to obtain the same result at the same frequency of application. Number of consecutive cold days (minimum temperature below 14ºC) and plant size do influence efficacy of treatment and therefore dosage and frequency must be adjusted.

CONCLUSION

Aviglycine can be used with success to control natural flowering in pineapples. The cost of treatment is still a concern and therefore trials to understand the role of all factors involved in the natural induction of flowering and the optimizing of applications, are continuing.

Keywords: Queen pineapple, *Ananas comosus*, natural flowering, inhibition, Aviglycine

INVESTIGATING SUGARCANE CULTIVAR X TIME OF HARVEST INTERACTIONS IN RELATION TO ENVIRONMENTAL FACTORS

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INTRODUCTION

Sugarcane production in South Africa is influenced by cultvar x time of harvest (TOH) interactions. Information on the adaptability of recently released cultivars to TOH is however lacking. The aims of this study were to: (1) evaluate the adaptability of new commercial cultivars to TOH, (2) to identify environmental factors characterizing different harvest cycles and investigate their effects on specific growth stages, and (3) to determine how cultivar traits are affected by TOH.

MATERIALS AND METHOD

Two field trials consisting of the same set of ten commercial cultivars were established on an experimental farm and harvested either early (May) or late (October) in the season for six ratoons. The trials were conducted as randomized complete block designs with six replicates. Each trial x ratoon combination was considered as a separate environment. Environmental covariates for temperature (TT), rainfall (RAIN), radiation (RAD), and a water stress index (WSI) were summarized within individual growth stages (establishment, stalk elongation and ripening). Additive main effects and multiplicative interaction (AMMI), principal components analysis (PCA), factorial regression, and genotype + genotype x environment (GGE Biplot) analyses was used to analyse the genotype x environment (G x E) interactions for cane yield (TCANE), estimated recoverable crystal (ERC) and tons ERC (TERC).

RESULTS AND DISCUSSION

The G x E interactions were significant ($P<0.001$) for all three variables, and the AMMI2 biplots accounted for a considerable proportion of the interactions. The biplots revealed two distinct non-overlapping clusters separating the early and late harvests. Cultivars N17, N19, and N27 showed adaptability to late harvesting, while cultivars NCo376, N29, N35 and N36 gave higher TERC when harvested early. Significant ($P<0.01$) correlations were observed between AMMI Interaction Principal Component Axis 1 (IPCA1) scores and TT and RAD during all three growth phases, suggesting that these factors were responsible for TOH variability. The higher TCANE of early harvests were shown to be due to greater exploitation of higher TT and RAD during stalk elongation. Cultivar N17 was identified as the most sensitive to changes in RAD during stalk elongation (1.73 unit change in TCANE per unit change in RAD). Biplots revealed that early harvests were closely associated with higher stalk population, while late harvests generally produced greater individual stalk mass.

CONCLUSIONS

The study successfully characterized cultivars according to adaptability to TOH. As a first for sugarcane, this study has shown that environmental covariates summarized within growth phases can be used to interpret G x E interactions, and such methodology will be extended to more extensive datasets in future.

Keywords: Biplot, Cultivar, Genotype x environment, Sugarcane, Time of harvest

THE EXTRACTABILITY OF CHROMIUM(III) AND NICKEL AS INFLUENCED BY SOIL WATER POTENTIAL LEVELS

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INTRODUCTION

The use of steel plant slag as liming material in the agricultural region of South Africa's Eastern Highveld necessitates an investigation into the mobility of the potentially toxic elements Cr(III) [through oxidation to Cr(VI)] and Ni.

Although sorption equilibrium studies have contributed significantly to determining sorption and precipitation mechanisms, these studies do not always correlate well with the reality of field conditions. For instance, soil water potential levels are not reckoned with. This study aims to bridge this gap and determine the effect of soil water potential on Cr(III) and Ni extractability, as well as the association of Cr(III) and Ni with certain soil mineral phases.

MATERIALS AND METHODS

The extractability of Cr(III) and Ni under soil water potential values ranging from -1 to -3100 $J.kg^{-1}$ was investigated, using 0.1 M $Mg(NO_3)_2$ and 0.02 M diammonium EDTA. Three soils (samples from an E-horizon, red apedal B- and yellow brown apedal B-horizon) were treated with 15 $mg.kg^{-1}$ Cr(III) and 15 $mg.kg^{-1}$ Ni. The association of Cr(III) and Ni with certain soil mineral phases, after reaching air dried conditions, was determined using 0.1 M $Mg(NO_3)_2$, 0.02 M diammonium EDTA, pH 2.0, 0.1 M $NH_2OH.HCl$, and pH 3.0, 0.175 M $(NH_4)_2C_2O_4$ + 0.1 M $H_2C_2O_2$.

RESULTS AND DISCUSSION

Using $Mg(NO_3)_2$ as an extractant yielded Cr(III) values below the method detection limit. The levels of Cr(III) extracted with EDTA, coupled with soil water potential levels had no significant effect on Cr(III) sorption, indicated the formation of inner-sphere surface complexes and in particular surface precipitates . The mechanism of precipitation is dominated by that of bulk solution saturation.

The $Mg(NO_3)_2$ and EDTA extractable Ni fractions were found to be steadily immobilised as the soils dry out. Nickel sequestration was pronounced after the soils reached water potential levels of -100 $J.kg^{-1}$, indicating mineral induced precipitation to dominate. Soil charge characteristics had a substantial effect on Ni sequestration. This was especially noted in the case of the red apedal B-horizon which yielded higher levels of Ni than either the E- or yellow brown apedal B-horizons when subjected to extraction using both $Mg(NO_3)_2$ and EDTA.

Subjecting the air dried samples to fractionation indicated a close correlation between both Cr(III) and Ni and the Fe content of the soils. This was observed for all of the mentioned extractants.

CONCLUSIONS

While soil water potential levels did not significantly influence Cr(III) sorption , Ni sorption was substantially affected . Both Cr(III) and Ni tend to associate with the amorphous Fe oxide phase in soil.

ACKNOWELDGEMENT

The South African Iron and Steel Institute (SAISI) funded this research

Keywords: Chromium(III), Nickel, Soil Water Potential

THE EFFECT OF PHOSPHOROUS FERTILIZER TYPE AND APPLICATION RATES ON THE BIOLOGICAL ACTIVITY OF *Artemisia afra*

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INTRODUCTION

Populations of medicinal plants are facing extinction due to their over exploitation by traditional healers and medicinal plant harvesters. ARC-Roodeplaat Vegetable and Ornamental Plant Institute aims to train traditional healers and farmers to propagate and grow their own medicinal plants resulting in the conservation of these plants. The aim of this study is to determine the effect of phosphorous fertilizers types and different levels on the bioactivity of *Artemisia afra*. Previous investigation indicated that nitrogen and potassium had no effect on the bioactivity of *Artemisia afra.*

MATERIALS AND METHODS

The experimental layout was a randomized complete block design with three phosphorus sources at five different levels each. The sources were superphosphate, supergrow and MAP applied at 0, 30, 70, 100 and 120 kg P ha $^{-1}$. The plot size was 2.8 m x 3.5 m, with 15 data plants per plot. The trial was harvested twice and the plant material were analysed. Aluminium Thin Layer Chromatography plates (20 x 20 cm) covered with silica gel (0.2 mm thickness) was used. Five hundred microlitres was applied on silica TLC plates and developed in a TLC tank with a solvent system of $_n$hexane: ethyl acetate (8:2) vv. The plates were viewed under the UV lamp and fluorescent bands were marked. The plates were sprayed with freshly prepared vanillin solution as a colouring reagent. The antibacterial assay was carried out following the microtitre plate method developed by Eloff (1998). The method was used to determine the minimum inhibitory concentration (MIC) of the *Artemisia afra* leaves crude extracts. The following microorganisms were tested against the crude extracts namely; a gram positive bacterium *Staphylococcus aureus,* and two gram negative bacteria *Escherichia coli* and *Klebsiella pneumoniae*.

RESULTS AND DISCUSSION

The TLC plates showed that all the plants material from the different treatments contained the same compounds or chemical constituents. Superphosphate showed the highest yield at the level of 120 kg P ha $^{-1}$ as compared to the other sources.

CONCLUSION

The application of different Phosphorus fertilizers increases the yield and does not have an effect on the biological activity of *Artemisia afra.* Plant materials showed to be active against all the bacteria tested.

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Keywords: antibacterial, micro-organisms, fertilizer

DYNAMICS OF FOLIAR ANTHOCYANINS IN INVOLUCRAL LEAVES OF THE *Leucadendron* 'SAFARI SUNSET'

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INTRODUCTION

Leucadendron are sought after cut flowers on international markets due to their brightly coloured flower heads, ranging from bright yellow to red and mixtures thereof. The red colouration of the involucral leaves of 'Safari Sunset' is unfortunately transient in nature. Undesirable colour changes render this cut flower unmarketable, resulting in a considerable loss of profit. A deeper understanding of the mechanism leading to colour change is needed to form the framework on which future manipulation strategies can be built.

MATERIALS AND METHODS

'Safari Sunset' shoots were sampled for two successive seasons and their pigment content determined (anthocyanins, carotenoids and chlorophyll). Besides the normal developing control shoots, some shoots were deconed by removing the inflorescence completely to investigate the correlation between floral development and changes in anthocyanins. The other treatment involved keeping the flower head artificially closed with pip-cleaners to determine the effect of flower head opening on the dynamics of anthocyanins.

RESULTS AND DISCUSSION

In the red *Leucadendron* cultivar Safari Sunset, the photosynthetic pigment degradation pattern is identical to that of yellow cultivars. However, colour expression is complexed by the presence of anthocyanins. Anthocyanin concentration was shown to be directly related to the opening of the flower head rather than to the phenological development of the inflorescence. With opening, the previously shaded inner involucral leaf surfaces are exposed to higher levels of irradiance and respond by turning red, presumably for photoprotection. Similar to yellow cultivars, any factor leading to the death of the florets before flowering, not only prevents the degreening of involucral leaves, but also prevents the opening of the flower head and therefore the associated change in anthocyanin levels.

CONCLUSION

To produce a more intense red flower head, the manipulation techniques should be aimed at increasing photo-oxidative stress experienced by the involucral leaves, but during the stage when the flower head begins to open, as anthocyanin synthesis is directly linked to opening of the flower head. Attempts to manipulate red colour when the flower head is still closed would be futile or at best, less effective.

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SCHMEISSER, M., STEYN, W. J., JACOBS, G. (2010) Regreening of involucral leaves of female *Leucadendron* (Proteaceae) after flowering. *Aust. J. Bot.* 58, 586-596.

Keywords: anthocyanins, colour change, pigmentation patterns

ECONOMY IN FUNCTION: REGREENING IN FEMALE *Leucadendron* (PROTEACEAE)

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INTRODUCTION

The involucral leaves of *Leucadendron* possess the novel ability to degreen and regreen naturally as part of their natural development, closely linked to the development of the inflorescence. Before flowering, the involucral leaves are green, which rapidly turn yellow with anthesis, only to regreen again after anthesis. The current study addresses the ecological significance of regreening encountered in *Leucadendron* cut flowers. A few possible hypotheses are postulated and evaluated as to why regreening occurs in *Leucadendron*.

MATERIAL AND METHODS

Gas exchange parameters of involucral leaves were determined when green before flowering, when yellow at anthesis and when regreened after anthesis. To determine the photosynthetic contribution of involucral leaves toward the development of the inflorescence, four treatments were done: no leaves removed, all leaves were removed, only stem leaves removed and removal of involucral leaves only. After five month, leaves and cones were evaluated for their total carbohydrate content. Fv/Fm measurements were done on the floral bracts of the inflorescences to determine the membrane integrity and damage to PSII.

RESULTS AND DISCUSSION

Regreened involucral leaves were shown not to play a significant role in providing photosynthates for the developing cone. Although the presence of regreened involucral leaves were shown to provide protection against high irradiance and radiant heating of the cone, they were not essential to ensure survival of the cone. The small floral bracts were shown to be very capable of adaptation. The most plausible reason for regreening is therefore assumed to be based on a cost-benefit relationship. As most *Leucadendron* are adapted to grow on very nutrient poor soils, the question should maybe be rephrased. Why waste valuable resources? Sclerophyllous leaves, like the involucral leaves, are costly to make and therefore reusing, rather than discarding them does seem a sensible strategy for survival.

CONCLUSION

The ecological significance of the regreening phenomenon does not appear to be related to survival and performance of the inflorescence, but rather linked to a cost-benefit relationship. However, further investigations are required.

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SCHMEISSER, M., STEYN, W. J., JACOBS, G. (2010) Regreening of involucral leaves of female Leucadendron (Proteaceae) after flowering. *Aust. J. Bot.* 58, 586-596.

Keywords: regreening

OIL YIELD AND QUALITY RESPONSE OF HYDROPONICALLY GROWN *Pelargonium graveolens* TO NITRATE LEVELS

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INTRODUCTION

Pelargonium graveolens oil is used as a flavouring agent in many major food categories, soft beverages, alcohol, and its oil is also used as an ingredient in the perfume and cosmetic industries (Gough, 2002). Several studies have been conducted to obtain high oil production and the N requirement of rose geranium has been studied extensively under open field conditions. This may provide an opportunity for growers with intensive plant production facilities to easily and accurately manage water and mineral supply. The aim of this study was firstly, to evaluate the effects of nitrate levels as a source of nitrogen on rose geranium yield and oil quality in hydroponic production. Secondly, to set standards for nitrate levels to be used in the nutrient solution for rose geranium.

MATERIALS AND METHODS

The trial was conducted in a greenhouse at the University of Free State. Experimentation protocols were carried out during spring and summer seasons (2009). The N-levels evaluated were 8, 10, 12 and 14 meq L^{-1}, and these treatments were assigned in a completely randomized block design with five replications. The cation composition of the four treatments remained constant. The feeding water contained 0.44 meq Na L^{-1}. The rest of the cations were made up to 1.0, 5.5, 6.5 and 2.5 meq L^{-1} for NH_4^+, K^+, Ca^{2+} and Mg^{2+} respectively. General Linear Model (GLM) of SAS was used to analyze the data.

RESULTS AND DISCUSSION

Plant height peaked at 10 meq L^{-1}, reaching 58 cm, but the highest number of branches (51 per plant) was produced at 12 meq L^{-1}. A similar trend was observed for total plant mass and plant fresh mass, yielding 10.9 t ha^{-1} and 823 g $plant^{-1}$ respectively (12 meq L^{-1}). Chlorophyll levels peaked at 12 meq L^{-1}. It was found that nitrate application lowered the S and P content of the leaves. Oil yield peaked at 12 meq L^{-1}**,** reaching 154 kg $ha^{-1}$and this yield was higher than the reported yield obtained under open field condition. Although the Citronellol:geraniol ratio indicated a sub-optimum oil quality at 10 and 12 meq L^{-1}, the quality of Geraniol and Citronellylformate at the 12 meq L^{-1} rate was acceptable**.**

CONCLUSION

The minimum N-level recommended for soil-less production of rose geranium oil is 12 meq N L^{-1}.

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Keywords: Oil Yield, Oil Quality

EVALUATION OF GRAFTING TECHNIQUES FOR THE PROPAGATION OF *Pappea capensis* ECKL. & ZEYH. (JACKET PLUM)

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INTRODUCTION

Pappea capensis is a small- to medium-sized tree with great economic potential. It produces edible fruits that can be processed into jelly, alcoholic beverages and vinegar while the leaves are a source of forage for livestock. Seed oil is used for medicinal purposes (Palgrave & Drummond, 1983) and has the potential to be used for bio-fuel. The tree has not yet been domesticated and therefore different grafting techniques were evaluated to facilitate early fruiting.

MATERIALS AND METHODS

Terminal scions with 2-3 buds were collected from a fruit-bearing tree growing at the Experimental farm, University of Pretoria. They were grafted onto two-year old potted seedling rootstocks. Three different grafting techniques were applied: a) Whip and whip-tongue grafting were conducted during October and December in a glasshouse, as well as outside under shade net, both with and without agar (4g/l) applied around the graft. b) Approach grafting using splice and tongue techniques. c) *In vivo* micro-grafting using slit and wedge techniques as well as side budding. Callus formation, graft–take percentage, survival rate and scion growth were monitored.

RESULTS AND DISCUSSION

Graft-take of approach-tongue grafting was significantly better than all the other methods ($P \leq 0.005$). There was no significant difference between the whip and whip-tongue methods or the interaction between the treatments. However, a higher graft-take of 60% was obtained in December compared with a 30% graft-take achieved in October. In the *in vivo* micro grafting, the slit technique appeared more promising than the wedge technique.

CONCLUSION

The study indicated that the whip and whip-tongue methods inside the glasshouse conducted during December, gave the best results. Approach grafting was highly successful but is not commercially feasible. The *in vivo* micro grafting method shows promise.

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Keywords: Pappea capensis, micrografting, whip, whip-tongue

THE EFFECTS OF NITROGEN FERTILIZATION AND DEFOLIATION ON BIOMASS PRODUCTION AND FODDER QUALITY OF THREE FODDER CROPS

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INTRODUCTION

Fodder production is considered as a solution to provide high quality forage to livestock irrespective of season and also ensure rangeland rehabilitation in semi-arid regions of Botswana. Three forage crops, babala (*Pennisetum americunum* (L)Leek), cowpea (*Vigna unguiculata* (L)Walp) and lablab (*Lablab purpureus* (L)Sweet) were investigated to determine the effects of Nitrogen (N) fertilization and defoliation on overall biomass quality and quantity.

MATERIALS AND METHODS

A completely randomized experimental design was used. The experimental design was a 3 X 4 X 3 factorial with factors, Forage crops (babala, cowpea and lablab), Nitrogen (N) levels (0, 50,100, and 150 kg N ha^{-1}) and 3 defoliation frequencies (three, two and one defoliation). The first treatment was defoliated three times at week three, five and seven. The second treatment was defoliated two times at week three and week seven while the third treatment was defoliated once at week seven. During defoliation plants were cut at a height of 25 cm from ground level in each pot using secateurs. Dry mass was determined and crude protein and crude fiber was determined by means of the Dumas method on a LECO FP 528 analyzer and on the ANKOM 220 Fiber Analyzer respectively.

RESULTS AND DISCUSSIONS

A significant ($P < 0.05$) interaction between crop and defoliation frequency occurred in terms of total dry matter production over the seven week period. It appears as if lablab dry matter production was less affected by cutting frequency than dry matter production of cowpea and babala. In none of the crops did a higher cutting frequency resulted in higher total dry matter production. In the case of lablab, however, there appeared to be very little (statistically non-significant) reduction in dry matter production at the highest cutting frequency. Nitrogen application of 50 kg ha^{-1} resulted in a significant increase in dry matter production compared to the control treatment that received no nitrogen but further increases in N application had no significant effect on dry matter production in any of the crops.

CONCLUSION

Defoliation frequency did not have significant effect on overall dry and wet matter in lablab but higher cutting frequency did tend to lower dry matter production in babala and cowpea. Low levels (50 kg N ha^{-1}) of nitrogen had a significant effect on dry matter production.

Keywords: defoliation, babala, cowpea, lablab, dry matter, Nitrogen

AGRONOMIC AND MILLING QUALITY EVALUATION OF PEARL MILLET GENOTYPES

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INTRODUCTION

Pennisetum glaucum L. R. Br.*,* is well adapted to production systems characterized by drought, low soil fertility, and high temperature. It is grown commercially in South Africa as a forage grass, but none of this grain is commercially processed. Pearl millet is endowed with enormous genetic variability for various agronomic traits, adaptation and quality traits. The relative importance of the crop in rural food systems and its adaptation to dry environments suggests opportunities should exist for commercialisation of pearl millet.

MATERIALS AND METHODS

During the 2006/2007 growing season, 24 diverse pearl millet genotypes (16 introduced from ICRISAT-Zimbabwe, seven other ARC collections and one local check) were evaluated for their agronomic performances. The experiment was laid out in the randomized complete block design with three replications. Supplementary irrigation was applied during early stages of crop establishment. A nitrogen fertiliser rate determination trial was carried out at ARC-Institute of Industrial Crops experimental farm, Brits during the 2007/2008. Treatments were a factorial combination of irrigation (dryland and supplementary irrigation) and N levels (0, 20, 40 and 60 kg N ha^{-1}). Grain milling hardness tests were carried out on 12 selected genotypes at ARC-GCI grain quality laboratory following Reichert *et al*. (1982) grain quality analysis procedure on decortication using a tangential abrasive dehulling device (TADD).

RESULTS AND DISCUSSION

Results indicated significant differences ($P<0.05$) among genotypes for most of the traits measured. Grain yield varied from 830 to 6347 kg ha^{-1}, and was highest for Okashana 1, followed by SDMV 96041 and lowest for GCI 4410. Yields vary depending on mode of production and region. In India, yields range from 770 -1100 kg ha^{-1} under rainfed conditions and 1100 - 3000 kg ha^{-1} under irrigation. In Africa Sahel and Sudano zones, yields range from 250 - 750 kg ha^{-1} under rainfed conditions.

The result indicated highly significant ($P<0.001$) grain yield differences between dryland and supplementary irrigation and nitrogen application rates. Supplementary irrigation increased grain yield by 0.7 t ha^{-1}. For Brits and similar environments N rate of 40 kg ha^{-1}, under both dryland and supplementaryirrigation conditions was optimal.

Genotypes tested for grain milling quality exhibited a wide range of abrasive hardness index (AHI) values. Genotypes with high AHI values, such as Okashana 1 (9.93), are regarded as hard and most suitable for milling.

CONCLUSIONS

Among all genotypes evaluated Okashana 1 gave the highest yields and possesses desirable agronomic and milling quality characteristics such as reduced stalk lodging, early maturity, bold grains and hard kernels.

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ACKNOWLEDGEMENTS

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Keywords: Genotypes, Grain yield, Milling quality, N fertiliser rate, Pearl millet

GENOTYPE BY ENVIRONMENT INTERACTION FOR SEED YIELD AND OIL CONTENT AMONG VERNONIA LINES

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INTRODUCTION

The stability and expression of crop yield and yield components depend on the genetic constitution and the intensity of the environmental conditions (Bradshaw, 1965; Shimelis and Shiringani, 2010). Multi environmental trials are important in plant breeding programs for recommendation and release of superior and stable cultivars in the target environments. The objective of this study was to identify superior genotype of vernonia (*Vernonia galamensis* var. e*thiopica*), a potentially new industrial oil seed crop, with high seed yield and increased oil content at two localities in the Limpopo Province.

MATERIALS AND METHODS

Field experiments were conducted during the 2006, 2007 and 2008 growing seasons at two localities in Limpopo Province viz. Syferkuil and Gabaza. Ten candidate varieties of vernonia were evaluated under the randomized complete block design with three replications. Seed yield and oil content were determined per variety across environments. Stability analyses of yield and oil content were conducted using the cultivar superiority statistics.

RESULTS AND DISCUSSION

Results indicated significant interaction among genotype by location and genotype by year both for seed yield and seed oil content ($P \leq 0.05$). Variety Vge-18 had high seed yield that ranged from 3095 to 3337 kg ha^{-1} followed by Vge-17 yielding 3006 to 3137 kg ha^{-1} at Gabaza. These varieties were also the best performers at Syferkuil where Vge-17 yielded 2915 to 3217 kg ha^{-1} followed by Vge-18 with 2819 to 3152 kg ha^{-1}. The cultivar superiority statistics allocated Vge-17 and Vge-18 as relatively high yielding and stable varieties across test environments. In both localities Vge-4 showed increased seed oil content measured at 43% (Gabaza) and 35% (Syferkuil). Other promising varieties with high seed oil content included Vge-33 at Gabaza (40-43%) and Vge-3 at Syferkuil (34-35%). Also, Vge-4 and Vge-3 had average stability for seed oil content.

CONCLUSIONS

The study identified Vge-17 and Vge-18 with increased seed yield while Vge-4 and Vge-3 had increased seed oil content with considerable stability. The candidate varieties could be useful for direct large scale production or strategic breeding of vernonia under these or similar environments.

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ACKNOWLEDGEMENTS

The National Research Foundation is acknowledged for financial assistance of the study.

Keywords: cultivar superiority, seed oil, stability analysis, stability analysis

THE EFFECTS OF PHOSPHORUS AND MUCUNA (*Mucuna pruriens*) MANAGEMENT OPTIONS ON THE CHEMICAL CHARACTERISATION OF A DEPLETED SANDY LOAM SOIL

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INTRODUCTION

Application of organic materials such as herbaceous legumes like mucuna (*Mucuna pruriens*) may increase crop-available Nitrogen (N), Phophorus (P), K (Potassium), Calcium (Ca) and Zinc (Zn) either directly by the process of decomposition of the biomass or indirectly by the production of organic acids (products of decomposition) that chelate Iron (Fe) or Aluminum (Al) and thus improving the CEC of the soil (Nziguheba *et al.,* 1998; Shoko, *et al*., 2010). The major objective of this study was to assess mucuna management options on the chemical characterisation of the soil.

MATERIALS AND METHODS

The study was conductedat the Grasslands Research Station in Marondera in Zimbabwe. The experiment was designed as a split plot with 2 P treatments and 40 kg P ha^{-1}) applied prior to planting a mucuna crop and 4 mucuna treatments as sub-plot factors (MF=mucuna incorporated at flowering, MAR= mucuna above ground removed at maturity and only roots incorporated, MPR = above ground biomass except pods incorporated at maturity and F = Fallow (control)). The effect of P and mucuna management options was measured on N, P, K, Ca, magnesium and Zn content of the soils.

RESULTS AND DISCUSSIONS

The MF management option and P40 treatment resulted in the highest N, P, K, Ca and Mg levels. However the P40 and mucuna treatments had significantly lower Zn levels than in the P0 and all the mucuna treatment combinations.

Table 1 Nitrogen (ppm) of the sandy soil under different management options of mucuna during the 2007 and 2008 seasons after two P treatments (P0 = No P applied (control) and P40 = 40 kg P $ha^{-1.}$ applied).

	2007 season		**2008 season**		**2 seasons mean**	
Treatment	***P0***	***P40***	***P0***	***P40***	***P0***	***P40***
Before planting mucuna	15.03					
F	15a	15a	15.01a	15.01a	15**a**	15**a**
MF	23.25c	24.25c	23.28e	24.32f	23.26**d**	24.29**e**
MAR	15.9a	15a	15.8b	15.01a	15.8**a**	15**a**
MPR	20.25b	21b	17c	21.10d	20.21**b**	21.42**c**

MF = mucuna incorporated at flowering, MAR = Mucuna above ground biomass removed and only roots incorporated, MPR = only pods removed and all the other above ground biomass was incorporated and F= Fallow (control). Values followed by the same unbold letter in a season and those followed by the same bold letter for the 2 season means are not significantly different at P = 0.05**.**

CONCLUSION

Phosphorus treatments and mucuna management options showed some great impact on the availability of essential nutrients. Generally mucuna incorporated at flowering (MF) at the P40 treatment will result in a saving on N, P and K fertilizers. However Zn levels are somehow negatively affected by mucuna management options under the P40 treatment.

ACKNOWLEDGEMENTS

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Keywords: exchangable bases, major nutrients, mucuna, Zn

CAN CROP MODELLING ENHANCE GENETIC IMPROVEMENT OF CROPS?

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Mathematical simulation of crop growth has become indispensable to the science and practice of crop production. Process-based models integrate knowledge and data across disciplines, thereby assisting the synthesis of new knowledge. Models support strategic (e.g. resource use and climate change impacts), tactical (e.g. planting time and density) and operational (e.g. irrigation scheduling) decisions. Models also have the potential to enhance crop improvement because they integrate physiological understanding, agronomic management practices, environmental information and sometimes genetic information, and hence could assist in a better understanding of genotype (G) by environment (E) by management (M) interactions. Improved understanding could enhance crop improvement by informing breeding decisions regarding targeted crossing, gene insertion and genotype selection.

This paper explores the potential of crop models for enhancing crop improvement by reviewing case studies, identifying key requirements and recommending future research. Examples are discussed of where models were used to (1) characterize crop environments (Chapman *et al.*, 2000); (2) unravel genetic and environmental control of complex traits; (3) assess trait impacts on crop performance (Chenu *et al.,* 2009) and; (4) design ideotypes. These clearly demonstrate the potential value of gene-to-phenotype modelling (Hammer & Jordan, 2007) but also highlight the need for quality data and credible models.

Reliable values for physiologically meaningful trait parameters (genetic coefficients) and genomic (QTL or allelic) data are needed for a range of diverse genotypes. The mechanistic rigour and biological realism of existing models need to be improved. Interactions between organ development, organ growth and source strength should be simulated to accurately predict the effect of low-level genetic traits on whole plant response to environmental and management factors.

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Keywords: crop model, plant breeding, trait, genotype, environment

POLLINATION VARIATION OF WHITE ROUNDUP READY HYBRIDS: DKC78-45BR SIDE-BY-SIDE TRIALS

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INTRODUCTION

During the 2008/09 production season pollination variation was experienced on Dekalb white *Roundup Ready* (DKC78-35R and DKC77-71R) and stack gene (DKC78-45BR) hybrids. When the pollination variation problem arose it became apparent after testing that the line used as the female parent (previously the male) carried a trait caused by cytoplasmic determinates, that is maternally inherited, termed cytoplasmic male sterility (CMS). Directly after identifying the underlying cause of the problem it was decided to fully compensate clients affected by the problem. To restore confidence in the hybrids and to prove that biotechnology did not cause the problem, it was decided to conduct the DKC78-45BR side-by-side trials.

MATERIALS AND METHODS

Forty-five dryland side-by-side trials consisting of blocks of DKC78-45BR with CMS and DKC78-45BR without CMS were planted over the western maize production area of South Africa. The hybrids were evaluated for pollination variation based on visual coverage and grain yield (t ha^{-1}).

RESULTS AND DISCUSSION

In the side-by-side trials the DKC78-45BR without the CMS no signs of pollination variation , whereas the DKC78-45BR with the CMS had a significant lower weighted percentage cover of 96.08% (P-value: 0.0004). No significant correlation was found between *Roundup Ready Plus* herbicide application and weighted percentage coverage or yield of these hybrids.

CONCLUSION

Pollination variation problems experienced with the Dekalb Roundup Ready hybrids is restored and the Roundup Ready technology had no effect on the occurrence of the problem.

ACKNOWLEDGMENTS

Monsanto Technology development team especially: Andrew Bennett, Leonard Oberholzer, Gerrie Ludick and Paul Groenewald. The Monsanto leadership and sales team who contributed greatly to this project.

Keywords: Dekalb, pollination variation, Roundup Ready

RAINWATER HARVESTING AND CONSERVATION PRACTICES FOR INCREASED CROPLAND PRODUCTIVITY IN THE EASTERN CAPE

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INTRODUCTION

Studies have shown that between 6 and 30 % of annual rainfall is lost to runoff under conventional tillage practices. Unlike conventional tillage, various rainwater harvesting techniques channel runoff to the productive part of the field which can then be used to increase the survival percentage of the crop. By implementing various rainwater harvesting and conservation (RWH&C) techniques on croplands, rural farmers farming on marginal land can minimize the risk of crop failure.

MATERIALS AND METHODS

Maize was planted on a statistically randomized trial with five treatments and four replications at the Fort Cox Agricultural College in the Eastern Cape Province. The trial was implemented during the 2008/09 growing season. The techniques were: mechanized basin (MB) plough; Daling (DAL) plough; in-field rainwater harvesting (IRWH) plough; minimum tillage (MIN); and conventional tillage (CON). The parameters measured include: rainfall, soil water content, grain and biomass yield over two growing seasons.

RESULTS AND DISCUSSION

The soil was classified as a Valsrivier form with 13 and 18 % clay in topsoil and subsoil, respectively. The results for the 2008/09 growing season indicate that on average the techniques that produced the highest yields were IRWH, MB and DAL followed by MIN and CON. Results for the 2009/10 growing season showed that DAL, MB and IRWH performed better than both CON and MIN.

CONCLUSION

This semi-arid, Fort Cox/Valsrivier ecotope is marginal for crop production as well as highly erodible, making it a risk under normal conventional cropping practices if not managed correctly. Preliminary results indicate that the two rainwater harvesting techniques and one of the conservation techniques increased maize yields when compared to conventional tillage, thereby making RWH&C practices a recommended option for increasing yields on marginal lands.

ACKNOWLEDGMENTS

Water Research Commission; Department of Agriculture, Forestry and Fisheries; Agricultural Research Council - Institute for Soil, Climate and Water; Eastern Cape Department of Agriculture; Fort Cox Agricultural College

Keywords: Croplands, rainwater harvesting, semi-arid, runoff

SOIL ORGANIC CARBON STATUS IN THE BERGVILLE AREA OF KWAZULU-NATAL

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INTRODUCTION

The benefits of no-till are numerous and the majority of these are related in some way to the increase in soil organic matter. As the precise nature of soil organic matter is as yet poorly defined, soil organic carbon (SOC) is used as a measure of the latter. Furthermore, particulate organic matter (POM) constitutes a dynamic fraction of SOM and is associated with short-term nutrient dynamics. The aim of this study was to evaluate the effects of long-term tillage practices, compared to natural veld, on SOC and POM carbon (POM-C). The Bergville/Winterton area was chosen for the study as the vast majority of no-till lands in KwaZulu-Natal older than 10 years are to be found here.

MATERIALS AND METHODS

Soil samples were collected at various depth increments and points in time (seasons) on three sites (Bergville, Loskop, Winterton) where conventional (Cn), no-till (Nt) and veld (Vt) treatments were situated in close proximity. Total SOC was determined using the Walkley Black method. The method of Gregorich & Ellert (1993) was used to determine POM-C. The procedure uses physical fractionation of a soil sample to yield various size fractions of SOM. Total C was determined on the 50-200 micron size fraction to represent POM-C.

RESULTS AND DISCUSSION

The largest differences for both the SOC and POM-C were obtained in the 0-50mm soil layer. Soil organic carbon (SOC) differed significantly ($P<0.05$) among sites, with the Loskop site displaying 41% higher SOC than Winterton (lowest). Comparing seasons, the highest SOC values were obtained in autumn (30 g kg^{-1}) and the lowest in spring (27 g kg^{-1}). Differences in SOC as a function of the treatments (Cn, Nt, V) were significant ($p<0.05$) at all depth increments. Larger differences in POM-C were obtained among treatments compared to SOC.

CONCLUSIONS

Significant differences in SOC and POM-C were obtained for sites, treatments and depth increments. No-till significantly increased carbon stock compared to conventional tillage. The use of POM C as a more sensitive measure of changes in carbon stock should further be investigated.

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ACKNOWLEDGEMENTS

The ARC for funding this study, M Whitwell for statistical analyses and farm owners for access to sample sites.

Keywords: no-till, particulate organic matter, soil organic carbon

POTATO PRODUCTION IN THE SANDVELD: IS IT SUSTAINABLE?

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INTRODUCTION

Agricultural production occurs in an environment from which it draws resources and emits substances, both which can potentially jeopardise sustainability. Potato production in the Western Cape Sandveld takes place in an ecologically sensitive and vulnerable environment. The question how potato production can be sustained in such a sensitive area asks for a scientific approach to define sustainability, to monitor practices and to improve it.

MATERIALS AND METHODS

Principles related to the ecological impact of potato production were developed (nature conservation, water preservation, and minimization of chemical inputs and carbon dioxide emissions) and criteria were derived regarding land clearing, irrigation, emissions, and others. Next calculable and measurable indicators were defined for the efficiency with which these resources are used, such as proportion of land cleared, potato yield, water use by the crop, amount of chemicals used and the energy content they represent, and the energy needed for farm operations. In-depth interviews were conducted with 14 farmers, representing 20% of the total potato area, to obtain current values of these indicators. These were compared to model outcomes of two main sustainability indicators: land and water use efficiencies.

RESULTS AND DISCUSSION

The values of land-use efficiency varied least between growers (36 to 58 Mg ha^{-1}), while the recorded water-use efficiency ranged between 3 and 9 g potato L^{-1} water. Phosphorus fertlilzer use efficiency varied most, between 98 and 995 g potato g^{-1} P applied. Model outcomes confirmed some of the trends revealed by the survey, e.g. growing potato in winter and growing them with less than optimal water offers possibilities to double water-use efficiency. Ways to derive indicator threshold norms are proposed, based on knowledge of physical and biological processes that determine resource availability, the observed variation among farmers and model outcomes.

CONCLUSIONS

Knowing indicator values, their ranges and means of improving them will help to establish sustainability norms, providing a quantitative framework for assessing sustainability of potato production in the Sandveld and other ecologically sensitive areas.

ACKNOWLEDGEMENTS

We acknowledge financial contributions by the Netherlands Ministry of Agriculture, Nature and Food Safety through the BO Cluster International Programme, the Netherlands Embassy in South Africa and Potatoes South Africa.

Keywords: sustainability, potato production , ecologically sensitive , Sandveld

NITROGEN DYNAMICS IN INDUSTRIAL SLUDGE-COAL ASH MIXTURES

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INTRODUCTION

Proper disposal of coal gasification ash generated by the process of producing synthetic fuel from low grade coal, has been a challenge to industry for many years. A potential management option is the establishment of vegetation on ash heaps. The co-disposal with industrial sludge may aid in creating a more hospitable environment for plants because it is a source of organic material and since it contains nitrogen (N), an element in which the ash is poor. However, the ash will be a challenging environment (high alkalinity and salinity) and can interfere with essential processes, such as nitrogen mineralization, which is important for the conversion of organic nitrogen into inorganic forms suitable for plant uptake. Hence the aim of the study was to obtain a better understanding of N dynamics under these perceived extreme conditions.

MATERIALS AND METHODS

A laboratory scale low tension column setup was developed and a wide compositional range of industrial sludge, fine and gasification ash mixtures, they were investigated under conditions of sequential wetting and drying. Nitrogen speciation of the leachate collected was carried out by means of the Kjeldahl distillation method.

RESULTS AND DISCUSSION

Analyses of the first leachate collected suggested that sludge addition had little effect on aqueous inorganic N concentrations. pH of these leachates was close to the NH_4^+/ NH_3 pK_a of 9.25, while the pH of treatments without sludge was greater than 11. It is possible that N(-3) speciation participated in buffering the pH of the sludge amended mixtures initially. Chemical speciation modelling suggested that NH_3 was the dominant N(-3) specie. Low aqueous N(-3) concentration was attributed to the high volatilization constant (Henry's constant) of NH_3 and the greater propensity of NH_3 to volatilize under alkaline conditions. However, subjecting these mixtures to four more wetting and drying cycles over 6 months moderated the mixtures in terms of salinity and alkalinity. It was expected that sludge would act as an electron donor, which potentially can impede the oxidation of NH_4^+. However, a slight increase in oxidized N (+5 and +3) in solution indicated that these systems did manage to oxidize some NH_4^+. The treatments with the highest sludge content (10 - 13 % on a dry mass basis) showed an increase from between 0.304 and 0.305 mg N kg^{-1} for the first leaching to 0.331 – 0.359 mg N kg^{-1} for the fourth.

CONCLUSION

In terms of alkalinity ash initially created an environment beyond conventional references of what is considered a growth medium for plants. This had a significant impact on N speciation and resulted in little conversion of organic N to aqueous inorganic N forms initially. After 6 months and 5 wetting and drying cycles the environment moderated to some extent. The detection of NO_2^- and NO_3^- indicated that conditions had become more conducive for NH_4^+ oxidation.

ACKNOWLEDGEMENTS

Sasol Technology (Pty) Ltd and Water Research Commission

Keywords: Co-disposal, Gasification ash, Low tension column, Nitrogen speciation, Mineralization, Industrial sludge

EFFECTS OF CONSERVATION AGRICULTURE ON SELECTED SOIL PROPERTIES AND YIELDS UNDER DRYLAND

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INTRODUCTION

Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture (FAO, 2007). In the process, CA aims to achieve a balance between agricultural, economic and environmental benefits, while improving the livelihoods of farmer, and protecting the environment (Dumanski *et al*., 2006). Agriculture benefits from CA mainly by the increase of soil organic matter (SOM) and all the subsequent advantages associated with a higher SOM content, such as increased infiltration, aggregate stability, better water-holding capacity and increased nutrient status (FAO, 2007). Preliminary results of the first three growing seasons of a CA field trial are discussed.

MATERIALS AND METHODS

A statistically designed field trial incorporates six cropping systems (maize monoculture, rotation and intercropping systems with maize, legumes and forage crops), two tillage practices (reduced tillage (RT) and conventional tillage (CT)) and two fertilizer levels (optimal and low). Soil samples were collected annually at four depths (0-5, 5-10, 10-30 and 30-60 cm). Soil analysis, grain yields and biomass are determined with standard methods.

RESULTS AND DISCUSSION

Organic C content in the 0-5 cm layer increased from 1.20% (2007) to 1.38 % (2009), and total N increased from 1.10% (2007) to 1.12% (2009). However, most soil properties did not show any significant changes after three years. Average maize grain yields decreased from 6.25 t ha^{-1} (2007/2008) to 2.45 t ha^{-1} (2009/2010) due to lower rainfall. However, comparison of different treatments of the 2009/2010 season show that maize monoculture grain yields were significantly lower at 1.69 t ha^{-1} compared to maize/cowpea intercropping of 2.49 t ha^{-1} and maize/oats and maize/vetch delayed intercropping of 2.59 and 3.05 t ha^{-1}, respectively. Biomass from grazing vetch was higher under RT treatments compared to CT treatments, while oats performed better under CT (grazing vetch under RT = 4.36 t ha^{-1}; grazing vetch under CT = 3.18 t ha^{-1}; oats under RT = 1.74 t ha^{-1}; and oats under CT = 2.67 t ha^{-1}).

CONCLUSIONS

Three years is a relatively short period to observe changes in soil nutrient status, although an increase in organic C content has been measured. RT and crop rotation were mostly responsible for increased maize grain yields and fodder production. Preliminary results show that practicing CA could result in higher yields in dry seasons.

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Keywords: Conservation agriculture, soil properties, yield, reduced tillage, crop rotation,

ESTIMATING WATER USE OF FRUIT TREE SPECIES IN SOUTH AFRICA

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INTRODUCTION

There is currently a need for comprehensive information on water use of fruit tree species in South Africa that can be used for improved irrigation scheduling and water licensing purposes. In order to fill this knowledge gap the Water Research Commission initiated a research project on water use of tree orchards in 2006. Existing models in South Africa cannot confidently simulate water use of fruit trees for different climate, soil, water and management conditions. Due to the complexity of fruit tree orchards, traditional soil water balance approaches to determine water use have proved to be problematic. It is therefore hoped that through the use of field measured sap flow rates, together with soil water content, total evaporation and the driving weather variables for atmospheric demand, an ideal data set will be generated for calibrating and verifying evapotranspiration models.

MATERIALS AND METHODS

Water use has been monitored in apples (Ceres), Valencia and Navel oranges (Groblersdal), nectarines and peaches (Rustenburg), pecans (Cullinan) and is currently being monitored in nectarines (Wolsely) and macadamias (White River). Sap flow is being monitored using a heat pulse velocity system. Ancillary measurements include irrigation frequency and amount, climatic variables from an automatic weather station, soil water measurements and total evaporation during key window periods with energy balance methods. In addition, measurements of canopy size, leaf area index and solar radiation interception are being performed at regular intervals.

RESULTS AND DISCUSSION

Seasonal trends in water use are clearly observable for all fruit tree species, with maximum water use found during the hot summer months. Water use was well correlated with canopy size, which was especially evident in the deciduous fruit trees. Total yearly water use has varied from approximately 400 mm in citrus to 700 mm in apples and 1000 mm in pecans. The use of FAO-56 crop coefficients for modelling water use has proved to be robust for both apples and pecans but in citrus this approach is problematic.

CONCLUSION

Water use has been successfully monitored in a number of fruit tree species together with a number of ancillary measurements which drive water use. Initial attempts to model this water use have shown great promise, which will enable the extrapolation of the results across various orchards and climatic regions in South Africa.

ACKNOWLEDGEMENTS

Funding support is provided by the Water Research Commission and the National Department of Agriculture.

Keywords: apple, crop coefficients, heat pulse velocity, oranges, pecans, water use

PLANT WATER RELATION OF PEARL MILLET UNDER WATER STRESS DURING VEGETATIVE GROWTH

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INTRODUCTION

Pearl millet (*Pennisetum glaucum* [L.] R. Br.) is a drought tolerant cereal crop planted mainly in arid and semi-arid regions. Water stress effects on agronomic crops remains one of the challenges facing agriculture production.

MATERIALS AND METHODS

Two pearl millet lines (GCI 17 and Monyaloti) were investigated at the University of Free State experimental farm at Kenilworth during the 2009/2010 growing season. The two pearl millet lines were grown under three irrigation levels, namely full (IR3) moderate stress (IR2) and rainfed (IR1) using a line source sprinkler.

RESULTS AND DISCUSSION

The differences in leaf water potential of stressed and irrigated plants were decreasing simultaneously with progression of water stress. The water potential of GCI 17 dropped to as low as -1.83 MPa on water stressed plants after 11 days of withholding rain. The leaf water potential for Monyaloti remained significantly higher in the corresponding irrigation treatments. Stressed plants had lower stomatal conductance values than the irrigated plants, which were also more pronounced as water stress progressed. The effect of water stress on reducing stomatal conductance was greater in GCI 17 than Monyaloti. Sixteen days after withholding rain from water stressed plots, GCI 17 plants had a relative water content (RWC) of 72.7% while the well-watered plants had 90.3%. Water stressed Monyaloti plants were at 82.8% RWC while the well-watered plants had a RWC of 92.9%. At turgor pressure equal to zero, GCI 17 plants from stressed and well-watered plots did not show any adjustments as they were relatively equal, -2.22 and -2.27 MPa respectively. For Monyaloti water stressed plants had potential of -1.72 MPa and well-watered plants had -1.61 MPa at tugor pressure equal to zero showing an osmotic adjustment of 0.11 MPa.

CONCLUSIONS

The leaf water potential was maintained higher in Monyaloti plants compared to GCI 17 plants and the same effect was seen with the stomatal conductance which was also lower in water stressed plants than irrigated plants in the pearl millet lines. Monyaloti, the local pearl millet variety, is better adapted to the water stress conditions than GCI 17. Further investigation of the effects of age on the leaf water potential, stomatal conductance, RWC and stomatal characteristics in relation to photosynthesis was recommended.

ACKNOWLEDGMENT

This project was funded by Water Research Commission project (WRC K5/1771/4).

Keywords: leaf water potential, osmotic potential, Pearl millet, relative water content, stomatal conductance, water stress

SHORT-TERM YIELD AND QUALITY BENEFITS OF BIOLOGICAL ENHANCEMENT STRATEGIES FOR SPRING WHEAT IN THE WESTERN CAPE

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INTRODUCTION

While crop rotation and reduced tillage methods are believed to have positive benefits in the shallow and fragile soils of the Western Cape, biological approaches have been developed to further enhance soil biology, crop health, development and yield. These approaches range from supplementation of organic matter by organically enriched fertiliser sources and the augmentation of favourable organisms by artificial means, usually with seed treatments containing spores of target organisms. A field study was conducted to determine if these strategies had any short-term benefit on wheat yield and quality in the region.

MATERIAL AND METHODS

Field trials were conducted at Riversdale and Langgewens in 2009 and at Riversdale, Moorreesburg and Caledon in 2010. In every experiment a RCB design with four replications was used. Trials were planted in established crop rotation systems, into stubble of the previous crop, using a no-till trial planter. Plots (2,2m x 20m) were at least 1m apart to minimise the risk of organisms influencing neighbouring plots. Treatments included inorganic fertiliser (N and P) as control and two types organically enriched fertiliser sources. Seed treated with *Mycorrhiza spp*., *Trichoderma spp*. or a combination of the two, were used as alternative enhancement strategies. In the case of the control treatments, standard fertiliser regimes for the area were used, while fertiliser levels were adapted according to instructions of the owner of the products used. The trials at Roodebloem and Langgewens were top-dressed. Standard weed, pest and disease control practices were applied. Plots were harvested with a plot harvester to determine grain yield, while hectolitre mass (HLM) and grain protein (%) were determined at ARC-SGI quality laboratory using standard procedures.

RESULTS AND DISCUSSION

During neither of the two seasons, or at any of the localities, did any of the enhancement strategies differ significantly from the control treatment (standard inorganic fertiliser) in terms of grain yield, HLM or protein content.

CONCLUSION

From these experiments, it can be concluded that none of the biological enhancement strategies had any immediate beneficial effect over and above crop rotation and conservation tillage methods in terms of yield or quality. Using these strategies over time or in poorer soils with lower biological activity and high disease pressure, may, however, prove more beneficial.

ACKNOWLEDGEMENTS

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Keywords: Wheat, biological enhancement, Mycorrhiza, Trichoderma, organically enriched,

REGISTRATION OF THE MN98550-5/MN99394-1 WHEAT RECOMBINANT INBRED MAPPING POPULATION

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INTRODUCTION

Mapping populations are useful tools for mapping important traits and identifying useful markers for marker-assisted selection in breeding. For this study, the MN98550-5/MN99394-1 hard red spring (HRS) wheat (Triticum aestivum L.) mapping population was developed by the University of Minnesota from the cross between the two advanced breeding lines MN98550 and MN99394. This population is comprised of a set of 139 F6 - derived F8 recombinant inbred lines (RILs) that have been used to identify chromosome regions harboring genes that influence important traits. Because this population originated from elite breeding lines, it contains genes that could be useful for wheat improvement.

PEDIGREE INFORMATION

The breeding line MN98550-5 is a single plant selection originating from the cross between the two HRS wheat varieties 'BacUp' (Reg. no. CV-854, PI 596533) (Busch et al., 1998) and 'McVey' (Reg. no. CV-894, PI 612966) (Busch et al., 1996), that are adapted to the Upper Midwest region of the U.S.A. The breeding line MN99394-1 is a single plant selection originating from the cross of SD3236/SBF0402. SD3236 and SBF0402 are HRS wheat breeding lines that were selected from the 1996 Uniform Regional Performance Nursery at 22 locations across the HRS wheat regions of the U.S. and Canada.

POPULATION CHARACTERIZATION

The population was assigned the USDA-ARS Germplasm Resources Information Network (GRIN) accession nos. GSTR 13301 -13439. The population was genotyped with diversity array technology (DArT) and simple sequence repeat (SSR) markers, and the genetic map was composed of 531 marker loci covering all 21 chromosomes of wheat. This population segregated for several important traits, including resistance to fungal disease (leaf rust caused by Puccinia triticina f. sp. tritici and stem rust caused by P. graminis f. sp. tritici), monomeric and polymeric proteins, kernel characteristics, agronomic and end-use quality traits, and their quantitative trait locus/loci (QTL) and closely linked markers and genes were identified (Tsilo et al., 2010a, b). The information obtained from QTL analysis was useful in selecting the best RILs as parents in our breeding program. Detailed information on this registration was submitted to the Journal of Plant Registration (in press).

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Keywords: Wheat, QTL, agronomic traits, quality traits, disease resistance

DOES BURNING OR TRASHING SUGARCANE REDUCE *Eldana saccharina* (LEPIDOPTERA:PYRALIDAE) POPULATIONS MOST? SOME INTERESTING INSIGHTS

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INTRODUCTION

BT1 is an acronym used for a sugarcane burning and trashing field assessment trial that was established on 25 October 1939 at Mount Edgecombe. It was designed to determine the long term effects of these two management practices, with and without inorganic fertiliser. Because of the debate as to whether burning or trashing of sugarcane reduced the presence of the stalkborer *Eldana saccharina* in sugarcane, BT1 provided the ideal experimental setup to provide an answer.

MATERIAL AND METHODS

BT1 is situated at Mount Edgecombe (Longitude: 31^{o} 04' 29" and Latitude: 29^{o} 43' 20") on a vertisol (Arcadia form) with an A-horizon depth of 500 mm and mean annual rainfall of 950mm. The design of the trial consists of four replications of two main plots each split into four sub-plots. The treatments are various combinations of trashed, burnt, fertilised and non-fertilised plots with the green leaves (tops) after harvest either spread or removed for the burnt plots only. The fertilised plots each receive 140 kg N and K/ha and 30 kg P/ha after harvest.

Eldana saccharina surveys were completed over 2 seasons (2004 and 2005) by taking 7 stalks in each of the centre three rows of each sub-plot, at equidistant intervals along each row, at each sampling date (total of 21 stalks per sub-plot). Each stalk was split longitudinally, and inspected for any life stages of the stalk borer and/or its parasitoids. Those found were counted and placed in labelled vials containing diet to rear them through for species identity. The % nodes damaged per stalk were recorded. In addition, three pitfall traps were positioned in the centre of each sub-plot and sampled for a period of 7 days per month to monitor predatory epigeal arthropod species diversity and abundance.

RESULTS

Insect predator numbers in trash mulched fields were more than double compare to burnt fields. This linked with the high C: N ratio of the mulch, would lead one to hypothesise that *E. saccharina* populations are expected to be low compared to burnt fields. This was the case, except that, contrary to expectations, damage by *E. saccharina* was highest for the trash mulched treatments receiving inorganic fertiliser. The C:N ratio of the trash mulch layer was 80, but the mulch itself contained 0.36% N which equates to 42 kg N/ha. This N is not all immediately available to the crop, but after 69 years the N release is continuous, coming also from the remnants of previous mulch layers.

CONCLUSION

The potential N deficiency of the mulched plots was overcome by the inherent N of the mulch layer leading to no N shortage as confirmed by leaf analysis. The inorganic fertiliser applied was therefore sufficient to make the plant attractive to *E. saccharina*. Careful monitoring of fertiliser applications should be done, for efficient growth of sugarcane to be maintained, and to reduce overfertilisation.

Keywords: Eldana, sugarcane, trash mulch, C to N ratio

NITROGEN MANAGEMENT IN SUGARCANE CROPPING SYSTEMS: CHASING EFFICIENCY USING ON-FARM MEASUREMENT AND MODELLING

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INTRODUCTION

Sugarcane cropping systems require the application of substantial amounts of fertiliser nitrogen (N), especially under irrigated conditions and in areas where rainfall is sufficient for high dry matter production. Inadequate N applications can reduce yields, while excess N or poorly-timed applications can result in the export of significant quantities of N to the environment as a pollutant. Informing growers on the optimal management of this nutrient is therefore essential.

MATERIALS AND METHODS

An N subroutine has recently been included into the Canegro crop model which is based in the Decision Support System for Agrotechnology Transfer (DSSAT) framework (Daroub et al., 2003). Data from a field and lysimeter trial conducted in Pongola, South Africa, were used to calibrate and test the model, following which the model was used to analyse potential approaches to improve fertiliser N management.

RESULTS AND DISCUSSION

Measured and simulated results show that on-farm monitoring of soil inorganic N levels and adjusting fertilizer rates accordingly has considerable potential for reducing fertiliser applications and unwanted N losses. Furthermore, during periods between active crop growth, significant amounts of inorganic N can build-up in a soil as a result of mineralisation. Accounting for this N allows for the application of fertiliser N later in the season (~55 days for the system studied) than is conventionally practiced (at planting or immediately after harvest for a ratoon crop), thereby significantly reducing the vulnerability of N to loss by leaching. When ammonium-based fertilisers are used, lower volatilization losses can also be expected with this strategy.

CONCLUSIONS

Modelling, combined with adequate measured data for calibration purposes, can be a powerful tool to identify improved N management practices for a system. In its current form, Canegro can be used to improve our understanding of N dynamics in sugarcane production systems, as well as to guide management practices and future research.

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Keywords: nitrogen, sugarcane, irrigation, modelling, Canegro, DSSAT

GENOTYPIC VARIATION OF FRUIT QUALITY TRAITS RELATED TO CONSUMER APPEAL IN APPLE BREEDING FAMILIES

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INTRODUCTION

Traditionally, assessment of visual and sensory fruit traits for selection purposes is performed by breeders on an individual basis, due to the practical limitations of consumer preference testing early in the breeding process (Hampson, 2000). The aim of this study was to study the eating quality and consumer preference of a large number of apple breeding selections, mainly to provide a preliminary prediction of consumer preference that could be useful in screening large numbers of breeding selections during the advanced selection phase.

MATERIALS AND METHODS

Descriptive sensory analysis with a trained panel was performed on apple parental genotypes and seedlings from breeding families using a 100 mm unstructured line scale. Instrumental measurements included puncture tests, TA and TSS measurements. Consumer acceptability was assessed by using a 9-point hedonic scale. Principal Component Analysis (PCA) was performed to project sensory and instrumental attributes onto the preference dimensions.

RESULTS AND DISCUSSION

Apple flavour and texture parameters (e.g. juiciness, crispness and crunchiness) were found to be the strongest drivers of consumer preference for eating quality, with sweet taste being a weaker driver. The textural attribute mealiness, in particular, but also the sensory descriptor sour taste, were both drivers of consumer dislike. A strong association was found between perceived and instrumental sourness, while a weaker association between perceived and instrumental sweetness was reported. Perceived sweetness, sourness and sensory texture were better predictors of liking and disliking than instrumental measurements of TSS, TA and firmness.

CONCLUSIONS

Texture is the strongest driver of consumer preference for apples. Instrumental assessment of quality traits cannot substitute for sensory analysis by a trained panel. Trained and consumer panels should therefore remain an important part of fruit quality assessment and can successfully be used in the breeding programme to direct consumer driven apple breeding.

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Keywords: Sensory analysis, fruit breeding, *Malus x domestica* Borkh.

APPLE PREFERENCE SEGMENTATION OF SOUTH AFRICAN CONSUMERS

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INTRODUCTION

Factors influencing consumer behaviour are increasingly explored from multi-disciplinary perspectives, due to the impact of these factors on consumers' behaviour and attitude towards food choices. Multivariate statistical analysis can be used to gain a better understanding of how segments of consumers differ in their preferences and to identify the attributes that each consumer segment responds to (Harker *et al.,* 2003).

MATERIALS AND METHODS

Descriptive sensory analysis using a trained panel was performed on nine apple cultivars. Consumer preference for apple eating quality was assessed by using a 9-point hedonic scale. This scale was also used to assess preference for apple appearance, providing consumers with photographs of all nine cultivars. Consumers were selected to represent an approximately equal number of white, coloured and black consumers, differing in age, gender and socio-economic background in the Stellenbosch area, Western Cape.

RESULTS AND DISCUSSION

Interaction was evident for the ethnic group*cultivar ($P<0.0001$) and age*cultivar ($P=0.0046$) combinations, suggesting that both ethnic group and age impact on consumer preference for eating quality. Principal component analysis (PCA) revealed that sweet and sour taste were important drivers of liking and disliking respectively for the black, coloured and older consumers, whereas these attributes were less important to the white and younger consumers. Consumer preference for appearance was also influenced by ethnic group and age. Black and coloured consumers preferred the appearance of 'Topred' and 'Golden Delicious', while white consumers rated the appearance of 'Topred' highest and 'Golden Delicious' lowest. Older consumers preferred the appearance of 'Topred' and 'Royal Gala', but rated 'Granny Smith' significantly lower than younger consumers.

CONCLUSIONS

Ethnic and age groups differ in their preference for apple eating quality and appearance. Sweet taste is the most important driver for the black, coloured and older consumer groups. Contrary to expectations, consumers preferred the appearance of 'Topred', the reddest cultivar included in this study.

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Keywords: Consumer segmentation, sensory analysis, *Malus domestica*

LONG-TERM LAND USE INDUCED SOIL CHEMICAL VARIATION ON THE MPUMALANGA HIGHVELD

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INTRODUCTION

The soils on the Mpumalanga Highveld are subject to a range of land uses of which the historic ones are mainly dryland crop production and grazing. Formal plantations are not common but woodlots (mainly wattle or eucalyptus) occur throughout the landscape. An increasing land use is open cast coal mining and the post-mining land use and land capability is highly dependent on the soil stripping, soil placing and rehabilitation approach followed by the mining company. The influence of pre-mining land use on post-mining land use and land capability is investigated in the light of significant soil chemical variation.

MATERIALS AND METHODS

A detailed soil survey was conducted near Pan Station for the purpose of informing soil stripping, placing and post-mining rehabilitation approaches. The survey was conducted as a 150 m grid survey with the subsequent sampling of selected soils for chemical and physical analysis. Sample sites were chosen to reflect differences in soil properties between cultivated fields, wattle woodlots and eucalyptus plantations. The age of the plantations and woodlots as well as the historic cultivation approaches could not accurately be established and anecdotal evidence was therefore relied upon.

RESULTS AND DISCUSSION

The soil analysis results indicated that there was a very significant difference between cultivated fields and woodlots/plantations. The main difference was observed in Ca levels where those in the surface horizons of cultivated fields often exceeded 2000 mg kg^{-1} and those in subsurface horizons of plantations and woodlots very rarely exceeded 50 mg kg^{-1}. In some cases subsurface horizons in plantations exhibited levels of below 10 mg kg^{-1} with one as low as 1 mg kg^{-1}. Similar trends, although not as pronounced, were observed for other cations as well as electrical conductivity and pH. Anecdotal evidence suggests that the plantations and woodlots were already well established by 1940, therefore providing an indication of the duration of differential ameliorant inputs.

CONCLUSIONS

The vast differences in soil chemical composition between different land uses poses major problems for soil rehabilitation efforts as the predictive capacity (from land use data) is lost once soils have been stripped and placed in different areas. Post-mining land use and land capability is a challenge as mining often leads to a drastic change in agriculture potential. These challenges are amplified if soil properties are not adequately (and intensively enough) assessed before mining and if adequate planning for placement and treatment is not conducted.

ACKNOWLEDGEMENTS

Xstrata Coal South Africa and Terra Soil Science for the funding of the investigation and research.

Keywords: Historic land use, post-mining land capability, rehabilitation, soil chemistry, soil survey

EVALUATION OF TRANSGENIC *Ornithogalum* PLANTS

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INTRODUCTION

Ornithogalum is an indigenous bulbous plant known for its beautiful cut flowers, which are very popular on the overseas flower markets. The flower breeding programme at the Agricultural Research Council - Vegetable and Ornamental Plant Institute (ARC-VOPI) has yielded several varieties of this popular flower, including line A2 (Rolou) which produces flamboyant yellow flowers with long stems. *Ornithogalum* is, unfortunately extremely susceptible to infection by the *Ornithogalum* mosaic virus (OrMV), which causes mosaic patterned leaves and, most importantly, deformed flowers, thus making the flowers un-marketable. This leads to large financial losses for the flower growers. In addition, the virus accumulates in the mother material.

MATERIALS AND METHODS

Plant transformation was implemented to transfer OrMV resistance genes to Rolou. The OrMV coat protein and replicase genes were transferred to Rolou using *Agrobacterium*–mediated transformation, and polymerase chain reaction (PCR) was used to confirm the presence of the genes. Two lines, A2:1 containing the replicase gene and A2:4 containing the coat protein gene were selected for a two-year contained greenhouse trial, which commenced in April 2009. Data collected from the trial included phenotypic evaluation of bulbs and cut flowers, molecular and virus resistance data.

RESULTS AND DISCUSSION

Transgene integration and heritability of the resistance genes from the first generation to second generation greenhouse plants were confirmed through PCR and Southern blot analyses. Expression of the transgenes was assessed by OrMV infection of the two transgenic lines and resistance was confirmed through ELISAs, visual assessment and performance of the transgenic plants in comparison to the non-transformed control. The cut flowers were compared to the non-transformed control and it was found that the flowers of line A2:4 are similar to the non-transformed control. The stems of the flowers of line A2:1 are shorter and may be suitable for marketing as a pot plant. Bulbs varying in size were harvested from both transgenic lines and it was found that bulbs >4 to size 6 cm can be used for evaluation of bulb growth; bulbs of size 6 - 9 cm can be used for cut flower production; and bulbs of size 9 - 11 cm can be used for multiplication of material.

CONCLUSIONS

Two transgenic *Ornithogalum* lines resistant to OrMV have been developed. Once a regulatory dossier has been developed for these events and approved by the regulatory authority, they will be suitable for commercial production by flower growers. This will assist to counteract the virus problems currently experienced by flower growers.

Keywords: Ornithogalum, Agrobacterium-mediated transformation, OrMV resistance

THE INFLUENCE OF SEEDING RATE ON THE ESTABLISHMENT AND PRODUCTION OF DRYLAND LUCERNE (*Medicago sativa*) IN THE WESTERN CAPE

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INTRODUCTION

Lucerne (*Medicago sativa*) is the most productive pasture legume in the Rûens area of the Western Cape and pastures are traditionally sown to cultivar SA Standard (SAS) (van Heerden & Tainton, 1987). Other more productive, grazing resistant and persistent lucerne cultivars have, however, been identified (van Heerden, 2005). As the seed of the new cultivars is expensive, lower seeding rates were evaluated as a means to optimize returns.

METHODS AND MATERIALS

Trials were conducted at Heidelberg (2003 to 2006), Caledon (2006 to 2009) and Stellenbosch (2010) under dryland conditions. At Heidelberg cultivars SAS, WL414, WL320, PAN4764, PAN4546, Alfagraze, Aurora, SA Select, Aquarius and Genesis were sown at two seeding rates of 6 and 12 kg ha^{-1} respectively. In the trial at Caledon cultivar WL 414, was sown at four different seeding rates of 3, 6, 9 and 12 kg ha^{-1} respectively. At Stellenbosch cultivar Magna 601 was planted at 10 seeding rates ranging from 1 to 10 kg ha^{-1}, during June 2010. The trials at Heidelberg and Caledon were part of grazed pastures and production was determined by cutting samples eight weekly in- and outside exclosure cages. The trial at Stellenbosch was not grazed and plants were dug up in each plot during September 2010 and counted. All lucerne samples were dried at 60^{o}C and weighed.

RESULTS AND DISCUSSION At Heidelberg there was no significant ($P \leq 0.05$) difference between the seasonal dry matter yield of the cultivars, as well as the two seeding rates. At Caledon there was also no significant ($P \leq 0.05$) influence of seeding rate on lucerne dry matter yield in the first year (2006/2007). During 2007/2008 the lucerne yield was, however, highest at the 9 kg ha^{-1}, but only significantly ($P \leq 0.05$) compared to the 3 and 6 kg ha^{-1} seeding rates. During 2008/2009 the lucerne yield was again highest at the 9 kg ha^{-1} seeding rate, but only significantly ($P \leq 0.05$) so compared to the 3 kg ha^{-1} seeding rate. The results derived in the trial at Stellenbosch, showed that a seeding rate of 7 to 8 kg ha^{-1} was most effective.

CONCLUSIONS

The research showed that dryland lucerne seeding rates can be lowered from the standard 12 kg ha^{-1} to at least 8 or 9 kg ha^{-1}, making possible a saving of 25 to 30% in seed cost.

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Keywords: lucerne, seeding rate, production, dryland

MON 89034 – A NEW BT-EVENT FOR CONTROL OF THE AFRICAN STEM BORER, *Busseola fusca* IN MAIZE

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INTRODUCTION

Bt-transgenic maize deploying the Monsanto event Mon 810 (*Cry1Ab* gene*)* has been commercially produced in South Africa since 1998. The area under Bt-maize has increased from 50 000 ha in 1998/99 to 943 000 ha (34.9%) in 2006/07. A limitation of Mon 810 is a reduced concentration of the Bt-toxin in silks which allows for increased survival of larvae derived from late oviposition. The Bt11 event of Syngenta (also *Cry1Ab*) which followed at a later stage, proved to be similarly limited. Severe damage to Bt-plantings caused by *Busseola fusca* during the 2004/05 season was subsequently shown to be due to some stem borer populations in the Christiana and Vaalharts areas becoming resistant to the currently used Bt-toxin. There is therefore an urgent need for new Bt-events to replace those currently available. In this study a second generation Monsanto event, Mon 89034, which provides effective control of a number of borer species in the USA, was evaluated. Mon 89034 encodes for the *Cry1A.105* and *Cyr2Ab2* proteins. With important differences in their mode of action these proteins provide a much more effective insect resistance management tool.

MATERIALS AND METHODS

Mon 89034 was compared to Mon 810 and susceptible standards over the three seasons 2006/07, 2007/08 and 2009/10. The study comprised two field trials and three laboratory evaluations. Artificial infestation of plants with neonate larvae (field) and forced feeding on various plant parts (laboratory) were used. Except for the first season, the testing included both Bt-susceptible and Bt-resistant insect populations. Evaluations included larval survival, larval mass gain, leaf feeding damage, the incidence of stem and ear damage, plant height reduction and yield loss.

RESULTS AND DISCUSSION

With forced feeding of larvae of a Bt-susceptible borer population on leaf tissue, stems silks, ears, husks and tassels Mon 89304 consistently resulted in significantly higher larval mortality than Mon 810. Using only leaf tissue in the evaluations of 2007/08, approximately 2.5% of Bt-susceptible larvae survived over the full trail period on Mon 810 whereas no larvae survived beyond day 4 on Mon 89034. The concomitant results of 2009/10 indicated 20% survival of a Bt-susceptible population on Mon 810. On Mon 89034 all larvae were dead between nine and 13 days and without significant mass gain. With a Bt-resistant population survival on leaf tissue of Mon 810 was about 40% compared to 80% on the susceptible standard. With Mon 89034 all larvae were dead before day 9. Larval mass increase was similar on Mon 810 and the susceptible standard. With Mon 89034 no mass gain was recorded. When feeding on silks larval survival of the Bt-resistant population was similar on Mon 810 and the susceptible standard. With Mon 89034 all larvae were dead by day 12. These laboratory results were largely confirmed in both field trials.

CONCLUSIONS

Mon 89034 was superior to Mon 810 for control of B. fusca including its Bt-resistant populations. Survival of larvae on silks of Mon 810 which has caused considerable complications under commercial conditions was effectively eliminated by Mon 89034.

Keywords: Bt -maize, *Busseola fusca*

DISAGGREGATION OF LAND TYPES EA34 AND CA11 WITH TERRAIN ANALYSIS, EXPERT KNOWLEDGE AND GIS METHODS

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INTRODUCTION

The lack of soil suitability maps has been named one of the reasons for failure among upcoming farmers. Traditional methods of soil survey are unfortunately labour intensive and expensive. The cost of traditional soil surveys can be greatly reduced by digital soil mapping (DSM). Because South Africa is blessed with the land type inventories, it seems logical that any attempt at DSM should start with the disaggregation of the land types.

MATERIALS AND METHODS

A preliminary soil group map was created during a desktop study. The land types were divided into terrain morphological units (TMU's), and the soils in the land type inventory divided into groups. From this a soil group map was created solely by terrain analysis. Secondly a field visit to the site was conducted with the land type surveyor for the area. The knowledge gained during this visit was used to update the existing soil map. The third part included soil observations of selected transects, on selected soilscapes, where after a final soil association map was created. The three created maps were tested with point observations, made during the field work for the Afsis project (Africa Soil Information Systems, www.africasoils.net).

RESULTS AND DISCUSSION

The results show the expected trend that the higher the input, the higher the map accuracy. The expert knowledge together with an understanding of the hillslope location and genesis of the dominant soils in a land type inventory provided the best improvement to existing land type polygons.

CONCLUSIONS

As the whole country is covered by land type inventories, disaggregation of land types is a viable and cost effective method of soil surveying, but the method can still be improved.

ACKNOWLEDGEMENTS

Africa Soil Information Systems (Afsis) University of the Free State: Strategic Academic Cluster 4

Keywords: Digital soil mapping, Disaggregation, Terrain analysis, Expert knowledge, GIS

GEOMORPHOMETRY AS INDICATOR FOR SLOPE POSITION

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INTRODUCTION

At local scales there is little variation in the soil forming factors as described by Hans Jenny in 1941 with the exceptions being *parent material* and *position in the landscape (topography)*. With expert knowledge these can be used to describe and even predict soil distribution. An understanding of the terrain can significantly decrease resources needed for a useful and meaningful soil survey but GIS generated terrain models are not always easy to use and interpret for soil survey purposes. The aim of this study is to refine a GIS method to determine position in the landscape for predictive soil mapping purposes.

MATERIALS AND METHODS

A 20m digital elevation model (DEM) was created from 20m contours for the Pafuri concession in the northern Kruger National Park. Various attributes can be derived from a DEM, such as plan and profile curvature as well as slope. One algorithm that is proposed for the determination of position in the landscape is Topographic Position Index (TPI). This algorithm calculates the difference between the elevation of a point and the average elevation of the surrounding area. However, when there is an upslope area with deep ravines, as well as a floodplain in the study area, as is the case at Pafuri, some smaller (but very important) topographic features are lost. In this study the TPI was calculated and compared to a revised version referred to as the Topographic Position Percentage (TPP). For the TPP the difference between the elevation of a point and the average elevation of the surrounding area is expressed as a percentage of height variation rather than height (in meters). Cross sections of the terrain were produced in different topographical areas and points along these transects classified by an independent person as either “hilltop”, “mid-slope” or “valley bottom”. These results were used to statistically compare the “accuracy” of the two algorithms TPI and TPP.

RESULTS AND DISCUSSION

The results of the upslope area did not differ significantly between TPI and TPP, but when the floodplain area was investigated, TPP was more accurate in describing the terrain differences therefore leading to a more accurate prediction of terrain position. The TPP was consistently better when compared to surrounding areas of differing size.

CONCLUSIONS

The TPP provides a method for finer and more detailed terrain position prediction – even in areas with significant topographic variation. This provides a useful tool in the refining of soil surveys. For prediction purposes more research is needed to correlate the occurrence of specific soils with TPP at different scales and in different areas.

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ACKNOWLEDGEMENTS

Terra Soil Science for the funding of the research.

Keywords: predictive soil mapping, terrain analysis, topographic position

IMPACT OF SOIL ACIDITY ON GROUNDNUT PRODUCTIVITY IN MPUMALANGA PROVINCE

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INTRODUCTION

In South Africa, groundnut (*Arachis hypogaea* L) is produced commercially in the North West, Free State and Northern Cape provinces, and by small-scale and subsistence farmers mainly in the Mpumalanga, Kwa-Zulu Natal and Limpopo provinces (Van der Merwe, 1981). In Mpumalanga, it is grown mostly on acid granite sands, and therefore, soil acidity is one of the major constraints in groundnut production. Application of lime to correct low pH is not always affordable to resource-poor farmers. The aim of the study was to identify genotypes that tolerate soil acidity under local environmental conditions.

MATERIALS AND METHODS

Sixteen groundnut genotypes were each grown in the 2008 season, with supplementary irrigation at two close sites that differed in soil pH (4.3 and 5.8) at Nelspruit (25^0 26' 25" S, 30^0 58' 57" E and 676m.a.s.l) in Mpumalanga lowveld. At each site, the cultivars were arranged in a randomized complete block design with four replications. Data on establishment, final stand at harvest, days to harvest, plot yield, biomass, shelling per-cent and seed size were recorded. Analysis of variance was performed using MSTAT-C statistical package.

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RESULTS AND DISCUSSION

Genotypes RG784 (2318 kg ha^{-1}), and *Inkanyezi* (2234 kg ha^{-1}) recorded significantly greater (p=0.05) pod and seed yields than the control genotype Rambo (1154 kg ha^{-1}) at soil pH 5.8. All the genotypes recorded lower establishment, yields and hundred seed mass at soil pH 4.3. Yield reductions due to low soil acidity were relatively low in the genotypes KaNgwane Red (14%) and ICGV95714 (39%). Genotypes Anel (1188 kg ha^{-1}), ICGV95714 (1013 kg ha^{-1}) and JL24 (927 kg ha^{-1}) recorded significantly higher seed yields than Rambo. Low seed mass accounted for the low performance at low pH since shelling per cent and mean number of pods plant $^{-1}$ were not affected by soil pH.

CONCLUSIONS

Outstanding genotypes are identified for further evaluation based on the significant differences (P=0.05) recorded on pod and seed yields, shelling percentage, number of seed per pod, seed yield per plant, seed size and days to maturity.

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Keywords: Smallholder farmers, shelling percent

THE POTATO TUBER MOTH – WHY CONTROL STRATEGIES SOMETIMES FAIL

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INTRODUCTION

The potato tuber moth (*Phthorimaea operculella*) is one of the most damaging potato pests in South Africa. Its larvae attack the foliage during the growing season as well as tubers in the soil and in storage. Annual yield loss to the potato industry of R 40 million is common. The potato tuber moth is only destructive during some seasons and on certain farms, and sometimes there is no clear reason why control strategies fail.

MATERIAL AND METHODS

In a three-year study with the potato tuber moth, from 2006 to 2009, it was demonstrated that resistance to insecticides was not a problem in South Africa. In the same study period, two case studies on farms in the Eastern Free State and in the Limpopo Province were undertaken to examine what the causes could have been for the high potato tuber moth infestations.

RESULTS AND DISCUSSION

The Eastern Free State farmers experienced severe yield losses during the 2007/2008 season – up to 40%. However, the preceding year and the following year only showed a 5% yield loss due to tuber moth damage. The only marked differences between these three years were prevailing weather conditions. During 2007/2008 a severe drought with abnormal high temperatures prevailed in the Eastern Free State. This was concluded to be the reason for the extraordinary high incidence of tuber moth with the associated high yield losses. The second case study showed that when a new potato field is planted near a newly harvested field, high tuber moth infestations can be expected early in the season in the new field. In the study it was shown that newly hatched moths appear from the soil for a period of three months after harvesting. On average 50 moths were caught per week per pheromone trap. These moths migrated to the new field and infested the young potato plants. Because the larvae penetrated the stems of the young plants, control with insecticides was not effective.

CONCLUSIONS

From the study it was evident that insecticides registered against the potato tuber moth in South Africa are still effective. Other factors should therefore be investigated as reasons why control sometimes fails. Two such factors were identified, i.e. prevailing weather conditions and nearby infestation areas. When these factors are ignored and precautionary measures are not put into place, huge losses may be experienced. A few such measures will be discussed.

Keywords: Potato tuber moth, Phthorimaea operculella, control

THE ROLE AND POTENTIAL OF PLANT CYSTEINE PROTEASE INHIBITORS FOR INSECT RESISTANCE

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INTRODUCTION

Plant cystatins represent an attractive target for the improvement of pest-resistance in crops intended for human use, given the absence of cysteine proteases in the human gut and the widespread occurrence of these target enzymes among herbivorous Coleoptera. Cystatins act as pseudo-substrates that enter the active site cleft of target cysteine proteases to form tight, reversible complexes that inhibit protease activity. A compensatory response in herbivorous Coleoptera towards dietary protease inhibitors in plant tissues has been noted in literature. Our goal, in this study, was to determine whether functional diversity of the potato beetle digestive Cys protease complement was matched with some functional variability of the potato host cystatin complement, using the wound-inducible eight-domain cystatin, potato multicystatin (PMC), as a model.

MATERIALS AND METHODS

Computational modelling was done to determine the predicted interactions between the potato multi cystatin domains and digestive cysteine proteases from the Colorado potato beetle. These cystatin domains were also cloned and expressed in a bacterial system and the inhibitory potential of purified proteins tested against commercial proteases as well as gut extracts of the Colorado potato beetle. To determine the compensatory response of the beetle towards the individual cystatin subunits bioassays were done in which each of the subunits were fed to the insects as a dietary supplements and their feeding, growth and digestive compliment were monitored.

RESULTS AND DISCUSSION

Computational modelling of the PMC domains interacting with Cys proteases of the beetle suggested the onset of variable interaction strengths for the PMC domains. These findings were empirically confirmed with protease inhibitory data showing complementary protease inhibitory spectra among the eight PMC domains. Some domains showed strong activity against potato beetle cathepsin L-like proteases (e.g. domains 2 and 6), in contrast with other domains targeting cathepsin B-like proteases (domains 1 and 3) or with domains showing no particular target specificity (domains 4 and 5).

CONCLUSION

These data suggest, overall, that functional variability among PMC inhibitory domains has evolved in response to predatory challenges by the Colorado beetle relying on Cys proteases for potato leaf protein digestion.

Keywords: Plant cysteine protease inhibitors, insect resistance, Coleoptera

POLLINATION EFFICIENCY IN HYBRID ONION SEED CROPS

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INTRODUCTION

Hybrid seed production constitutes two thirds of all onion seed (*Allium cepa*) sold by major seed companies worldwide. Hybrid onion seed crops in South Africa are known to have poor seed set and consequently low yields of seed. In the literature, there is a dearth of publications on the pollination efficiency and subsequent fertilisation of hybrid seed onion crops. While studies have been conducted to determine to what extent pollinators in field are the cause of this problem, it has yet to be established whether the pollen or pollination process may be at fault. From the instant the pollen comes into contact with the stigma, until the time that it has reached the ovule, is there an underlying factor that could cause less than satisfactory pollination?

METHODS AND MATERIALS

A field research trial was conducted in a commercial planting of onion seed at Rooirivier in the Little Karoo. Five trial plots were randomly selected in blocks of male fertile and male sterile ("female") onion plants. In each plot, the main umbels on ten male sterile plants were bagged prior to bloom in order to prevent contact with any pollinator insects. At full bloom, the virgin florets on each of the bagged umbels were hand pollinated and re-bagged. Samples of these florets were collected in the field in accordance with time and analytical protocols. In the laboratory, each sample was examined using florescent microscopy. Tests were conducted to determine the viability of pollen collected from the male plants attending female rows, using a thermo-gradient germinator. Weather data at the site was logged for the duration of the pollination period. Soil and leaf analyses were done to evaluate the nutrient status of the plants. Drip irrigation scheduling was monitored with the use of tensiometers. Field pollination was promoted by the introduction of hived bees at the commencement of flowering.

RESULTS AND DISCUSSION

Preliminary results show that pollen tube growth rates are optimal at 27.5°C with 50% relative humidity. The growth rate at this regime varied ranged from 350 to 650µm over a 24 hour period. While there are six ovules per floret, results show that more than six pollen tubes are required to obtain optimal fertilisation. Weather records reflect a wide range in daily temperature and humidity. During the peak flowering period, daily temperatures peaked at 37°C.

CONCLUSIONS

Pollination in seed crops is a specialised process and management acumen is needed to optimise all agronomic inputs and to counter the effects of extreme temperature and humidity.

Keywords: Microscopy, Onion seed, Pollination, Pollen tube, Seed set

NATIONAL INVASIVE ALIEN PLANT SURVEY

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INTRODUCTION

The objective of the project was to establish and implement a cost-effective, objective and statistically-sound invasive alien plant monitoring system for South Africa, Lesotho and Swaziland, at a quaternary catchment level. Since a complete inventory and a standard sampling approach both have limitations owing to the size of the study area and the variation in the natural environment, an innovative sampling approach was required.

MATERIALS AND METHODS

In order to detect the maximum variation in an area with the least sample points, sampling was conducted along an environmentally variable gradient found to contribute the most to an invasive alien plant species' occurrence. A stratified proportional approach, incorporating 74,000 sample points, was adopted for landscape areas while riparian areas were sampled every two kilometres along mainstem rivers. A regular grid point layer was created for selected quaternary catchments to serve as an independent source of verification for the landscape sample points. An airborne field survey of each sample point was then conducted using trained observers and the simultaneous acquisition of oblique aerial photographs.

RESULTS AND DISCUSSION

A strong correlation was found between the stratified proportional sample points and the regular grid verification layer which resulted in a 0.1% sampling intensity at 86% accuracy. The data are only intended for use between, and not within, quaternary catchments and are limited to the 26 terrestrial invasive alien plant taxa observed. The study was also restricted to untransformed land-cover.

CONCLUSIONS

Twenty million hectares of South Africa were found to be invaded, an area twice as large as previous estimates. Projections to control mechanically and chemically are R12 billion or 41 years (at current funding levels).

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Keywords: invasive alien plant, environmental association, stratified proportional sampling, airborne field survey

ACCELERATING RESISTANCE BREEDING IN WHEAT VIA THE INTEGRATION OF MARKER ASSISTED SELECTION AND DOUBLED HAPLOID TECHNOLOGY

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INTRODUCTION

Genetic resistance, produced by using resistance genes from wheat and related wild species, is the simplest and most cost-effective way to guard against the wheat rust diseases. The pyramiding of resistance genes in a single line is a vital practice in achieving durable resistance. This study aimed to demonstrate that breeding for wheat rust resistance can be accelerated via the integration of marker assisted selection (MAS) and doubled haploid (DH) technology.

MATERIALS AND METHODS

Rust resistance genes *Lr19*, *Sr31/Lr26/Yr9/Pm8* and *Lr54/Yr37* were combined by means of crossing. Breeders' lines which have complex resistance including *Lr24/Sr24*, *Lr34/Yr18*, *Sr36* and *Sr2*, were used. Marker assisted selection (MAS) was used to type populations for the abovementioned genes and select for favourable combinations. Using an adapted version of the DH method (maize pollination technique) developed by Pienaar *et al.* (1997), an inbred population was developed from the selected lines, after which the lines were characterised molecularly for the resistance gene translocations which they contain.

RESULTS AND DISCUSSION

The study produced 27 lines with diverse genetic profiles. Seven lines contain four translocations (*Lr24/Sr24*, *Lr34/Yr18*, *Sr2* and *Lr19* or *Sr31*) each, 11 lines contain three genes each, six lines contain two genes each and three lines contain a single translocation (*Lr24/Sr24*). The reality that rust pathogens have already overcome three of the resistance genes in the final population – *Lr19*, *Sr31* and *Sr24* – is a clear indication of the value of using non-major gene resistance for bringing about durable resistance. The focus should fall ever more upon the application of quantitative trait loci (QTL) for this purpose, which will result in MAS contributing to the development of more durable resistance.

CONCLUSIONS

The value of the integration of MAS and DH in combination with conventional breeding practices in breeding programmes has already been illustrated internationally for increasing the rate of cultivar development and this is reaffirmed by this study.

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Keywords: Gene pyramiding, species genes, wheat rust

MAPPING THE DISTRIBUTION OF CALCIUM IN APPLE TISSUE WITH PROTON-INDUCED X-RAY EMISSION - AFTER APPLICATION OF ADDITIONAL FOLIAR OR SOIL CALCIUM

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INTRODUCTION

Fruit with a high total calcium concentration [Ca] often displays internal quality disorders (bitter pit, low firmness) that are linked to insufficient calcium (Ca). Although bulk elemental analysis can be used to quantify the total content and concentration of plant nutrients like Ca on a per fruit basis, this method renders limited knowledge as to where Ca is located in the fruit tissue, the distribution in the tissue, and the [Ca] at specific locations. Different fruit disorders are associated with a deficient Ca concentration in specific tissues (eg cortex or peel) and cannot be predicted accurately with an indiscriminate whole fruit analysis.

MATERIALS AND METHODS

Fruits were cut diagonally to produce thin apple slices at 80 days after full bloom (dafb) and at harvest. These were freeze dried and mounted onto carbon coated Formvar plates. Fruit Ca concentrations were established using Micro-PIXE analyses via a nuclear probe. Maps were obtained by repetitive scanning of 3.0 MeV focused proton beam on areas ca. 2 mm x 2 mm. Typically 12 scans were necessary to cover the distance from fruit peel to core.

RESULTS AND DISCUSSION

The concentration of Ca was the lowest in the fruit cortex (120 -450 ppm) when compared to the skin (700 – 2200 ppm) and core (300 – 700 ppm). This is in agreement with existing literature (Wilkinson and Perring, 1961). Fruits sampled at 80 dafb followed the same trend, but overall Ca concentrations were much higher in the skin core and cortex when compared to the fruits sampled at harvest. PIXE analyses results showed that Ca distribution is also closely associated with the distribution of vascular bundles in the fruit. The contribution of additional Ca from the foliar versus soil application is also discussed.

CONCLUSION

Both at harvest and at 80dafb, fruit [Ca] was the lowest in the fruit cortex compared to the peel and core. This inadequate distribution of Ca may be partly responsible for the expression of Ca deficienciy symptoms in fruit with adequate amounts of total Ca. To reduce the deficiency in fruit [Ca] in specific tissues, it is necessary to determine the contribution of the applied Ca in order to recommend the preferred application method to increase [Ca] in specific tissues.

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Keywords: Bitter pit, Foliar sprays, Pre-harvest Ca applications

THE EFFECT OF HARVEST TIME ON THE DEVELOPMENT OF LEAF BLACKENING IN *Protea* CV. SYLVIA

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INTRODUCTION

Leaf blackening is a serious postharvest condition that manifests in most *Protea* cut flowers as a discoloration developing on leaves. This disorder remains the single most important constraint to the export of these niche products (Van Doorn, 2001). Generally, harvest time of cut flowers affect the immediate carbohydrate and water status of the stem (Dole, 2005). However, no clear guidelines exist as pertaining to optimum harvest time for *Protea*. The aim of this study was thus to evaluate the development of leaf blackening in *Protea* cv. Sylvia (*P. eximia X P. susannae*), a cultivar especially prone to leaf blackening, when harvested at various times during the day.

MATERIALS AND METHODS

Flowering four-flush stems of 'Sylvia' were harvested at the commercial soft-tip stage on 18 February at 17:00 and 08:00, 10:00, 13:00 and 15:00 on the following day. Ten stems per harvest were standardized to 20 leaves per stem and hydrated for 1 hour at room temperature. Water content, reducing sugars, sucrose and starch concentration, including total phenolics were determined for the terminal flush at each harvest time. Stems were either fresh evaluated or stored for 3 weeks at 2°C where after stems were evaluated for a 10 day vase life period. Leaf blackening was assessed by recording the percentage leaves ≥10% blackening per stem throughout the vase life.

RESULTS AND DISCUSSION

Stems harvested in the morning had the highest incidence of leaf blackening, both when fresh evaluated (±60%) or stored (±90%), on day 10 of vase life. Water uptake was lower in the morning than in the afternoon. Reducing sugars were the lowest in the morning, but the starch content remained relatively consistent irrespective of harvest time. Water content of leaves harvested in the morning was higher compared to leaves harvested in the afternoon.

Harvesting *Protea* stems in the morning is not optimal to delay leaf blackening or to facilitate processing time as the more hydrated stems of the morning harvests would have a lower capacity for pulse solution uptake with subsequent longer processing times. In addition, the lower carbohydrate levels of the morning harvested stems would be conducive in the development of leaf blackening.

CONCLUSIONS

The time of day for harvesting may be an important consideration in a management strategy to control postharvest leaf blackening in *Protea* cv. 'Sylvia'.

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Keywords: water relations, pulsing, hydration, longevity, vaselife