A TUBE WETTING FRONT DETECTOR FOR IRRIGATION MANAGEMENT

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INTRODUCTION

The development of sound irrigation management tools like wetting front detectors can bridge the gap between science and practice. Wetting front detectors are simple devices that provide basic information, like the depth of infiltrating water below the soil surface which the grower can use to improve his/her irrigation management. This study has investigated if the 90 cm long tube detector would respond to tensions wetter than 90 cm. The study also investigated if the tresponse time of the tube detector could be influenced by the hydraulic characteristics of the wick materials.

MATERIALS AND METHODS

The tube wetting front detector is made up of two concentric pipes of different diameters and filled with special wick material to produce a hanging column of water from unsaturated flow that exerts tension on the bulk soil. A contact material similar to the wick material is placed on the opening of the tube to ensure continuity between the wick material and the bulk soil. Two tube detectors each 90-cm long were filled with Diatomaceous Earth material (D.E) and another two were filled with very fine sand (D36) and installed with the opening of the tube buried 150 mm below the soil surface. Tensiometer and Time Domain Reflectrometry probes were used to measure tension and soil water content in the contact material respectively. Water volume in the detector was measured with a syringe. Another set of two tube detectors each 90 cm long where one filled with D.E and another filled with very fine sand and a tensiometer placed at the opening of each tube were allowed to dry in the open air after both tubes were saturated.

RESULTS AND DISCUSSION

The empirical test in the open air showed a linear regression functions between water level in the tube and the contact material tension. The regression values were (R^2 =0.99) for D.E and (R^2 =0.97) for very fine sand. Water level in the tube was regressed against time to determine whether the wick materials are energy or conductivity limited over the 0-100 cm tension. The water level decreased linearly for D.E, indicating that the rate of drying was energy limited, but for very fine sand it had two stages of drying; with the first stage energy limited and the second stage conductivity limited.

The in-situ measured soil water retention curves for both wick materials indicated that the slopes of retention curves were very close to each other. The water volume can be plotted against the tension of the contact material and the maximum sensitivity limit set as 95 cm tension to show whether the tube detector has recorded a particular event or not. According to these specific setups, the tube wetting front detectors sensed 75-90% of the fronts with strengths between 0-95 cm tension.

CONCLUSIONS

The tube wetting front detector tested under field conditions showed that it can detect 75-90% of the fronts and, therefore, the tool can be used as a tension-switch detector.

Empirical tests showed that water level in the tube was linearly related to the contact material tension and indicated that the tube detector could be used as a tensiometer for the 0-90 cm tension.

The empirical test and in-situ measured retention characteristics showed that the rate of emptying between the two wick materials were different.

ACKNOWLEDGEMENT

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Keywords: tube detector, contact, wick, tension-switch

RESPONSES OF GROUNDNUT GENOTYPES TO SOIL ACIDITY IN KWAZULU-NATAL

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INTRODUCTION

Soil acidity limits crop production by causing Ca, Mg and P deficiencies, or toxicities of Mn and Al, among others. Large parts of KwaZulu-Natal are characterized by acid soils which contribute to reductions in crop yields. The logistics and cost of liming as a tool for remediation of acid soils, are beyond the means of most small-scale farmers in the region. A study was carried out in a controlled environment growth room at the University of KwaZulu-Natal to investigate genotypic variations in groundnut to soil acidity as an alternate tool for small-scale farmers for improving the production of the crop in the acid soils of KwaZulu-Natal.

MATERIALS AND METHODS

Groundnut genotypes were grown in 15 cm diameter pots, each containing 1.1 kg of soil with acid saturation of 45%, collected from a virgin land in Bergville (KwaZulu-Natal). The conditions of the growth room were day/night temperatures 28/20 ^{o}C, photoperiod 14 h, relative humidity 60% and light sources provided by fluorescent and incandescent lamps to give a light intensity of 285.15 $\mu molm^{-2}s^{-1}$. The experiment was a factorial combination of nine groundnut genotypes and four remediation treatments in four replications. The remediation treatments comprised applications of lime as $Ca(OH)_2$ (1.1 g / 1100 g soil), phosphorus as KH_2PO_4 (0.12 g / 1100 g soil), a combination of $Ca(OH)_2$ (1.1 g /1100 g soil) and KH_2PO_4 (0.12 g / 1100 g soil), and a control. Plants were watered adequately throughout the study. At flowering, the shoot material was harvested and shoot dry mass, Ca, Mg, P as well as Mn and Al levels were determined. The acid saturation of the soil was also determined at the time of harvest.

RESULTS AND DISCUSSION

In six genotypes the control treatments had lower dry masses and shoot Ca, P and Mg levels, while the values for the genotypes Rambo and Billy were higher suggesting that the uptake of these nutrients by the two genotypes was less affected by the untreated acid soil. The remediation with lime, P or a combination of these, increased shoot dry matter, Ca, P and Mg levels ($P < 0.05$) of the six genotypes that showed poor growth in the acid soil. The benefits of remediation to the genotypes Billy and Rambo were, however, less pronounced. Shoot Al and Mn levels were relatively higher in the control treatments for the first lot of six genotypes than for Billy and Rambo. However, remediation treatments reduced the shoot Al and Mn concentration ($P < 0.05$) in the six genotypes. On the other hand, remediation had little influence on the shoot Al and Mn levels of the genotypes Rambo and Billy. The lime source reduced soil acidity from 45 to 10%.

CONCLUSIONS

The responses shown by the genotypes in respect of shoot Ca, P and Mg on one hand and Al and Mn on the other suggest that the two genotypes Billy and Rambo are more tolerant of acid soils than the others tested. These preliminary results present a small window of opportunity for groundnut production by small-scale farmers in KwaZulu-Natal who cannot afford the full cost of acid soil remediation.

ACKNOWLEDGEMENTS

We thank the Research Office of the University of KwaZulu-Natal for providing the funds for this project.

Keywords: Acid soils, Nutrients, Shoot Al level

EFFECT OF MICROENCAPSULATED ALACHLOR ON SOUTH AFRICAN SUNFLOWER (*Helianthus annuus* L.) CULTIVARS

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INTRODUCTION

The microencapsulated formulation of alachlor [2-chloro-N-(diethylphenyl)-N-methoxymethyl acetanilide] is becoming increasingly popular for use on sunflower in South Africa, where it is registered for use at a rate of 1.54 to 1.92 kg ai ha^{-1}. It is applied pre-emergence mainly to control annual grasses, some broadleaf weeds, and yellow nutsedge under certain conditions. Some injury symptoms, apparently herbicide induced, have been observed on sunflower where this herbicide has been applied in the field. The objectives of this study were to test commercially available sunflower cultivars for their tolerance to this herbicide, as well as establish if soil type played a role in herbicide sensitivity.

MATERIALS AND METHODS

The response of 22 commercially available sunflower cultivars was tested in a glasshouse experiment using both a sand (10% clay) and a sandy loam soil (20% clay). Five rates of alachlor (0, 0.5, 1, 2 and 4 times the recommended application rate for each of these soils) were applied and leached into the soil after planting. Pots were placed in an air-conditioned glasshouse at a 28/ 18°C day/night temperature regime under natural light conditions with a 13 hour daylength. A randomized complete block experimental design with three replicates was used. Plants were harvested 38 days after planting, at which stage plant height, mass (fresh and dry) and seedling survival rate were determined.

RESULTS AND DISCUSSION

Characteristic symptoms of alachlor phytotoxicity (stunted plants with small, dark green shrivelled or badly crinkled leaves) were noted in all cultivars at high application rates (two or four times recommended application). Results indicated that cultivars differed with respect to alachlor tolerance, but that behaviour was modified by soil type. All effects were far more pronounced on the lighter soil, despite a lower recommended application rate. Plant height was affected by increasing application rate to a far greater degree than dry mass. Although the application rate for this herbicide is lower on a lighter soil, plant growth was significantly reduced at the recommended application rate (1.536 kg ai ha^{-1}) on the lighter soil. An interesting finding, which must now be confirmed through field trials, was the reduction in seedling survival rates with increasing application rates. This showed significant reductions at the recommended application rate on both soils, although the effect was again far more pronounced on the lighter soil.

CONCLUSION

The results indicate that despite the lower recommended application rate of microencapsulated alachor on sandy soils a far greater degree of sunflower damage due to the herbicide can be expected on these soils, and that the cultivars reacted differently to the herbicide on the two soils used in this trial. These findings could go some way towards explaining at least some of the problems that have been found on sunflower where this formulation of alachlor has been applied.

Keywords: Herbicide, Sensitivity, Soil type, Survival, Tolerance

THE USE OF MID-INFRARED SPECTROSCOPY FOR THE ROUTINE PREDICTION OF VARIOUS CONSTITUENTS IN SOIL SAMPLES SUBMITTED FOR FERTILITY ANALYSIS

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INTRODUCTION

It has been reported in literature that mid-infrared (MIR) is superior to near-infrared (NIR) for the estimation of common soil properties (McCarty et al., 2002; Pirie et al., 2005; McCarty and Reeves, 2006). The objective of the study reported here was to determine whether MIR could be successfully used to estimate various constituents commonly determined in soil.

MATERIALS AND METHODS

926 soil samples were collected from various localities in South Africa. These were air-dried and milled to pass a 1-mm sieve. Sub-samples were scanned in duplicate using a Bruker Tensor 27 FT-IR spectrometer with HTS-XT automatic sampler. The MIR spectra obtained were used calibrate the instrument so that it could be used to estimate organic carbon, total nitrogen, clay percentage, exchangeable acidity, percent acid saturation and exchangeable Ca and Mg in soil samples.

The conventional laboratory methods against which the MIR spectrometer was calibrated were as follows: Total carbon and nitrogen values were obtained using the Dumas dry combustion method (on a Leco CNS-2000 analyser). Samples that had pH_{KCl} values higher than 5 or that had a distinct carbonate peak in the MIR spectrum were analysed for carbonates by loss of mass after treatment with 5 *M* HCl. These carbonate values were subtracted from the respective total carbon values to give an "organic carbon" value. Clay percentages were determined using the pipette method. Exchangeable acidity (exchangeable H^+ and Al^{3+}) was determined by titration with 0.005 *M* NaOH solution after extraction with 1 *M* KCl. Exchangeable Ca^{2+} and Mg^{2+} were determined by atomic absorption spectroscopy after extraction with 1 *M* KCl. Percent acid saturation was determined by dividing the exchangeable acidity by the total of the extractable cations ($K^+ + Ca^{2+} + Mg^{2+} + Al^{3+} + H^+$). values higher than 5 or that had a distinct carbonate peak in the MIR spectrum were analysed for carbonates by loss of mass after treatment with 5 HCl. These carbonate values were subtracted from the respective total carbon values to give an "organic carbon" value. Clay percentages were determined using the pipette method. Exchangeable acidity (exchangeable H and Al) was determined by titration with 0.005 NaOH solution after extraction with 1 KCl. Exchangeable Ca and Mg were determined by atomic absorption spectroscopy after extraction with 1 KCl. Percent acid saturation was determined by dividing the exchangeable acidity by the total of the extractable cations (K + Ca + Mg + Al + H).

Calibrations of MIR against the conventional methods were developed by performing multivariate data analysis using the OPUS chemometrics software (v. 5.5) supplied by Bruker. This software uses the partial least squares regression fit method (PLS 1) to correlate spectral characteristics in the MIR region (such as absorbance and peak slope) with desired parameters. Spectral pre-processing methods selected for the calibrations included second derivatives, first derivative plus vector normalization, minimum-maximum normalization, first derivative plus multiplicative scattering correction and straight-line subtraction. Test set validations were performed on all calibrations.

RESULTS AND DISCUSSION

Very promising calibrations were obtained for predicting the organic carbon (r^2 = 0.929), total nitrogen (r^2 = 0.915) and clay percentage (r^2 = 0.936). These calibrations were able to predict the organic carbon, total nitrogen and clay percentages in independent test samples with a high degree of accuracy (r^2 of test sets varied between 0.841 and 0.931).

The acidity, acid saturation and exchangeable Ca and Mg calibrations are not sufficiently accurate to replace the traditional methods used to determine these parameters, and will rather be used for quality control purposes. Large differences between the MIR values and the results obtained through traditional means would indicate that the conventional analysis on the sample(s) should be repeated.

CONCLUSIONS

Mid-infrared spectroscopy is a cheap and rapid means of estimating the organic carbon, total nitrogen and clay contents in soils. It can also be used for quality control for other standard soil fertility analyses.

Keywords: mid-infrared spectroscopy, soil fertility, organic carbon, total nitrogen, clay

EVALUATION OF BIOLOGICAL AMENDMENT SUBSTANCES ON MAIZE (*Zea mays* L.) PERFORMANCE UNDER VARIABLE FIELD CONDITIONS

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INTRODUCTION

The recent global food crises attributed to rising human population and low yields call for production strategies that can stimulate increased and sustainble crop yields. Also, the scarcity and rising cost of mineral fertilizers and the negative impact of climate change further constitute bottlenecks to effort targeted at achieving increased crop yields. Unfortunately, problems of rapid solubility, high volatility and occasional pollution of groundwaters that accompanies use of mineral fertilizers, exacerbate ecosystem degradation (Foster & Chilton, 2003). Efforts to mitigate these challenges necessitated the development of plant nutrient alternatives such as industrial manufactured biological amendment substances (IMBAs). Several of these IMBAs are produced, registered and marketed in South Africa without substantial agronomic data to substantiate their efficancy or describe their residual soil impact. Therefore, the objective of the study was to assess the agronomic efficiency of selected biological amendment substances for maize production under different field conditions.

MATERIALS AND METHODS

Field trials using nine IMBAs were conducted in the 2006/07 and 2007/08 production seasons at four localities (Bethlehem, Potchefstroom, Bothaville and Ottosdal) that have varied soil and climatic conditions. The IMBAs evaluated along with inorganic fertilizer and an u namended control included included Biozone, Advanced Crop Care, Gromor Accelerator, Growman, K-humate, Lanbac, Molcast, Montys Organics and Promis. Application rates for the IMBAs were as recommended by the suppliers while inorganic NPK fertilizer was applied based on the optimum recommended rate for each site using LAN, super phosphate and MOP, respectively as N-P-K sources. Treatments were arranged as randomized complete block design with four replications. Maize cultivar PAN 6479 was planted at 1.5 m inter and 0. 3 m intra-row spacing to achieve a population of 22 222 plants ha^{-1}. Growth and yield data were recorded at different stages and agronomic efficiency of the IMBAs relative to inorganic NPK fertilizer treatments calculated after grain harvest. Data were subjected to analysis of variance using Statistix 8.1 and differences in treatment means tested at 5% probability level.

RESULTS AND DISCUSSION

The different IMBAs exerted variable effects on maize plant vigour, leaf area index (LAI), maize grain and stover yields, with significant ($P<0.05$) difference between localities. In 2006/07, grain (3 329 kg ha^{-1}) and stover yields (6340 kg ha^{-1}) from Molcast amended plots at Potchefstroom were significantly ($P<0.05$) higher than yields from NPK plots. However, in 2007/08, patterns were competely different. K-humate gave significantly ($P<0.05$) higher grain yield (3787 kg ha^{-1}) than the other IMBAs evaluated at Bothaville except in Biozone plots. Molcast gave significantly ($P<0.05$) higher stover yield at Ottosdal (11053 kg ha^{-1}) than all the other treatments. The agronomic efficiency of the different IMBAs varied greatly across localities, from negative to positive (-10.3 to 22.9), being generally higher in Bethlehem and Bothaville than at Potchefstroom and Ottosdal. The highest tissue N content of 2.3 % in maize stover obtained after grain harvest was K-humate amended plots at Ottosdal.

CONCLUSIONS

The agronomic efficiency of the different IMBAs varied greatly across seasons and inconsistent across different soil types. Nevertheless, the results from this study reveal that K-humate and Molcast showed promising potential for increase maize productivity across all localities. The were definite season X site interaction.

Reference

FOSTER, S.S.D & CHILTON, P.J., 2003. The processes and gl obal significance of acquifer degradation. Philosophical Transactions: Biological Sciences 358, 1957-1972.

Keywords: Industrially manufactured biological amendments, maize productivity, agronomic efficiency, nutrient uptake, soil fertility

THE EFFECT OF RAINFALL AND TEMPERATURE ON THE PREHARVEST SPROUTING TOLERANCE OF WINTER WHEAT IN THE DRYLAND PRODUCTION AREAS OF THE FREE STATE PROVINCE

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INTRODUCTION

Preharvest sprouting (PHS) is a risk factor in winter cereal farming in certain environments. This is because even mild sprouting affects the suitability of wheat for end-use products. The role of dormancy loss may be affected by environmental conditions during grain development. In South Africa, rainfall occurs in most seasons during the grain harvesting period. Rains after wheat is physiologically ripe can cause preharvest sprouting which can lower the baking quality of flour due to the synthesis of alpha-amylase. Therefore dormancy and consequently preharvest sprouting (PHS) is an important consideration for farmers when choosing a cultivar.

In this study we investigated the effect of temperature and rainfall on preharvest sprouting values of selected cultivars by using the meteorological data from plant to harvest. In the process we aimed to determine which phase in the growing period contributes most to the variability in PHS tolerance/susceptibility, which is commonly experienced in the dryland wheat producing areas of the Free State Province.

MATERIALS AND METHODS

To establish a quantitative relationship between PHS and different climatic characteristics, eighteen winter wheat cultivars were planted in three regions representative of the wheat growing conditions of the Free State Province of South Africa over four years. Climatic characteristics (total rainfall, minimum and maximum temperatures) during six environmental periods were investigated, namely plant to harvest (PH), anthesis to harvest (AH), grain filling (GF), 14 days prior to maturity (14M) and 10 and 20 days prior to harvest (10H and 20H) respectively. These data sets were correlated with PHS to determine if climate during various stages of grain development had an effect on the expression of dormancy and subsequent PHS.

RESULTS AND DISCUSSION

A combined ANOVA on PHS over years and localities to test for cultivar effect differences indicated a highly significant locality by year by cultivar interaction. To determine if climate had an effect on the PHS tolerance of the various cultivars, especially those that don't seem to be stable with regard to their PHS tolerance, the meteorological data were used to determine possible relationships between PHS and the various climate characteristics. RESULTS obtained showed that there was no significant correlation ($P>0.05$) between PHS and rainfall in the six climate periods tested. However, a highly significant ($P=0.008$) positive correlation ($r=0.715$) was observed between PHS and minimum temperatures during the grain filling period. Principal component analysis (PCA) on mean PHS values to examine the interrelationships of the cultivars with PHS identified three distinct groupings of cultivars, ranging from PHS susceptible to PHS resistant.

CONCLUSIONS

A fairly strong positive correlation ($P\leq0.01$) was found between PHS and minimum temperature during grain filling. This generally implies that higher minimum temperatures during grain filling were associated with higher PHS values, indicating lower PHS resistance. Large variations in PHS values were also observed between the various cultivars, indicating that certain cultivars are more sensitive to environmental effects than others.

ACKNOWLEDGEMENTS

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Keywords: Preharvest sprouting, temperature, rainfall

EVALUATION OF IRRIGATION SCHEDULING PRACTICES ON WATER LOGGING AND SALINITY AT COMMERCIAL FARMS

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INTRODUCTION

Water tables near or in contact with the root zone induce water logging and salinization. Both conditions may cause yield losses for different reasons and should be managed accordingly. Water logging is due to a lack of oxygen in the rhizosphere that hampers respiration. Salinity is mainly caused by salt that is transported from the water table through capillary rise. The salt accumulates in the root zone during transpiration and effect yield negatively by lowering the osmotic potential of the soil solution. Utilization of water tables therefore demands special management through irrigation scheduling. The aim of this paper is to evaluate irrigation practices on commercial farms with respect to water table utilization and salinization.

MATERIALS AND METHODS

The evaluation was done on a case study basis with wheat as the crop at Orange-Riet Irrigation Scheme. The amount of rainfall plus irrigation (R+I, rain gauges) and change in soil water content (ΔW, CPN neutron water meter) were measured, while evapotranspiration (ET) was estimated with the model SWAMP from seed yield measurements. Capillary rise (+Du) or deep percolation (-Dp) were weekly calculated with the soil water balance equation. Surface runoff was assumed negligible. Water table heights (piezometers) were measured weekly. Salt gain by the profile was calculated from electrical conductivity (EC) measurements of R, I and Du. Water table qualities were measured weekly. Salt lost by the profile through deep percolation was estimated with an empirical model from the EC of the irrigation water, EC at the start of the season, depth of soil and Dp. The EC of a saturated extract was also taken at the start and end of the season, by sampling the soil at 300 mm depth intervals.

RESULTS AND DISCUSSION

The farmers applied between 369 and 656 mm a^{-1}, while R amounted to approximately 150 mm. The total ET varied from 500 to 666 mm, with a net ΔW of approximately 50 mm. Calculations showed that Du occurred mostly during the first 70 days, while Dp mostly took place from day 70 onwards. Three of the case studies showed a net loss of water. One case study demonstrated the value of deficit irrigation. Here it was calculated that the crop obtained 40% of its total water use from the stored water in the profile. The soil water content was generally higher than the drained upper limit and varied between 327 and 534 mm 1800 mm^{-1}soil depth. The water tables varied between 435 and 2050 mm from the soil surface. From the correlations it was not clear whether the high water tables caused yield reductions. Salt gain by the profiles over the growing season through rainfall, irrigation and capillary varied between 500 and 2000 kg ha^{-1}, while the net salt loss through deep percolation varied from 788 to 1009 kg ha^{-1}. Only the case study where the water table was utilized significantly resulted in a significant net gain (1000 kg ha^{-1}) in salt over the growing season. The EC of the profiles varied from 38 to 83 mS m^{-1} at the start of the season and from 51 to 125 mS m^{-1} at the end.

CONCLUSION

It seems if the farmers were apparently accurate in determining the weekly and total crop water use from an agrometeorological view. Closer analysis revealed that the farmers do not monitor soil water content or water table heights. In most cases the estimations had led to uncontrolled water loss through drainage. Fortunately it also helped to leach excess salts from the root zone. The sustainability of this practice is currently under investigation in a four year Water Research Commission funded project.

Keywords: Irrigation scheduling, soil salinity, water logging , water tables

CROP PRODUCTION AND PLANT NUTRITION AFTER 15 SEASONS' IRRIGATION WITH DIFFERENT QUALITIES OF COAL MINE WATER

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INTRODUCTION

The agronomic sustainability of crop production using gypsum-rich coal mine waters (EC that ranges between 120 and 400 mS m^{-1}) was studied on annual cash crops such as maize, wheat, sugarbeans and potatoes, and vegetables such as peas, sweetcorn, pumpkin and soybean. The study also investigated the nutrient imbalances of crops that could occur as a result of unfavourable nutrient interactions.

MATERIALS AND METHODS

Plant samples were taken from representative 1 m^2 areas, in 3 replications every 10-14 days for 15 seasons to determine the above-ground dry matter accumulation. Leaf samples were also taken at critical crop growth stages to determine possible nutritional imbalances for 15 seasons. Irrigation and rainfall were recorded. The yield of the crops was compared with yield obtained from dry land farming and crops irrigated with fresh water. Leaf analyses were interpreted by both the Sufficiency Range (SR) approach and the Diagnosis and Recommendation Integrated Systems (DRIS) method.

RESULTS AND DISCUSSION

The yield of maize obtained from fields irrigated with gypsiferous mine water (average 5 t ha^{-1}) was lower than the average yield usually obtained from fields irrigated with normal fresh water (>8 t ha^{-1}), but was higher than the yield of dry land farming in the area (3 t ha^{-1}). Wheat is known to be more tolerant to salinity than maize and yield of wheat was not affected by the salinity of the irrigation water. The yields obtained from the vegetables were not satisfactory for the trial period, which could be related to poor irrigation site selection. In all the crops irrigated with gypsiferous mine water, N, K and Mg were required in relatively larger quantities than the other nutrients. In the maize and wheat leaves, N and K were the most deficient nutrients, compared to the others, and could probably be due to poor fertilization management. High K levels were also found in the soil solution in all the sites as a result of the high Ca concentration in the irrigation water which led to a release of K into the soil solution by cation exchange processes.

CONCLUSIONS

Crop production under irrigation with mine water rich in Ca and SO_4 is, therefore, feasible and sustainable if properly managed. Clearly recognizable leaf symptoms associated with specific nutritional disorders were not observed. It, therefore, seems that crops can be produced using gypsiferous mine water without experiencing major plant nutritional problems, but it is essential to take into account what ions in the irrigation water are being added to the soil.

Keywords: coal-mine water, irrigation, crop production, plant nutrition, salinity

GREEN MANURE CROPS: THEIR GROWTH AND EFFECT ON NEMATODES OF SUGARCANE

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INTRODUCTION

Green manure crops are commonly used in the South African sugarcane industry to improve soil health and break the pest and disease cycle. However incorrect selection of a green manure crop may result in worse pest problems. The current study, which was part of a larger project looking at integrated pest management strategies, was initiated to look at the growth of these crops and investigate their effect, in summer and winter cycles, on plant parasitic nematodes of sugarcane. In addition, we investigated whether these changes continued into the proceeding sugarcane crop.

MATERIALS AND METHODS

Two pot trials were established at the South African Sugarcane Research Institute, Mount Edgecombe, Durban. In the winter trial, planted in May 2007, six crops viz. barley (*Hordeum vulgare*), black oats (*Avena strigosa*), canola (*Brassica napus*), grazing vetch (*Vicia villosa* x *dasycarpa*), serradella (*Ornithopus sativus*) and wheat (*Triticum aestivum*) were evaluated. In the summer trial, planted in October 2007, seven crops viz. brachiaria (*Brachiaria humidicola*), buckwheat (*Fagopyrum esculentum*), dolichos beans (*Dolichos lablab*), desmodium (*Desmodium uncinatum*), melinis (*Melinis minutiflora*), sunn hemp (*Crotalaria juncea*) and velvet beans (*Mucuna deeringiana*) were evaluated. In both trials, the green manures were grown for 3 months after which half of the pots were destructively sampled for nematode analyses and the remaining half harvested and the green manure residue placed back on the soil surface after sugarcane was planted. Sampling for nematodes involved removing 500 ml of soil and 50 g of roots from which nematodes were extracted with the Seinhorst and mist chamber techniques respectively. Total aboveground dry weight biomass and soil cover were also determined. Nematode data was transformed to log (x+1) before statistical analyses (JMP version 5.0, SAS).

RESULTS

For both pot trials there were noticeable differences in nematode numbers between treatments. In the winter pot trial, serradella and black oats significantly reduced the total number of nematodes especially the number of *Paratrichodorus.* Grazing vetch had the opposite effect with a significant increase in total numbers. Black oats and wheat significantly reduced the number of ectoparasitic and endoparastic nematodes respectively in the soil. However, after replanting the pots to sugarcane, the differences between treatments became non-significant with only a few crops (barley, canola, serradella, wheat) exhibiting significantly greater numbers of *Xiphinema* compared to the control.

In the summer pot trial, dolichos and velvet beans significantly increased numbers of free-living and *Helicotylenchus* nematodes respectively as well as significantly increasing numbers of *Xiphinema* and total numbers of nematodes. Brachiaria significantly reduced numbers of endoparasitic nematodes in both the soil and roots. These pots have been replanted to sugarcane to see if the green manuring effect continues into the sugarcane crop.

Although barley (3.5 tons/ha), black oats (3.9 tons/ha) and wheat (4.5 tons/ha) produced a larger biomass, the serradella and grazing vetch covered more of the soil surface (>90%). For summer planting, brachiaria, dolichos and melinis covered more than 80% of the soil surface and brachiaria and melinis produced more than 10 tons dry matter/ha of aboveground biomass.

CONCLUSION

Fallowing fields between sugarcane cycles is an important part of the IPM strategy. However, choice of green manure crop is vital as each crop has different growth characteristics and different effects on pest populations.

Keywords: fallow, integrated pest management, plant parasitic nematodes

HIGH TEMPERATURE EFFECTS ON PHYSIOLOGY, GROWTH AND FLOWERING OF PROTEA CV. PINK ICE

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INTRODUCTION

Seasonal fluctuations in temperature as well as high temperature stress at any given phenological period strongly affect leaf gas exchange, growth, flowering and the timing of phenological shift in plants. The influence of environmental factors, such as temperature, on flower bud induction and development in commercial *Protea* cultivars is not known. In addition, temperatures are predicted to increase by 2-3°C in the Western Cape over the next 30-40 years. The objective of this study is to investigate the role of temperature during various phenological stages in *Protea* cv. Pink Ice, focusing on physiology (gas exchange and carbohydrate availability), growth and inflorescence development. This will enable producers to better predict (inter-annually and regionally) the flowering period, intensity and harvest period for more effective marketing, and allow adaptation to a warmer climate.

MATERIALS AND METHODS

Greenhouse-based warming experiment

A gradient of seven temperature levels was established in a glass-roofed open-sided greenhouse in Stellenbosch, ranging from ambient to ambient+3.6°C using infra-red lamps. Air temperature at plant height and soil temperature were monitored with TinyTag mini-dataloggers. The experiment started on 19 May 2008, using four drip-irrigated potted plants per temperature level. Leaf gas exchange was measured on eight leaves per temperature position and included light-saturated rate of net CO_2 assimilation (A_{max}), light- and CO_2-saturated rate of net CO_2 assimilation (A_{sat}), dark respiration rate (R_d), stomatal conductance (g_s) and transpiration rate (E) measured under ambient treatment temperature. The temperature optimum of CO_2 assimilation (T_{opt}) was measured on one leaf per temperature position. Bud growth was monitored regularly.

Field verification experiment

In a commercial 'Pink Ice' block on a farm outside Stellenbosch, two temperature treatments were established in June 2008 using infra-red lamps, ambient and ambient+2°C, with six plants per treatment. Gas exchange together with vegetative and reproductive growth were measured as above.

RESULTS AND DISCUSSION

'Pink Ice' showed seasonal acclimation of the optimum temperature for photosynthesis (T_{opt}), decreasing from autumn to winter and increasing in spring and summer, tracking ambient temperature changes. A_{max} and A_{sat} increased during spring from winter minimums, but decreased as summer heat set in. Stomatal conductance was constant during winter and spring but decreased into summer. Warming treatments had little effect on gas exchange during winter and early spring, apart from increased g_s and E during mid-winter. From late spring onwards, A_{max}, A_{sat}, g_s and E decreased with increased warming. Warming resulted in earlier budbreak ("green point") in spring in both the greenhouse and field experiments. Vegetative and reproductive growth rates were monitored. We conclude that warming in the cool season (winter) promotes physiological processes and budbreak, but warming in the warmer summer could be detrimental to gas exchange, carbohydrate availability and flowering.

Keywords: Climate change, gas exchange, heat stress, phenology, *Protea*, temperature

INFLUENCE OF TWO COVER CROPS ON THE GROWTH OF *Zea mays* AND *Cyperus esculentus* UNDER FIELD CONDITIONS

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INTRODUCTION

The challenge to crop production is increasing food production on smaller farming areas. Cover crops are being promoted as an alternative method for attaining sustainable food production by improving the soil characteristics and suppressing weed growth. *Secale cereale* (stooling rye) is one of the most widely used cover crops. However, little is known about the weed suppressive abilities of *Lolium multiflorum* (Italian ryegrass). *Cyperus esculentus* (yellow nutsedge) is ranked among the most notorious weeds in the world. Research indicates a 41% yield reduction in maize when no weed control was done on a field initially infested with 1200 shoots m^2. The objectives of the study were to measure the residual effects of Italian ryegrass and stooling rye on maize and yellow nutsedge growth, in particular the ability of the cover crops to control yellow nutsedge and the subsequent influence on crop yield.

MATERIAL AND METHODS

The four-year study was conducted at the Cedara, KwaZulu-Natal. Stooling rye cv. “Agri Blue”and Italian ryegrass cv. “Midmar” were planted in autumn and biomass samples were collected in October. A week thereafter, the cover crops were sprayed with glyphosate at 6 L/ha. Maize (PHB 32D99) was hand-planted at 40 000 seeds/ha during the first week of November. Emergence was recorded for a maximum of eight days. Two weeks after emergence, 45 maize seedlings were cut above the soil surface for dry weight determination. It was repeated four and six weeks after emergence. Plant height was recorded 17 weeks after emergence. Four maize rows were harvested for yield determination. Two, four and six weeks after maize emergence, *C. esculentus* samples were collected from six 0.09 m^2 quadrants and dry weight determined. Samples were collected in and between the maize rows. Treatments were replicated four times in a randomized block design. Mean separation was done with the Least Significant Difference Test at P=0.05.

RESULTS AND DISCUSSION

The control treatment, consisting only of weed residues, had a significantly lower average residue yield over the four seasons than the stooling rye and Italian ryegrass, while the average yield of the cover crops was similar. Italian ryegrass inhibited maize emergence significantly more than stooling rye, even though they had similar residue yields. Both cover crop residues inhibited the final maize germination percentage in comparison to the weed residues. At two weeks after maize emergence, Italian ryegrass residues between the maize rows significantly suppressed *Cyperus esculentus* growth compared to stooling rye residues, but the effect started to diminish after four weeks. Cover crop residues also had a negative influence on maize seedling weights after four weeks, as both the effects of the weed and the residues severely inhibited maize growth. After six weeks the stooling rye had a more suppressive effect on *C. esculentus* growth and a lesser effect on maize growth than did the Italian ryegrass. The early effect on maize growth was carried through to yield. No significant differences in yield between the control and stooling rye treatments were observed, but Italian ryegrass significantly reduced maize yield.

CONCLUSIONS

The amount of residue on the soil surface is not the main determining factor in suppression of *C. esculentus* or maize growth, but rather the type of cover crop residue. Italian ryegrass had the biggest potential to suppress early growth of the weed but it had a negative effect on maize growth. Stooling rye had a lesser impact on maize growth, while still suppressing the growth of the weed.

Keywords: Weed management, Cover crops

THE IMPORTANCE OF MAINTAINING THE COLD CHAIN TO AVOCADO RIPENING AND QUALITY

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INTRODUCTION

Successful storage of avocados requires the earliest possible removal of field heat and maintaining temperature throughout storage. The Perishable Products Export Control Board (PPECB) has recommendations and guidelines available for the handling of avocados due for export to minimize increases in pulp temperature. These documents stress the importance of fast removal of field heat and minimising delays in transport and transfers, and conclude that the postharvest age of fruit and the product temperature are the most important determining factors in fruit market quality. Inadequate temperature management is common in the South African avocado industry and is costing growers money and reducing fruit quality. It is also possible that controlled atmosphere and 1-MCP treatments may be avoided with better cold chain management.

Recently it was showen in Chilean work that breaking the cold chain reduces avocado quality by increasing transpiration and thereby mass loss. Breaking the cold chain near the end of storage resulted in the fruit entering the ripening process (softening and changing colour). Other experiments storing fruit at 1°C (and even -0.5°C) resulted in higher quality than fruit stored at 5.5°C. These ultralow storage temperatures may mitigate some of the effects of cold chain breakage as the pulp temperature will remain below critical levels longer than fruit stored at the conventional 5.5°C.

This study aims to compare the effect of storage temperature and the effect of breaking the cold chain at various points in a simulated shipping trial.

MATERIALS AND METHODS

Fruit were sourced from Everdon Estate (KwaZulu-Natal Midlands) and stored using two temperature regimes with 10 fruit per treatment and each fruit as a replicate. Fruit were picked on 2nd and 22nd of July and the 11th of August. The cold chain was broken at 1, 7, 14 and 21 days after packing. Carbon dioxide, ethylene, firmness and appearance were monitored until ripeness at ambient temperature after 28 days storage.

RESULTS AND DISCUSSION

Fruit only showed significant differences in the physiological parameters on the first day after removal from cold storage, but fruit quality was severely affected by breaking the cold chain. Storage temperature also had a significant effect on fruit quality. Storage at 5.5°C resulted in only having between 8 and 30% sound fruit while storing fruit at 1°C resulted in an increase in the percentage of sound fruit to 80% for the control. Breaking the cold chain anywhere in the shipping process severely reduced fruit quality. This was mitigated by storing fruit at 1°C, but it is imperative to maintain the cold chain from the packhouse to the shipment's final destination.

CONCLUSION

Breaking the cold chain is known to be detrimental to fruit quality and this has been shown to be true for avocados. Although fruit recover physiologically in terms of respiration and ethylene evolution, quality is severely affected. Breaking the cold chain results in severe shrivel and a large proportion of unmarketable fruit. Reducing storage temperature from 5.5°C to 1°C can buffer fruit from breaking the cold chain. It is once again stressed that maintaining the cold chain is crucial in delivering quality fruit to export markets.

Keywords: Cold Chain, fruit quality, ultralow storage

EVALUATING THE AGRONOMIC SUSTAINABILITY OF THE IN-FIELD RAINWATER HARVESTING TECHNIQUE ON VARIOUS ECOTOPES

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INTRODUCTION

Subsistence farmers occupy a large area east of Bloemfontein around Thaba Nchu. They do not have food security because the area is marginal for crop production. There are three reasons for this: (a) low and erratic rainfall that amounts to a mean of 543 mm per annum; (b) a corresponding high evaporative demand of 2198 mm per annum; and (c) dominantly duplex and clay soils on which rainwater productivity (RWP) is low due to high ex-field runoff (R_{ex}) and evaporation (Es) losses. It was hypothesized that the in-field rainwater harvesting (IRWH) technique could improve crop yields compared to conventional tillage (CT) on various ecotopes.

MATERIALS AND METHODS

To test the hypothesis, field experiments were conducted during the period 1996/1997 to 2002/2003 on the Glen/Bonheim (45% clay in A horizon), Glen/Swartland (38% clay in A horizon), Khumo/Swartland (17% clay in A horizon), Vlakspruit/Arcadia (42% clay in A horizon), Sepané 7/Oakleaf (42% clay in A horizon) and Willow Park/Katspruit (30% clay in A horizon) ecotopes. Agronomic productivity was measured by maize and sunflower seed yields obtained from on-station and on-farm experiments. The treatments were CT; IRWH with a bare basin and bare runoff area (BbBr); and IRWH with organic mulch in the basins and a bare runoff area (ObBr). Grain yield for maize and sunflower was determined. RWP was calculated with the equation of Botha (2006). Transpiration (Ev) was determined with the procedure proposed by Tanner & Sinclair (1983). R_{ex} was measured with automatic tipping bucket runoff meters on the Glen/Bonheim and Glen/Swartland ecotopes and estimated using a prediction equation from Hensley *et al*. (2000) for the other ecotopes.

RESULTS AND DISCUSSION

The mean grain yields over the seasons for CT and the mean of the two IRWH treatments were 1297 and 2428 kg ha^{-1}, respectively for maize and 1270 and 1893 kg ha^{-1}, respectively for sunflower. RESULTS showed that IRWH significantly increased maize and sunflower yields compared to CT. This was found to be due to the ability of IRWH to stop R_{Ex} completely; enhance in-field runoff (R_{In}) and its resulting beneficial redistribution of water in the soil profile; minimize Es/ET, and contribute towards higher transpiration. The IRWH techniques were 82% more efficient than CT at converting rainwater into seed yield. Both yield and RWP results showed that IRWH stabilizes crop production, compared to CT. There was a consistent trend in yield and RWP *viz. ObBr > BbBr > CT over the seasons.* . ObBr > BbBr > CT over the seasons.

CONCLUSION

It can be concluded that IRWH was more agronomically sustainable than CT on the six ecotopes tested. The IRWH technique is therefore recommended to be used by subsistence farmers around Thaba Nchu.

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Keywords: water use efficiency, in-field rainwater harvesting, maize, sunflower

PREDICTION OF FERMENTABLE STARCH CONTENT BY NEAR-INFRARED SPECTROSCOPY

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INTRODUCTION

Measuring the starch content of corn allows ethanol plants to know how much ethanol can be produced from a specific lot of corn. The developments of quick and easy starch measurement methods are important in maximizing the ethanol yield of corn. Measurement of starch content in corn has been done through several laboratory procedures. Fermentable starch best indicates the amount of ethanol produced by the dry-grind method. Conventional laboratory fermentable starch measurement can take hours to days to complete. Near-infrared spectroscopy (NIRS) is a rapid nondestructive technique that is able to measure organic substances in minutes. NIRS could be useful in predicting the amount of fermentable starch in corn samples.

MATERIALS AND METHODS

Near infrared (NIR) spectra from a FOSS Infratec 1229 Grain Analyzer (FOSS Group, www.foss.dk) was obtained for 249 corn samples. Laboratory fermentable starch measurements from the Illinois Crop Improvement Association were also obtained from the 249 corn samples and were used as the reference data. A fermentable starch partial least squares (PLS) calibration relating fermentable starch content to NIR spectra was developed. A multiple linear regression (MLR) including combinations of current NIR measurements (protein, oil, starch and density) was also used to predict fermentable starch content. Leave-one-out, full cross validation was used to validate the calibration models. The first external validation was conducted using 26 samples representing a wide range of composition. Calculations involving the models, PLS, and MLR were obtained using The Unscrambler 9.7 (CAMO Inc., www.camo.com).

RESULTS AND DISCUSSION

The current NIR calibration factors produced similar validation statistics (based on the R^2 -coefficient of determinationand the SECV -standard error of cross validation) as the new NIR calibration for fermentable starch. The NIR calibration for fermentable starch had a R^2 of 0.863 and a SECV of 0.025, while the MLR for the combination oil, starch, and density had a R^2 of 0.795 and a SECV of 0.030. All combinations for MLR analysis (protein, oil, starch, and density) had similar results for SECV and R^2.

The PLS calibration had poor results in predicting corn ethanol yield from the 26 external validation samples, with an SEP=0.40 and a R^2=0.28. The MLR component model gave consistent results to calibration cross validation. The best combination in validation was protein and starch with an SEP=0.044 and a R^2= 0.88.

CONCLUSIONS

A PLS based fermentable starch calibration for Infratec NIRS units was developed using ethanol yield reference data from Illinois Crop Improvement Association. MLR analysis with predicted values of oil, starch and density to predict ethanol yield resulted in similar validation statistics to the new PLS calibration. The PLS model was slightly more precise, but the MLR model may be more practical for actual use. The constituent calculation performed better than the spectra calibration in validation. Implementing a constituent calculation is easier and more economical than implementing a new NIRS calibration, for similar SECV's. Any NIRS unit can use constituent regression.

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Keywords: Corn, quality , near-infrared spectroscopy, ethanol

PHENOLOGY AND POTENTIAL SEED PRODUCTION OF JACKET PLUM (*Pappea capensis* ECKL. & ZEYH.)

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INTRODUCTION

Pappea capensis Eckl. & Zeyh. is found across Southern Africa in different habitats except forests. Trees found in arid and semi-arid areas are usually multi-stemmed, up to four meters high and evergreen. In areas of high rainfall they are semi-deciduous and grow up to nine meters tall. Flowers are either male or female and although most references state that trees are dioecious, the trees are indeed monoecious (Fivaz & Robbertse, 1993). As the seeds contain about 70 % oil this tree could be a source of oil for potential bio-diesel production. The trees have not yet been grown commercially with the result that very little is known about tree phenology and seed production. In this study tree distribution, tree phenology and seed production were studied to gain information that can be applied in commercial tree propagation and seed production.

MATERIALS AND METHODS

A distribution map of *P. capensis* (South Africa) based on herbarium specimens collected over a period of 120 years was obtained. According to the map it was possible to distinguish five, more or less discontinuous locations excluding Swaziland. Information on the reproductive stages was collected from the literature. From the different herbaria, information about location, collection date, flowering (male and female) and fruiting times were collected from herbarium specimens. This information was used to compile phenograms for each of the five localities.

The canopy size of seven trees in the Steytlerville Karoo, Eastern Cape was calculated using the formula $4\pi r^2/2$. The number of fruit per square meter were counted, harvested, dried and weighed to provide yield estimates per tree.

RESULTS AND DISCUSSION

The compiled phenograms indicate that the trees can start flowering in September to May and fruiting occurs from December to July. Flowering does not seem to relate directly to rainfall or temperature. In tropical fruit trees like mango, avocado and litchi, flowers are produced on the youngest mature flushes. *P. capensis* probably shows the same tendency whereby semi-deciduous trees in the Northern locality flower in autumn on shoots from the spring flush while in southern localities trees flower in spring on the mature autumn flush. Seed production depends on canopy size and varied between eight to 90 kg per tree. It can be extrapolated that in orchards with 400 trees/ hectare, a yield of five to 10 ton per hectare is achievable.

CONCLUSIONS

P. capensis has a wide distribution in South Africa and time of flowering varies among populations. Rainfall and temperature do not seem to have a direct effect on flowering time, but it is more likely that flowering occurs only on young mature flushes and the time of flushing varies among different populations in specific climatic areas. Commercial orchard seed production should therefore be a viable option.

ACKNOWLEDGMENTS

Thank you to the National Research Foundation for funding this project, to the South African Weather Services for their help with extracting the requested climate data for the different locations, and the National Herbarium in Pretoria.

Keywords: Monoecious, dioecious, phenograms, yield

INCREASING AGRICULTURAL WATER USE EFFICIENCY BY SECONDARY CONSUMPTION OF THE DRAINAGE WATER

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INTRODUCTION

Scarcity of water and fertile land is the major restriction for agricultural production in the Arava desert of Israel. Soilless cultivation methods reduced the demands for arable land and opened new opportunities for the monitoring and control of the irrigation water. Founded on the steadily declining local resources of brackish water (2-3 dS/m), the present challenge of the growing sweet pepper industry is to significantly increase the agricultural water use efficiency. Whereas water recycling systems turned out to be too expensive and exigent, the reuse of the drained water in a secondary, less sophisticated, cropping system seemed more feasible. Our objectives were: 1. to examine water-saving opportunities opened by the new concept during periods of maximum plant water demands; 2. to test plant performance in the soilless, as well as in the conventional soil culture.

MATERIALS AND METHODS

Two model farms were established on a commercial scale in Paran, in the central Arava Valley. In each pilot venture, a 2.5 ha area has been divided into two parts: about 20% is used for sheltered soilless cultivation, the drainage water of which is hoarded and reused to irrigate the rest of the area. The soilless culture comprised of packages 40 cm wide and 20 cm deep containing volcanic ash (0-8mm) with 25% (v/v) compost. The drainage water was collected in an intermediary underground reservoir, from which the water was pumped to a 120 m^3 reservoir used to irrigate a 2 ha field of conventional sweet pepper crop on native soils. Environmental and physiological data were recorded continuously using a "Phytech" monitoring system. Here we present results from one farm in the 2006/7 season.

RESULTS AND DISCUSSION

Sweet pepper (cv. 7182) was planted on Aug. 14, 2006 and grown for 165 days, during which 285 mm of water was utilized for irrigation, thus saving 499mm per season. The water saving was mostly significant during the first month – about 70%. Following the removal of the shading nets and during days 37-62 from planting, during the rapid phase of plant growth and the major period of fruit set, water demands increased dramatically. Despite this, a 30% water saving was recorded during that period. Following this phase, the water demands declined gradually and the rates of water saving increased again to a level of 60-75% of the available water quotas. The fruit yields were 12.2 and 8.5 kg/m^2, in the soilless and the native soil, respectively.

The water reuse system was highly effective during the first month of the pepper season, when a 70% water and fertilizer saving was obtained. During the major growth season, the water demands were very high and the rates of water saving were reduced to about 33%. Still, the significance of the water saving during this stage of the crop development is the flexibility given to the farmer to wisely allocate the available water among fields in order to open "bottle-necks" and to leach the excess salts that accumulate in the rhizosphere due to the insufficient water quotas. The water-saving rates increased again to considerable levels throughout the rest of the season. The nature of the cultivation system that reuses the water is highly relevant to the effectiveness of the water saving as well as to the yield levels obtained.

CONCLUSIONS

More than 60% water savings can be made by reusing draining irrigation water. Although costly, the approach of integrated systems that reuses water seems especially attractive where water availability is extremely low. Beyond the higher agricultural water use efficiency obtained, this way of water sharing may diminish local and regional conflicts about water.

Keywords: brackish water, Capsicum annuum, irrigation, soilless culture, water reuse

ACCUMULATION OF SUCROSE, GLUCOSE AND FRUCTOSE IN THE FLAVEDO IS INFLUENCED BY POSITION IN THE 'NULES CLEMENTINE' MANDARIN CANOPY

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INTRODUCTION

Photosynthesis provides the required carbohydrates for fruit development, while respiration releases the stored energy from these carbon compounds during postharvest storage. It is therefore important that fruit structures have adequate carbohydrate content at the start of the postharvest period. In addition to the supply from the leaves, the citrus fruit rind (flavedo and albedo) has the ability to accumulate carbohydrates via its own photosynthetic system in the chlorophyll containing flavedo.

MATERIALS AND METHODS

In this experiment, during 2004 – 2007, the three main sugars (sucrose, glucose and fructose) were determined in the flavedo of 'Nules Clementine' mandarin (*Citrus reticulata* Blanco.) fruit during stages II and III of development. The flavedo sampled was from the inside (low light) or outside (high light) fruit of the tree canopy. During 2007, the photosynthetic and respiration rates of fruit belonging to either of these two light classes were measured pre- and post-colour break.

RESULTS AND DISCUSSION

The results indicate a constant rate of increase in sucrose content until harvest, whereas the glucose and fructose increased sharply only in the last month of fruit development. The flavedo that had developed in the low light (inside fruit) was less well coloured (higher Hue°), and h ad reduced carbohydrate content compared to the flavedo developing in high light conditions (outside fruit).

CONCLUSION

This could possibly be attributed to the higher photosynthetic rate of the outside fruit. Increased susceptibility to postharvest physiological disorders of "inside flavedo" could be the result of the lower carbohydrate content compared to the "outside flavedo".

Keywords: citrus, carbohydrates, light

OXIDATIVE BREAKDOWN OF ACID AZO DYES BY MN OXIDES

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INTRODUCTION

Azo dyes are problematic contaminants in many soils and waters. Azo dye contamination emanates from textile, tannery, food and printing industries. Apart from the aesthetic problems associated with azo dye contamination many of these dye compounds are carcinogenic and pose a risk to human and ecosystem health. Many biotreatment technologies achieve the reductive cleavage of the azo bond, which generates a range of aromatic amines that are colourless but significantly more carcinogenic than the parent azo compound. Advanced oxidative techniques have been successfully employed to degrade azo dyes. However, these techniques are often expensive and unsuitable for soil remediation, thus the development of an oxidative soil and water treatment technique utilising a Mn oxide mining waste is appealing.

MATERIALS AND METHODS

Mn mining waste was reacted with a model azo dye, acid orange 7 (AO 7), under a range of chemical conditions commonly present in textile effluent. The reaction mechanism was established using a number of analytical techniques including UV-visible spectroscopy, liquid chromatography, mass spectrometry and high pressure liquid chromatography. Reaction rates and orders were established using an initial rate method. Real-time *in situ* observation of AO 7 oxidation on a Mn oxide surface was achieved using attenuated total reflectance Fourier transform infrared (ATR-FTIR) spectroscopy.

RESULTS AND DISCUSSION

The oxidative breakdown of AO 7 by the Mn oxide containing waste is inversely proportional to pH. The reaction is initiated on the phenolic moiety of the dye and proceeds via successive one electron transfers from the dye to the oxide surface. The terminal reaction products observed after the reaction of AO 7 with the Mn waste were 1,2 naphthoquinone and 4-hydroxybenzenesulfonate. The ATR-FTIR investigation demonstrated that initial sorption of AO 7 is pH dependent and outer-sphere. A pronounced lag phase exists between the initial sorption of the dye to a Mn oxide surface and the initiation of oxidation. This lag phase can indicate that either the transfer of the initial electron is rate limiting or that correct orientation followed by inner-sphere complexation is necessary before oxidation can take place. The observed surface controlled reaction was supported by a *pseudo* fractional rate order with respect to AO 7 concentration.

Dye oxidation by the Mn waste was not influenced by light. Increasing acetate buffer strength and Na_2SO_4 concentration enhanced the oxidation of AO 7 by the Mn waste. The oxidizing capacity of the waste is long lasting with dye oxidation observed 60 days after continual dye replenishment.

CONCLUSIONS

The results from this investigation demonstrate that the Mn oxide containing mine waste oxidatively breaks down the model azo dye AO 7. This suggests that the Mn mine waste may provide a suitable soil and water remediation technology for dye polluted soils and waters.

ACKNOWLEDGEMENTS

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Keywords: manganite, mine tailings, organic pollutants, kinetics

THE IMPACT OF COPPER OXYCHLORIDE CONTAMINATION ON MICROBIAL COMMUNITIES IN ACIDIC SANDY LOAM SOILS

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INTRODUCTION

Copper oxychloride is applied annually to vineyards as a fungicide to control a significant number of plant diseases. Some of this copper (Cu) ends up in vineyard soil, and if present, in the adjacent pristine natural vegetation. In many cases these soils are slightly acidic, making Cu more mobile and bio-available than in alkaline soils. The accumulation of Cu results in changes in soil microbial community composition and diversity. These changes in soil microbial diversity may impact on the capacity of agricultural land to remain productive.

MATERIALS AND METHODS

A study was carried out to determine the response of different microbial parameters to copper oxychloride in acidic sandy loam soil (average pH of 5.2). The soil that was used to prepare five series of microcosms was collected from three different wine farms near Stellenbosch and Somerset West in the Western Cape. The series were prepared as follows: Series I, uncultivated soil obtained from Nietvoorbij Research Farm (Stellenbosch) on which natural fynbos vegetation was removed 20 years earlier resulting in the growth of various indigenous grasses; Series II, potting soil prepared from the same soil as Series I by adding sterile sand; Series III, soil obtained from a two-year-old vineyard on a commercial wine farm near Stellenbosch; Series IV, virgin soil originating from the same farm as Series III, but collected beneath typical indigenous fynbos vegetation; Series V, soil originating from a 17-year-old vineyard on a commercial wine farm near Somerset West. The first series of soil microcosms was prepared from Series I by adding nine different amounts of copper oxychloride to each of nine sub-samples of soil at the following concentrations: 0, 10, 20, 30, 40, 50 100, 500 and 1000 mg/kg Cu. Each of these nine soil + Cu treatments was subdivided into triplicate microcosms in polythene bags, each containing *ca.* 2 kg of soil, equivalent to a soil column, 10 cm in diameter and 20 cm in height. Microcosms prepared from Series II - V were similar to the first series, but received fewer treatments (0, 30, 100, and 1000 mg/kg Cu). Sterile distilled water was added to each of the microcosms to establish a soil moisture content of 15% (v/w). Thereafter 200 ml water was added to each microcosm every 2 weeks. Culturable microbial populations, whole community metabolic profiles and protozoan numbers were monitored periodically for 245 days in the various microcosms.

RESULTS AND DISCUSSION

Microbial populations responded differently to the applied copper (Cu). Number of protozoa and metabolic potentials of the soil microbial communities decreased. Metabolic potentials of the soil microbial communities was not significantly affected by ≤100 mg kg^{-1} additional Cu. In contrast, a negative impact on protozoa was observed in soil that contained only 15 mg Cu kg^{-1}. This negative impact on numbers of protozoa was less severe in soils containing raised concentrations of phosphorus and zinc.

CONCLUSIONS

The accumulation of Cu in soil may have detrimental effects on agriculture if it is not closely monitored. Of the microorganisms investigated protozoa were found to be most sensitive to elevated Cu levels. The pivotal role of protozoa in the mineralization process, and the negative impact of relatively low Cu concentrations on the populations of these microbes in soil, suggest that soil processes in these soils may be negatively affected at much lower levels of Cu than is commonly believed.

Keywords: copper oxychloride, metabolic potential, microbial community, protozoa

WHEAT KERNEL HARDNESS DETERMINED BY NEAR INFRARED HYPERSPECTRAL IMAGING

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INTRODUCTION

Near infrared (NIR) spectroscopy is a single point spectroscopic method where the NIR region (700–2500 nm) of the electromagnetic spectrum is utilised (Miller, 2001). NIR hyperspectral imaging a cutting edge technique which provides a chemical map of the sample imaged. Thus the chemical information and distribution of chemical components are both captured in one image (Grahn & Geladi, 2007).

Wheat kernel hardness is a physical characteristic of wheat that influences the conditioning process of the wheat, flour yield and particle size of the flour, the shape and size of the flour particles, and ultimately the end use properties of the flour. Most methods used to determine wheat hardness are based on sieving, grinding resistance, virtreousness and near infrared methods dependent on flour particle size (Osborne, 1991).

A rapid, non-destructive method, i.e. near infrared (NIR) hyperspectral imaging was evaluated to determine hardness of whole wheat kernels of different hardness (soft, bread, durum).

MATERIALS AND METHODS

Six sets of eight whole wheat kernels were randomly selected from three different hardness classes (durum, bread and biscuit wheat). Images of the wheat kernels were acquired on SiC sandpaper, at room temperature using a Spectral Dimensions MatrixNIR camera (Malvern Instruments LTD., UK). The spectral range varied from 960 to 1662 nm.

Image data were transformed to absorbance values in ISys v.4.0 software (Malvern Instruments Ltd., UK). Principal component analysis (PCA) with three principal components (PCs) were used to identify and remove unwanted regions (background, shading, dead pixels, specular reflection) in the image; this analysis were performed in Evince v.2.0.18 software (UmBio AB, Umeå, Sweden). Additional PCs were calculated, and the images were further subjected to exploratory interactive multivariate analysis (Evince v.2.0.18) using PCA.

Partial least squares-discriminant analysis (PLS-DA) was performed to determine the possibility of predicting endosperm hardness from a NIR hyperspectral image.

RESULTS AND DISCUSSION

PC loading line plots were studied, together with assigned absorbance peak values. The loading line plot of the cleaned image had the shape of a typical average spectrum of wheat, suggesting that it does not contain any useful chemical information regarding the difference in endosperm hardness. Score plots of PC2 vs PC3 showed three distinct clusters that were assigned to the three classes namely soft, bread, and durum endosperm. Variation in PC2 was attributed to starch and moisture for soft and bread endosperm, and starch, moisture and protein for durum endosperm. Variation in PC3 and PC4 was attributed to starch for all types of endosperm.

Two PLS components were adequate to model 91% of the variation in Y modelled in durum and soft endosperm; 77% of the variation in Y modelled in bread and soft endosperm; while three PLS components were adequate to model 67% of the variation in Y modelled in bread and durum endosperm.

CONCLUSION

PCA was found to be an effective tool for data exploration, as well as identification and classification of clusters of different wheat hardness. PC2 separated between soft and bread-durum endosperm, while PC3 separated between durum and bread-soft endosperm. The largest variation could be explained in PC2: this was also apparent in the PLS-DA results.

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Keywords: Near infrared hyperspectral imaging, wheat hardness

SYNERGY OF PARAQUAT WITH GLUFOSINATE AMMONIUM AND TERBUTHYLAZINE IN THE CONTROL OF PARAQUAT-RESISTANT RYEGRASS (*Lolium* SPP.)

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INTRODUCTION

Non-selective herbicides such as paraquat and glyphosate have been widely used in orchards and vineyards in the Western Cape for many years. Resistance of ryegrass (*Lolium rigidum*) to glyphosate and paraquat in the Western Cape was reported during 2001 and 2002 respectively.
The aim of this study was to restore paraquat's efficacy in biotypes showing resistance to the herbicide.

MATERIALS AND METHODS

All trials described below were conducted in pots under controlled environment conditions at the University of Stellenbosch. The herbicides were applied with a pneumatically driven pot spraying apparatus. Plants were sprayed at the 4 to 5 leaf stage at a rate of 400L ha^{-1}. The adjuvants Agral 90® and $(NH4)_2SO_4$ were used. ^{14}C Paraquat was used to monitor movement of the herbicide in the plant as determined by a phosphor imager.

RESULTS

The pre-treatment of ryegrass with glufosinate ammonium overcame paraquat resistance. When paraquat and glufosinate ammonium were applied as a tank mix, the addition of an adjuvant became more important. The results show that although tank mixes with suitable adjuvants are effective there is a fairly long time frame in which split applications can successfully be made. Significantly better results were achieved when paraquat and glufosinate ammonium were combined with terbuthylazine.

Phosphor images taken 24h after the ^{14}C paraquat was applied show clearly that both acropetal and basipetal movement of the herbicide in the leaf occurred freely in the leaves of susceptible biotypes. Similar images of the paraquat movement in the resistant biotype show that the herbicide hardly moved from the spot where it was applied to the leaf.
The addition of glufosinate ammonium to paraquat made little difference to the movement of paraquat during the first 24 h period after treatment but after 48 h the combination of the two products led to a significant increase in the acropetalous movement of paraquat in the resistant plants.

DISCUSSION

Paraquat, terbuthylazine and glufosinate ammonium, all have different modes of action but all three herbicides ultimately lead to an inhibition of photosynthesis. This reduction in photosynthesis enhanced the efficacy of paraquat in resistant ryegrass by improving translocation of the product. Precisely how this is brought about is not yet known but inhibition of photosynthesis leads to a lower energy level in the plant. This in turn could thwart the mechanism used by resistant plants to sequester paraquat or render the sequestered state unstable.

CONCLUSION

This study demonstrates conclusively that the movement of paraquat in plants is an essential step in determining its herbicidal efficacy. The identification of the mechanism conferring resistance to paraquat as well as the means to overcome this trait provides incontrovertible proof that the accepted hypothesis, viz. that paraquat is an exclusively contact herbicide, is no longer valid. This indeed is a sad reflection on our state of knowledge of a herbicide discovered more than half a century ago and emphasizes the need for ongoing basic research into herbicide mode of action and resistance mechanisms.

Keywords: paraquat, terbuthylazine, glufosinate ammonium, resistance, ryegrass

PREDICTIVE CAPABILITY AND COST EFFECTIVENESS OF DIFFERENT SURVEY INTENSITIES FOR DETAIL SOIL MAPPING. A CASE STUDY FROM THE WESTERN CAPE

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INTRODUCTION

The demand for better quality high-income perennial crops for the local and export markets (e.g. vines and fruit) adapted to the climatic conditions of the Western Cape, necessitates that planning at block level is done properly. A detail soil survey is therefore the first step for such planning. Detail soil surveys, however, are becoming increasingly more costly and clients might want to save on survey costs by reducing the survey intensity. In this paper a detail soil survey was used as a case study to try to determine the most cost effective survey intensity that still ensure quality soils information.

MATERIAL AND METHODS

Detail soil survey information of a 37 ha farm along the Theewaterskloof dam, Villiersdorp, using GIS technology, were used to make conclusions about map predictability capabilities and survey cost effectiveness. A total of 147 profile pits were made on a grid layout of 50 m x 50 m (400 observations per 100 ha). The soils were described and classified according to the South African soil classification system. A map legend (representing soils classified to the phase level and which formed the bases for demarcation of the map units) was developed based on soil property variations that might have an effect on agricultural land potential, soil suitability, amelioration measures and potential land use. An originally hand-drawn soil map was subsequently digitized using GIS Arc View. Three additional soil maps, using the same profile data but eliminating in a systematic manner one, two or three profiles, were drawn and digitized to represent map equivalents of 200, 100 and 50 observations per 100 ha respectively. The four maps produced were used to determine the number of map units, boundary lengths and polygon size.

RESULTS AND DISCUSSION

As expected, most polygons, representing soil map units, occur on the 400obs/100ha soil map, with increasingly less on the 200obs/ha and 100obs/100ha. Compared to the 400obs/100ha, only 40% of the original number of map units was demarcated on the 50obs/100ha. Following the same trend, although not to the same degree, the number of soil forms identified dropped with 40% on the 50obs/100ha, compared to the 400obs/100ha. Individual map units, calculated for a 100 ha area, had the smallest size for the 400obs/100ha, increasing almost linearly, becoming almost 3 times larger in the 50obs/100ha. Tukulu form soil, best suitable soils for perennial crop production on the farm and Estcourt form soil, one of least suitability, were used to determine the effect on number of map units (therefore interpretation capability) at the various map intensities. Four map units were identified for 400obs/100ha, in both Tukulu and Estcourt soils, but these dropped to three and two respectively for the 50obs/100ha. Total cost per single observation was determined to be the cheapest for the 400obs/100ha, with 50 obs/100ha the most expensive (about 1.4 times higher). Assuming that smaller map units are more accurate for interpretation purposes, the best map information at the lowest observation cost (i.e. best value for money) was the 400obs/100ha. The 200obs/100ha worked out to be a very practical alternative, giving good information at a reasonable cost. The 100obs/100ha may be a second alternative but too much detail information is lost at 50obs/100ha to make it a “value for money” survey technique.

ACKNOWLEDGEMENTS

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A.F. Ellis for GIS analyst work.

Keywords: detail soil survey, soil survey predictability, soil map unit

AN ATTEMPT TO QUANTIFY SOIL CONDITIONS THAT MAY PLAY A ROLE IN WATER CONTAMINATION FROM CEMETERY LEACHATE. EXAMPLES FROM THE WESTERN CAPE

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INTRODUCTION

Rapid expansion of cemeteries in certain areas has caused concern about the possibility of releasing hazardous chemicals/disease organisms into the surroundings. Media reports mentioned that present wood coffins that are commonly used are so thin that it can hardly prevent leakage before burial occurs. In the soil, corpses are also subject to various sets of decomposition processes principally resulting from aerobic or anaerobic conditions. The presence of percolating groundwater and microorganisms further affects the rate of breakdown and fate of the products. This study attempts, by using soil classification, hydrology and terrain parameters, to quantify conditions that may play a role in contamination from cemetery leachate.

MATERIAL AND METHODS

Twenty-three cemeteries, stretching from the Cape Peninsula to the Overberg and Boland regions were investigated. Soils were described and classified according to the South African soil classification system. Slope aspect and possible occurrence of an aquifer were determined and distance to nearest steam or river was measured. The hydrological flow path in the soil solum was determined using soil forms as basis. Soil wetness was estimated by the method currently in use in the Western Cape. Soil and terrain factors were used in a parametric approach to try to qualify the risk of contamination of soil and streams or aquifers from hazardous effluents. Firstly, soils were grouped into recharge (dominantly vertical flow of water), interflow (lateral movement) or saturated soils according to the pedo-hydrological model suggested by Van Huyssteen *et al* (2008) and a parametric weighting given to each profile. Similar weightings were given for factors that might influence throughflow of ions and contaminants such as aspect, expected depth and duration of soil wetness and soil texture. Values of the two soil factors (i.e. wetness and texture) were summarized and then multiplied by the values allocated for the hydrological model and the aspect value to derive at a so-called soil contaminated index where the lowest values represent soils where low contamination can be expected. By dividing this index value with the distance to nearest steam or aquifer, an ecological hazard figure was calculated.

RESULTS AND DISCUSSION

Nine out of the twenty-three cemeteries visited appear to have soils (mainly Oakleaf or Constantia form soils) that might be considered to have a low (index <50) risk of contaminating the surrounding area or the aquifer below. Six were given a very high (>400) contamination rating (mainly Kroonstad or Dundee form soils) and serious consideration should be given to the handling of corpses to prevent direct leakage from coffins if these areas are to be used in future. The ecological hazard index also indicated that some cemeteries pose a thread to possible contamination of nearby streams or to the aquifer while others can be regarded as “safe”. Further research is also urgently needed to determine any contaminants in soil and water surrounding possible pollutant cemeteries. Observations made during the survey also revealed that in some cemeteries latest burial practices (e.g. too shallow) will further increase contamination of soil and water sources in future.

Reference

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Deliverable 5. WRC Project K5/1748

Keywords: Cemetary leachate, soil contamination

COMPARATIVE RESPONSE TO NITROGEN RATE OF DIRECTLY SEEDED AND TRANSPLANTED MAIZE

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INTRODUCTION

Monitoring studies carried out in Zanyokwe irrigation scheme in the Eastern Cape showed that the average maize grain yields achieved by farmers was 2.4 t ha^{-1}. The low maize grain yields were partly attributed to poor management of fertiliser and low crop stands. Farmers in Zanyokwe are more interested in green rather than grain maize for production as this offers better returns compared to grain maize. Transplanting is a strategy that is used by some commercial farmers for green maize production in South Africa. Birds feeding on emerging maize seedlings are a serious problem in Zanyokwe and many other parts of South Africa. With green maize production, good stand establishment becomes very critical since the price is charged per cob, and transplanting can help in this respect. The objective of the study was to determine maize yield response to nitrogen (N) rate with direct seeding and transplanting.

MATERIALS AND METHODS

The trial was planted on-farm at three farmers' fields in the Zanyokwe irrigation scheme. The treatments were N rate (0, 60, 120, 180, 220 and 300 kg N ha^{-1}) and establishment method (direct seeding and transplanting). The experiment was laid out as a 2 x 6 factorial in a randomised complete block design with three replicates. The target population was 41 152 plants ha^{-1}. Irrigation water was applied using the sprinkler system and the amount applied varied with rainfall received as well as crop growth stage. Analysis of variance was performed on crop stand, days to 50% flowering and milk stage, and on cob length, green and grain yield.

RESULTS AND DISCUSSION

Transplanting resulted in significantly higher crop stand of 99% compared to direct seeding which achieved 81%. The reduction in crop stand with direct seeding was as a result of birds which fed on the emerging seedlings. Improved crop stand with use of transplants would translate to more cobs per unit area and higher grain yield, and hence more profit. Transplanted maize developed more rapidly, reaching flowering stage 10 to 23 days earlier than direct-seeded maize. This means that transplanting can result in more timely operations and better resource use by eliminating the need to replant or gap fill; operations which would require additional resources. There was no significant difference between 220 and 300 kg N ha^{-1} with direct-seeding and between 180, 220 and 300 kg N ha^{-1} with transplanted maize. Given that irrigated agriculture is the largest single user of water in South Africa, an important aspect of irrigation water management in crop production should be to increase water use efficiency. More rapid growth at higher N rates and/or with transplanting would contribute to improved water use efficiency resulting from both shorter crop duration and higher yields. At low N rates, transplants yielded higher green cob weight, grain yield and longer cobs than direct seeded maize, but fertilisation at 300 kg N ha^{-1} resulted in similar yield. The minimum N rate required for the production of a marketable cob was 149 kg N/ha with direct seeding and 98 kg N ha^{-1} with transplanting. Regardless of establishment method, the grain yield obtainable at the highest N rate of 300 kg N ha^{-1} was 11.1 t ha^{-1}. The results indicate that N rate could be reduced by as much as one third and still obtain marketable cobs if seedlings are used instead of seeds. This may be an answer to smallholder farmers who commonly apply low N rates to their maize crop.

CONCLUSIONS

Transplanting can help in achieving a good plant stand which would translate to more green cobs and higher grain yields. It can also improve on water use efficiency by reducing the amount of irrigation water application due to shorter crop duration in the field. Fertilisation at 220 to 300 kg N ha^{-1} resulted in similar crop growth rates regardless of establishment method. Transplanted maize can be grown at lower N rates but still achieve similar yield potentials as direct-seeded maize.

ACKNOWLEDGEMENT

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Keywords: maize yield, establishment method, N rate, transplanting, direct seeding, growth

GEOGRAPHICAL DIFFERENTIATION AND GENETIC VARIATION OF *Lolium* SPP. IN THE WINTER RAINFALL AREA OF THE WESTERN CAPE PROVINCE

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INTRODUCTION

Herbicide resistant *Lolium* spp. (rye grass), a weed of Mediterranean origin, is a serious problem in Western Cape grain producing areas as it is threatening more than 100 000 ha of productive grain fields.

Weed species with a high level of genetic diversity, like *Lolium* spp, are considered to show significant potential for weed adaptation and decrease the efficacy of weed control.

The aims of this study were 1) to assess the distribution of genetic variability of rye grass (*Lolium* spp.) in order to clarify the genetic structure of this species, 2) to determine the phylogeny of *Lolium* spp., 3) determine the presence of *Fusarium pseudograminearum*, in samples of *Lolium* spp. collected for this study and 4) analyse soil samples at each locality where *Lolium* spp. was sampled.

MATERIALS AND METHODS

The software program Survey Toolbox© was used to determine 40 randomly selected geographic coordinate points in the main agricultural production areas for grain, vineyards and fruit in the Western Cape Province.

Total DNA was extracted from all sample leaves according to the modified CTAB protocol. Simple sequence repeats (SSR) were analysed using an appropriate selection of the published primer pairs for *Lolium* spp., distributed across the genetic map to ensure a random selection of genetic markers, and data produced by AFLP were compared using the Mantel test.

A second specimen of each sample was collected and morphologically analysed at the Compton herbarium. A third specimen from each locality was analysed for the presence of *F. pseudograminearum*. Soil samples were taken at each locality for analyses.

RESULTS AND DISCUSSION

All 10 specimens collected in the Overberg, were morphologically identified as *L. rigidum.* Morphological identification of *Lolium* spp from other regions, varied. Similarly, high levels of genetic diversity were observed among specimens. *Fusarium pseudograminearum* was isolated from six samples. *Lolium* spp. can therefore act as alternative hosts and a source of inoculum of this important soilborne pathogen of barley and wheat in the Western Cape Province.

CONCLUSIONS

The high levels of genetic diversity indicate the adaptability of *Lolium* spp. to production practices. The presence of *F. pseudograminearum* on some *Lolium* spp. further complicates sustainable dry land crop-production, since the build-up of herbicide resistant *Lolium* spp. may lead to a higher incidence of crown rot on wheat and barley due to a higher disease pressure.

Keywords: geographical differentiation, *Lolium* spp., *Fusarium pseudograminearum*

OPTIMIZATION OF NITROGEN USE FOR RYEGRASS WITH A VARIABLE NITROGEN APPLICATION

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INTRODUCTION

In intensive pasture production systems nitrogen (N) fertilization is the main input to achieve optimum forage yield and quality. In pasture growers usually apply fixed amounts of N after each cut by splitting the recommended annual amount into the number of harvests, irrespective of variation among re-growth cycles. This may cause imbalances in forage yield and quality in a fodder flow program with excessive accumulation of N in some cuts and deficiency in others. Excessive N fertilizer application may increase environmental risk by contaminating underground water and r educe the quality of pasture. Application of variable rates of N according to pasture requirement could alleviate these problems. For this research, soil nitrate solutions collected from wetting front detectors and N status of plants were used for estimating the most suitable N rates.

MATERIALS AND METHODS

Field experiments were carried out at Cedara, in the KwaZulu-Natal Midlands in the 2008 season. Italian ryegrass was planted on a clay loam soil under dragline irrigation in early autumn. Seven N treatments, including four fixed nitrogen rates (0, 20, 40 and 60 kg N ha^{-1}) and three variable rates (based on soil nitrate-N, soil nitrate-N and plant N as mass balance by calculating input equals to output, and mass balance but use a deep soil nitrate-N for irrigation scheduling) were used. Treatments were arranged in a randomized complete block design with three replications. Nitrogen and K were surface applied at the beginning of each regrowth cycle. The pasture was harvested at the three leaf stage 50 mm above ground level. Treatment forage biomass and N content were determined at each harvest. Throughout the season soil solutions were collected from wetting front detectors installed at different depths. Soil nitrate was monitored by analysing the solutions using nitrate colour test strips. Soil samples were also collected below the root zone in order to determine the extent of leachable N. Efficiencies of water, irrigation, soil N, and N fertilizer use were determined.

RESULTS AND DISCUSSION

Forage yield response to N differed among regrowth cycles and growing seasons. For most harvests, there were no significant differences in forage yield when 60 kg of N ha^{-1} or variable N application rates were used. However, a significantly higher N uptake was observed when 60 kg of N ha^{-1} was used. This may lead to excessive N accumulation in pastures. Overall, higher agronomic and N fertiliser use efficiencies were obtained when low N (20 kg of N ha^{-1}) and variable N levels were applied. Significantly less N was applied in the variable rate treatments without significant reductions in forage yield and quality.

CONCLUSIONS

Application of variable N rates based on the soil nitrate analysis (using soil solution samples and colour test strips) is more efficient than fixed rates and therefore a better management option for ryegrass pasture production systems.

ACKNOWLEDGMENTS

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Keywords: Mass balance , Wetting front detector, Soil nitrate-N

EFFECT OF CROP LOAD ON 'CRIPPS' PINK' FRUIT QUALITY

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INTRODUCTION

Crop load has a significant effect on fruit quality and future productivity of apple orchards. The optimum fruit load balances yield and quality, resulting in a higher profit. The objective of this trial is to determine the effect of crop load on 'Cripps' Pink' fruit quality and long-term productivity.

MATERIALS AND METHODS

2006/07

Ten-year-old 'Cripps' Pink' apple trees on M793 rootstock were hand thinned to establish five crop load levels: (1) 2 or 3 fruits per cluster, according to the commercial thinning practice (control), (2) one fruit per cluster in the lower half (< 1.8 m) of the tree, (3) one fruit per cluster throughout the tree, (4) one fruit per cluster throughout and removal of small fruit (< 29 mm), (5) one fruit per cluster throughout, removal of small fruit and removal of fruit from the inner canopy. Treatments were randomized in 12 blocks with one tree per plot. Fruit were sampled per tree per harvest occasion and the remaining fruit were pooled per treatment in picking crates for grading at the "Two-a-Day" packhouse. Sampled fruit was used to determine foreground (red) colour, background colour, sunburn incidence, flesh firmness, fruit diameter, fruit mass, anthocyanin concentration of the peel, starch conversion, total soluble solids (TSS), and titritable acididity (TA). Vegetative and reproductive development were assessed by measuring one-year-old shoot growth and counting the number of mixed buds, vegetative buds and flowers on a representative scaffold branch.

2007/08

Treatments were repeated as for 2006/07 except for the control treatment, which entailed the thinning to 1 or 2 fruit per cluster. Fruit quality and reproductive and vegetative development were evaluated as in the previous season. Fruit storability was also evaluated after storage for three months at -0.5°C. Shelf life was assessed after one week at 15°C.

RESULTS AND DISCUSSION

The different thinning methods gave rise to yields ranging from 99 to 138 ton·ha^{-1} in 2006/07 and 94 to 138 ton·ha^{-1} in 2007/08. As expected, fruit diameter and mass increased linearly with decreasing crop load. Fruit firmness, TSS and TA increased with decreasing crop load, whereas sunburn percentage was not affected. Higher crop load delayed the average harvest date. Sample grader data revealed a tendency for higher percentage Class 1 fruit at the lower crop loads, while undersized and poorly coloured fruit tended to increase with an increase in crop load. However, more Class 1 ton·ha^{-1} was obtained at higher crop loads. There were no significant differences in vegetative and reproductive development or in the storability of fruit.

CONCLUSION

Fruit quality was improved at lower crop loads but the increase in Class 1 fruit as a percentage of the total crop did not compensate for the higher absolute Class 1 yield at the higher crop load level. The extremely high yields attained at the highest crop load did not induce alternation and also did not have an adverse effect on tree vigour. This research contributes significantly to the debate as to whether producers should strive for lower, but sustainable yields of better quality or for maximum yield at minimum permissible quality.

Keywords: 'Pink Lady', yield, maturity, colour, quality

OPTIMISING THE YIELD OF SUFFICIENLTY GREEN 'GRANNY SMITH' APPLES

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INTRODUCTION

'Granny Smith' apples in South Africa are prone to develop sunburn and red blush if exposed to full sunlight. In order to reduce the severity of these problems, 'Granny Smith' orchards are generally vigorous with heavily shaded canopies. Fruit from the inside of these canopies tend to be low in chlorophyll with a pale green colour. The aim of the research reported here was to quantify the relationship between canopy position and fruit colour and to use this information to devise pruning strategies that would both improve green colour and reduce sunburn and red blush.

MATERIALS AND METHODS

The first experiment was conducted in a vigorous orchard with an E-W row orientation in the Grabouw region. Five canopy positions were selected: the exposed northern (A) and southern (E) periphery of the canopy, a partially exposed position halfway towards the centre of the tree on the northern (B) and southern (D) side of the tree, and the centre of the tree next to the trunk (C). A single fruit was tagged 1-1.5 m above the ground at each position for 20 trees. Light intensity at fruit level, fruit peel temperature and colour was measured at regular intervals during the 2007/08 season. At commercial harvest, fruit from each position was scored for sunburn, red blush and green colour and the chlorophyll concentration measured.

Four pruning treatments that differed in severity and timing were evaluated for their effect on yield and fruit quality in the same vigorous orchard mentioned above. Control trees were lightly pruned during winter. Treatments 2 and 3 entailed severe pruning during winter and summer respectively while treatment 4 entailed pruning as for treatment 2 with the addition of follow-up light management during summer. Fruit were sampled to assess green colour, sunburn and red blush while remaining fruit was sample graded. Peel chlorophyll concentrations were determined for the greenest and least green sides of fruit.

RESULTS AND DISCUSSION

Exposed fruit on the northern side of trees experienced the highest irradiance levels and peel temperatures during fruit development followed by exposed fruit on the southern side and partially exposed fruit on the northern side. Fully shaded and partially shaded fruit on the southern side of trees received the least light and experienced the lowest peel temperatures. Exposed fruit on the northern side and fully shaded fruit had the lightest green colour, while fruit on the southern side of trees had the darkest green colour. Fruit of the exposed northern side showed the most sunburn, red blush and yellowing. It seems that 'Granny Smith' green colour can be optimised by increasing light distribution within the canopy while minimising the proportion of fruit exposed to direct sunlight for long periods.

Summer pruning improved the green colour of fruit whether accompanied by winter pruning or not. Treatment samples did not differ significantly with regard to red blush and sunburn percentages while sample grading data indicated that winter pruning reduced the percentage sunburnt fruit.

CONCLUSION

The darkest green 'Granny Smith' apples were found on the southern side of E-W planted rows. Exposed fruit generally developed sunburn or red blush while fruit from the densely shaded interior of the canopy were pale green in colour. Summer and winter pruning strategies that stimulate shoot development in the outer canopy while also increasing light distribution within the canopy may increase the yield of dark green 'Granny Smith' fruit.

Keywords: chlorophyll, irradiance, red blush, sunburn, pruning, fruit peel temperature

WEED CONTROL EFFICACY OF DIFFERENT SOIL CULTIVATION PRACTICES ON A MEDIUM TEXTURED VINEYARD SOIL IN THE BREEDE RIVER VALLEY

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INTRODUCTION

Consumers of agricultural products demand that the use of chemicals and the negative impact of agricultural practices on the environment must be restricted. The aim of this study was to determine the weed control efficacy of different soil cultivation practices on a medium textured soil in the Breede River Valley over the long-term.

MATERIALS AND METHODS

The trial was conducted from April 1993 to March 2005 on a medium textured soil in a Chardonnay/99 Richter vineyard near Robertson (33°50'S, 19°54'E) established during October 1992. Eleven soil cultivation treatments were applied and replicated four times in a fully randomized design. Dry matter production by both the cover crops and the associated weeds was determined at the end of August (just before bud break), end of November (during berry set) and again at the end of January (just before harvest), according to the procedure described by Fourie *et al*. (2001).

RESULTS AND DISCUSSION

Throughout the twelve year study, the stand of winter growing weeds in the treatment in which *Triticale* v. Usgen 18 (triticale) was sown annually (SA) and full surface chemical control was applied from bud break (BB) was significantly less than that of the treatment in which no cover crop was sown and the weeds were controlled chemically in the vine row and mechanically in the work row from bud break (Control). The same trend occurred when triticale was sown in the SA, BB treatments in which triticale was rotated with *Vicia dasycarpa* Ten. (grazing vetch) annually and biennially, respectively. Total suppression of the winter growing weeds was achieved with triticale (SA, BB) during 1995 and from 2001 to 2004. This was also achieved during 2001, 2002 and 2004 with the SA, BB treatment in which triticale and grazing vetch was rotated biennially.

From 1995 onwards, the stand of summer growing weeds measured end of November in the triticale (SA, BB) treatment and the SA, BB treatment in which a mixture of *Secale cereale* L. v. Henog (rye) and *Vicia faba* L. v Fiord (fababean) was established was significantly lower than that of the control. With the exception of 1998 and 2004, this trend was also observed in the SA treatment in which triticale was established and full surface chemical control was applied from berry set (AB) as well as in the SA, BB treatment in which triticale and grazing vetch were rotated annually. Total control of the summer growing weeds was achieved with a straw mulch (BB), triticale (SA, BB), the rye/fababean mixture (SA, BB), and the SA, BB treatment in which triticale and grazing vetch was rotated biennially from 2001 to 2003. This trend was also observed during 2001 and 2003 in the triticale (SA, AB) treatment and the SA, BB treatment in which triticale and grazing vetch was rotated biennially.

CONCLUSION

Total control of both winter and summer growing weeds can be achieved over the long-term by sowing triticale annually and controlling the cover crop chemically during bud break.

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Keywords: weed control

PLANT-PARASITIC NEMATODES: A THREAT TO MAIZE PRODUCERS IN COMMERCIAL AND DEVELOPING AGRICULTURE SECTORS

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INTRODUCTION

Local maize production is hampered by infection of economically important plant-parasitic nematodes (PPN), particularly root-knot nematodes (RKN; *Meloidogyne* spp.). Since chemical control is not always a viable option in resource-poor or commercial maize production, a need for the development of alternative nematode control strategies exists. Additionally, the wide host range of PPN and the lack of resistance in local varieties and hybrids annually result in severe yield losses. Therefore, cost-effective strategies that could be em ployed in integrated pest management systems are urgently needed.

MATERIALS AND METHODS

To review the nematode situation, two independent surveys were conducted during the 2007/08 growing seasons. Evaluation of the host suitability of commercial material and inbred maize lines, hybrids and open-pollinated varieties (OPV's) was also done in separate greenhouse trials using *in vivo* cultured root-knot nematode eggs and s econd-stage juveniles (J2) of both M. incognita and M. javanica as inoculum. The OPV QS-Obatampa that was previously identified to have RKN resistance was subsequently tested under semi-controlled conditions in microplot trials using initial inoculum densities ranging from 0 (untreated control) to 40 000 eggs and J2/maize seed for the respective RKN species. In addition, two trials were conducted in resource-poor farmers' fields near Coligny (North West Province) and Bosbokrand (Northern Province) to evaluate economically viable and environmental-friendly nematode management strategies such as soil solarisation, cattle manure amendment and intercropping of *Tagetes* spp. A crop rotation trial was also conducted in microplots at Potchefstroom (North West Province) over five consecutive growing seasons to demonstrate the effect of cropping sequence on reduction of RKN numbers. Crosses were also made between the three RKN USA lines Mp710, Mp711 and MP712 with resistance to RKN and popular, local white maize inbred lines with resistance to northern corn leaf blight and grey leaf spot.

RESULTS AND DISCUSSION

Several genotypes showed resistance to *M. incognita* race 2 a nd/or *M. javanica*, based on RKN reproduction factor values (RF values) lower than 1. The OPV QS-Obatampa maintained significantly lower *M. javanica* and *M.* incognita race 2 numbers compared to the respective susceptible standards in both trials. This OPV also compared well with the exotic RKN-resistant line Mp712w. Alternative control strategies showed substantial suppression of RKN numbers both at Coligny and Bosbokrand. A carrot-dry bean-cabbage-maize crop sequence significantly reduced population levels of *M. javanica*. S_2 and S_6 populations resulting from crosses between RKN-resistant maize lines and local genotypes showed that RKN resistance was successfully introgressed. A substantial number of these plants had RF values < 1.

CONCLUSION

Host plant resistance, soil solarisation, cattle manure amendments, intercropping with *Tagetes* spp. and crop rotation could be used effectively to reduce RKN populations. The use of these strategies, singly or combined, in integrated management (IPM) systems by commercial as well as resource-poor maize producers are thus recommended.

ACKNOWLEDGEMENTS

The South African Maize trust and the Agricultural Research Council are acknowledged for partial funding of this research. Drs Gary Windham and Paul Williams of the USDA-ARS are also acknowledged for supplying us with maize germplasm with resistance to root-knot nematodes.

Keywords: root-knot nematodes, management

GENOTYPE AND ENVIRONMENTAL EFFECTS ON HARDNESS IN MAIZE (*Zea mays*) GROWN IN SOUTH AFRICA

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INTRODUCTION

Maize is the largest grain crop produced in South Africa at around nine million tonnes per annum with most being used domestically for human food. The maize milling industry prefers to use large kernelled maize that is hard. Harder endosperm textured cultivars have higher milling efficiencies. For the production of maize, the growing environment has a major impact on final quality and, in particular, hardness. However, like most other cereal species, maize hardness is controlled by both cultivar as well as growing environment. This study assessed maize hardness from trials grown over two years from 11 locations to determine genetic and environmental influence on maize hardness.

MATERIALS AND METHODS

A series of trials were grown in 2004/2005 and 2005/2006. The trials were in randomised block designs with three replicates for each cultivar. In the 2004/2005 trial, 47 cultivars were grown at seven sites (Bethlehem, Demals, Klerksdrop, Olifansfontein, Potchefstroom, Rushof, Tweebuffels). In 2005/2006, 39 cultivars were grown at three sites (Bethlehem, Potchefstroom, Rushof). Four cultivars were common over the two seasons (CRN3549, PAN6043, PHB3203W, SNK2911). The Milling Index (MI) method was used as described in Van Loggerenberg and Pretorius (2004) where maize is milled on a laboratory roller mill system (Roff mill) and the meal and bran fractions determined. The MI was carried out in at least triplicate. The MI data was analysed for genotype, environmental and genotype x environment interactions by ANOVA using Statistica (V 8.0).

RESULTS AND DISCUSSION

There was considerable variation between cultivars with average MI ranging from 108 (quite soft) to 127 (hard) in 2004/05 and from 87 to 110 in 2005/06. For the 2005/06 season, the range in MI was slightly broader but averaged less than the 2004/05 season with the average yearly values being 101 and 119 for the 2005/06 and 2004/05 seasons, respectively. For the four cultivars grown over two seasons, there was a difference between the rankings of these with PAN6043 being the lowest in MI of the four in 2004/05 but the highest of the four in 2005/06. Conversely, PHB3203W was the highest of these four cultivars in 2004/05 but the lowest in 2005/06.

The analysis indicated strong and significant ($P < 0.05$) effect for MI between cultivars and sites. However, there was a non-significant ($P > 0.05$) cultivar by site interaction. Greater than 50% of the variation in MI was explained by cultivar, suggesting that cultivar has a greater effect than environment on MI. Further analysis of the data with protein and or grain yield as a covariate may provide more information on the level of genetic and environmental influence on maize hardness grown in South Africa.

CONCLUSION

These results showed significant ($P < 0.5$) genetic and environmental effects on hardness as measured by the MI method. These results are to date the most comprehensive study assessing genetic and environmental effects on maize hardness from trials grown in South Africa and suggest that breeding for specific maize hardness levels could be achievable.

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Keywords: cultivar, environment, milling index

RELATIONSHIPS BETWEEN PHYSICAL PROPERTIES OF SOIL TYPES AND THE ROOT DENSITY OF MAIZE

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INTRODUCTION

Various soil physical properties influence root development. Past South African studies on root development focused heavily on the effects of irrigation and tillage practices. The tillage practices were mainly applied on sandy to sandy loam soils, with a massive apedal structure. Recent advances in tillage suggest that the in-field rainwater harvesting (IRWH) technique is suitable for clay and duplex soils in semi-arid zones of South Africa. To date none of the biophysical studies in IRWH has focused on root development. The objectives of this study were: (i) to evaluate the interrelationships between soil physical properties in master horizons, irrespective of soil type; and (ii) to assess the effect of soil physical properties on root density of maize under the IRWH system.

MATERIALS AND METHODS

The experimental site was located at the Paradys Experimental Farm of the University of the Free State and is part of Land type Ca22. The 55 ha experimental site was subdivided into 75 experimental plots of equal size. Maize was planted at 18 000 plants.ha^{-1}. Just after flowering, plants from a 20 m^2 area of each plot were cut at ground level and above-ground dry biomass determined. The latter was expressed relative to the highest biomass measured. Root studies were conducted on 13 selected plots that covered a range of relative biomass yields. The soils of these plots were described and classified into three soil forms, *viz* Tukulu, Sepane and Bloemdal. Soil-root samples (using a 1 litre core sampler) and soil samples were taken per master horizon. Roots were separated from the soil by wet sieving. Root length was measured with an infrared line intersection counter and expressed as root density (km.km^{-2}). The soil samples were used for determining soil physical properties, *viz.* silt + clay content, water stable aggregates, modulus of rupture (MOR), bulk density (Db) and organic carbon content. Multiple regression analyses were performed and a correlation matrix drawn up in order to examine the interrelationships between root density and selected soil physical properties of the various master horizons.

RESULTS AND DISCUSSION

Due to 20 years of cultivation on this 55 ha, the interaction between physical properties in the A horizon was clouded to a high extent. In the B horizon, regardless of soil form, there was a strong positive correlation between silt + clay content and MOR (62%) as well as Db (50%). Modulus of rupture, bulk density, depth and aggregate stability of 4 mm, 0.5 mm and 0.25 mm sizes explained 79% of the variation in root density of maize, regardless of soil form. Mean root densities for the Tukulu soils were 0.01 km.km in the A horizon (Std dev = 0.05) and 0.005 km.kmin both the B (Std dev = 0.13) and C (Std dev = 0.15) horizons For the Bloemdal soils they were 0.3 km.km: in the A horizon (Std dev = 0.14), 0.1 km.kmin the B horizon (Std dev = 0.01) and 0.3 km.kmin the C horizon (Std dev = 0.03). For the Sepane soils they were 0.35 km.kmin the A horizon (Std dev = 0.05), 0.1 km.kmin the B horizon (Std dev = 0.13) and 0.21 km.kmin the C horizon (Std dev = 0.15).

CONCLUSIONS

Maize root density was much lower in soils of the Tukulu form, as a result of unfavorable physical properties, than in soils of the Sepane and Bloemdal forms, with very little difference between the latter two.

Keywords: soil types, soil physical properties, maize root density

THE EFFECT OF FIRST RATOON SUCKER SELECTION ON PRODUCTION POTENTIAL OF TISSUE CULTURED CAVENDISH BANANAS

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INTRODUCTION

Banana tissue cultured plants produce many suckers soon after establishment in the field. To maintain high yields and s uperior fruit quality, the original plant density and spatial arrangement must be maintained throughout the life of the banana plantation. This is only possible with optimum initial management of the suckers which emerge continuously around the parent plant. The best sucker for the next crop must therefore be identified and selected. After selection, all unwanted suckers are then destroyed. The first series of suckers to develop after planting is referred to as the “first flush”. Retention of first flush suckers creates apical dominance, which can suppress or delay emergence of further suckers. Early destruction of first flush sucker growing points allows another group suckers (“second flush”) to emerge few weeks later.

First ratoon selection from the second flush of suckers is now the most popular practice wherever new tissue culture plantations are established worldwide. However, many growers still do early selection from the first flush. Conversely, others do continuous permanent desuckering which can lead to very late selection of the first ratoon sucker. The aim of this study was to evaluate differences between selecting from the so-called “first flush” and “ second flush” of suckers, and what influence these differences had on annual yield and lifetime of the plantation.

METHODS AND MATERIALS

Tissue cultured plants were established in randomized block experiments in the cool subtropics at Burgershall Research Station in September 2005 an d January 2006, and in the hot subtropics at Komatipoort in April 2006. The trials comprised 4 sucker selection treatments from the first or second flushes x 5 replications x 12 data plants per plot. A single guard row was planted around each plot. At flowering of the parent plants, stem circumference and height of parent and selected ratoon 1 suckers were measured. At harvest, bunch weights and number of hands per bunch for all cycles were recorded, and yield calculated.

RESULTS AND DISCUSSION

Results obtained from the September planting at Burgershall showed that neither early nor late sucker selection has an influence on vigour or production potential of the parent crop. For both the January planting in Burgershall and the April planting in Komatipoort, early selection had an influence on the plant vigour of the parent crop. Production potential was also influenced due to smaller bunch mass and the fact that harvest time was delayed. No significant yield differences were measured with the late sucker selection treatments.

CONCLUSIONS

Optimum sucker selection time and orientation in a banana plantation is of importance - especially for the first ratoon suckers. The yield factor that is mainly influenced is cycle time and therefore annual yield. Only after completion of the ratoon 1 crop cycles will it be possible to see the influence of shorter harvest to harvest intervals, achieved with early sucker selection, on the production potential of future crop cycles. From current results it is evident that planting date, plant density, soil vigour and general management play a vital role when deciding to select from the first or second series of suckers.

Keywords: Banana, tissue culture, sucker selection

SHOOT ALLOMETRY OF *Jatropha curcas* L.

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INTRODUCTION

Allometric equations are defined by $Y = a D^b$, where Y is tree biomass, D is stem diameter, and a and b are constants (Ter-Mikaelian and Korzukhin, 1997). Allometry offers a reliable and non-destructive approach for estimating tree growth, carbon fluxes and carbon sequestration in the wood and leaves of trees, predicting implications of large-scale deforestation and carbon sequestration on carbon cycle, and estimating the extent of microclimatic modifications trees provide in the context of agroforestry. There is, however, no information about the application of allometry on *Jatropha curcas* L., (*Jatropha*), a multi-purpose tree species with vast potential as a source of bio-diesel. *Jatropha* also provides fuel in the form of wood and charcoal, with energy values of 15.5 MJ kg^{-1} and 30 MJ kg^{-1}, respectively (Openshaw, 2000).

OBJECTIVE

The objective of this study was to examine reliability of allometric equations for predicting above-ground biomass and dimensions of *Jatropha*.

MATERIALS AND METHODS

The experiment was carried out at the Ukulinga Research Farm of the University of KwaZulu-Natal, Pietermaritzburg Campus ($30^{o}24'$S, $29^{o}24'$E). Ukulinga has an altitude of 781 m, average annual rainfall of 680 mm and mean annual temperature of 18.4 ^{o}C. A sampling plot of 50 m by 25 m, with planting density of 1100 trees ha^{-1} was used. Twelve representative *Jatropha* trees were sampled destructively between the 4th and 13th March 2008. Total height, canopy height, mean maximum canopy diameter, basal diameter and leaf area of each tree and its branches were measured. Oven-dried masses of stems, branches and leaves were also obtained. Canopy volume, woody and total above-ground dry masses were calculated from the data. All data were transformed to $\log_{10}$ forms. Basal diameter was plotted against the selected parameters and linear regressions fitted. Significances of the resulting regressions were examined using the ANOVA *F-test,* at a = 0.01. Correlation coefficients (r) were also calculated.

RESULTS AND DISCUSSION

At tree level, there were highly significant relationships between stem diameter and above-ground dimensions, namely: tree height, canopy volume, canopy height, mean maximum canopy diameter and leaf area. The correlation coefficients were 0.949 and higher. Basal stem diameter also showed highly significant allometric relationships with woody above-ground biomass (r = 0.987) and total above-ground biomass (r = 0.983). Likewise, basal branch diameter was of highly significant value in explaining variations in branch and leaf biomasses, branch dimensions and leaf area. The resulting correlations were very strong and positive (r > 0.88).

CONCLUSIONS

Both at tree and branch level, basal diameter was of high value in explaining the variations of the selected biomass and dimension parameters. Allometric equations using basal (stem or branch) diameter are, therefore, reliable for estimating above-ground biomass and dimensions for *Jatropha.* The results present valuable information in the development of generalised allometric equations for *J. curcas* L.

ACKNOWLEDGEMENTS

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Keywords: Allometry, Basal diameter, *Jatropha curcas* L.

SORPTION OF HEAVY METALS, PB (II), CU (II), ZN (II), AND NI (II) ON PINE BARK BASED COMPOSTS

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INTRODUCTION

A significant percentage of South African soils in the mining areas have high levels of heavy metals, notably Hg, Cr, Pb, Zn, Cu, Ni, Cd, As, etc. Therefore, there is a need to evaluate low cost materials that could be used in reducing the bioavailability of heavy metals in contaminated soils. The objective of this study was to determine the heavy metal retention capacities and hence remediation potential of pine bark-based composts formulated by Mupondi *et al*. (2006) for selected metals ions, namely Pb (II), Cu (II), Zn (II) and Ni (II). The composts were pine bark (PB), pine bark-goat manure (PBG) and pine bark-sewage sludge (PBS).

MATERIALS AND METHODS

The adsorption of Cu (II), Pb (II), Zn (II) and Ni (II), on composts was determined in three replicate sub-samples of 1.0g of compost to which 30 cm^3 solution containing 0, 10, 50, 100, 200 or 400 mg l^{-1} of metal ions was added. 0.01 M $CaCl_2$ was used as a background electrolyte and the experiment was conducted without pH adjustment. The compost suspensions were shaken mechanically for two hours and then centrifuged and filtered to obtain clear solutions. Heavy metals were determined in the solutions by atomic absorption spectrophotometer. The amount of heavy metal sorbed was calculated as the difference between the amount of heavy metal added and that remaining in solution after equilibration. The linear form of the Langmuir and Freundlich equations were used to calculate sorption parameters.

RESULTS AND DISCUSSION

The Langmuir sorption maximum capacity of the composts for metal ions followed the order PBG >> PBS > PB and similar trends were observed for the Langmuir constant b and the Freundlich constant K_F. Higher adsorption capacities of Cu (II), Zn (II) and Ni (II) ions were found in the PBG composts than in the PB and PBS composts. The maximum sorption capacity of PBG compost for different metals followed the order Cu (II)>Pb (II)>Zn (II)>Ni (II) whereas, the maximum binding capacity of PB and PBS composts followed the order Pb (II) > Cu (II)> Zn (II) > Ni (II). The removal of heavy metals by the composts may be attributed to the binding of heavy metals by adsorption, chelation and ion exchange on the surfaces of the composts.

CONCLUSION

Pine bark/goat manure (PBG) was the most effective for the removal of heavy metals, removing more than 97% of Cu (II), Zn (II) and Ni (II) and 84% of Pb (II) from solution. Thus, pine bark/goat manure compost can be used effectively for the bioremediation of heavy metal contaminated soils.

ACKNOWLEDGMENTS

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Keywords: Compost, Goat manure, Heavy metals, Pine bark, Sewage sludge, Sorption

IMPROVEMENT OF VERNONIA GALAMENSIS, A POTENTIAL HIGH VALUE OIL CROP, USING POLYPLOIDISATION – PRELIMINARY RESULTS

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INTRODUCTION

Epoxy oils are important in industry for the manufacture of plastic formulations, protective coatings, lubricants, and other products. Current industrial techniques are expensive, generate large amounts of chemical waste, and produce high viscosity oil. A natural low-viscosity, epoxy oil can be derived from the seeds of *Vernonia galamensis* (Cass.) Less, a herbaceous member of the Asteraceae family. The low viscosity and polymerizing characteristics of this oil make it especially valuable as a solvent in industrial coatings and paints, for environments where fumes from traditional solvents are hazardous or polluting. Some of the products that are being developed from *Vernonia* oil are degradable lubricants and lubricant additives, epoxy resins, adhesives, insecticides and insect repellants, crop-oil concentrates, and the formulation of carriers for slow-release pesticides.

The development of alternative crops is receiving increased recognition as an answer to some of the problems facing today's agriculture. New industrial crops could significantly diversify agriculture and create markets that are essentially noncompetitive with existing crops. In order for *Vernonia* to be commercialized, seed retention and yield both need to be improved and therefore ongoing selection and breeding programmes increase the chances of improving these traits. Polyploidy as a breeding tool was investigated for the improvement of *Vernonia galamensis*.

METHODS AND MATERIALS

A method and conditions required for the induction of polyploidy using a mitotic inhibitor in *Vernonia galamensis* seeds, were developed. Polyploids were confirmed using flow cytometry. Various anatomical, morphological and horticultural traits were measured and compared with diploid lines. Furthermore, *in vitro* and *ex vitro* vegetative propagation methods were also investigated.

RESULTS AND DISCUSSION

Polyploids were obtained by treating different seed lines with varying concentrations of colchicine, a mitotic inhibitor. Polyploids were distinguished from chimeras using flow cytometry. Anatomical and morphological differences were recorded for the polyploid and diploid lines. Seed fertility was also observed in the polyploid lines. An *ex vitro* microcutting method was established for vegetative propagation of the species using nodal cuttings which rooted readily. A method for the *in vitro* propagation of this species was also developed. Material is currently being bulked up to determine field performance, as well as for oil extraction.

CONCLUSIONS

Polyploidisation was achieved in *Vernonia galamensis* and there were marked differences between polyploid and diploid lines. Furthermore, it appears that the polyploid lines are fertile to some extent. Future oil extraction trials will give an indication of whether oil content has increased in the seeds and whether there is any variation in oil profiles. Furthermore, distribution of fatty acids will also be determined with a view to elucidating whether it is economically viable to extract oils from the rest of the plant.

Keywords: Polyploidy, Vernonia, breeding, improvement, oil

THE EFFECT OF CROP ROTATION ON RYEGRASS (*Lolium* SPP) SEEDLING DENSITIES IN THE SOUTHERN CAPE

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INTRODUCTION

Producers who have converted to conservation farming systems now rely on chemical weed control measures. A consequence of this is the development of herbicide resistance in several weed species, and in ryegrass in particular. Producers have been advised to alternate the chemical groups used, to limit the development of herbicide resistance. Crop rotations have been widely advocated to facilitate the use of different groups of chemicals. The objective of this study was to quantify the effects of different crop rotation treatments on the density of ryegrass seedlings in the top-soil of shale-derived soils in the southern Cape region.

MATERIALS AND METHODS

Data were collected from a long-term, field-scale crop rotation experiment at the Tygerhoek Experimental Farm, Riviersonderend, South Africa, from 2002 to 2008. The experiment is laid out in a randomized blocks design with six crop rotation treatments. Treatments included several combinations of continuous cropping and crop/annual legume pasture rotations, and a lucerne pasture. The following crops: wheat (W), barley (B), oats (O), canola (Ca) and lupin (L); and pastures: lucerne (Luc) and medic–clover mixture (P), were used. Continuous cropping rotations were: WBCaWBL and WCaWL. Various combinations of crops (C) were used in three- and four-year rotations with pasture (P) namely: PPC, PCPC and PPCC. Standard farm implements and machinery, and recommended herbicides were used to manage the crops and pastures.

Twenty randomly placed soil cores, each 40mm in diameter, were collected to a depth of 50mm in each plot during March each year. The 20 soil cores from each plot were mixed and placed on top of sterilised potting bark in seedling trays to a depth of 20 mm. The trays were watered once a day and all ryegrass seedlings were counted and removed. Counting continued until the end of August each year. Ryegrass counts per tray were converted to seedlings m^{-2}.

RESULTS AND DISCUSSION

Mean ryegrass densities per treatment at the start of the trial in 2002 were high, ranging from 2535 to 3931 seedlings m^{-2}. Ryegrass densities did not differ among rotation treatments ($P>0.05$) indicating similar seedling densities across all treatments at the start of the trial (March 2002). Densities declined rapidly in all treatments with the PPC, PCPC and PPCC rotations and the Luc treatment maintaining lower densities (< 300 seedlings m^{-2}) from 2004 to 2008. Seedling densities in the WCaWL continuous cropping treatment was higher ($P<0.05$) than in the crop/ pasture rotations from 2006 to 2008 and the WBCaWBL rotation also had higher densities ($P<0.05$) than the crop/pasture rotations in 2006 and 2007. Field inspections, however, indicated that soil type in the WCaWL treatment in replication 1 and herbicide resistance in the WBCaWBL treatment in replication 2 could have contributed to poor ryegrass control in those treatment plots. Removal of those data from the analyses resulted in no differences ($P>0.05$) in ryegrass seedling densities among all treatments with ryegrass seedling densities being maintained at below 200 seedlings m^{-2} from the 2006 to 2008 sampling dates.

CONCLUSIONS

Ryegrass densities were successfully reduced to high but manageable numbers in all rotation treatments. The inclusion of a pasture phase does, however, improve options for managing ryegrass particularly if herbicide resistant plants are already present in the field and where soil type may restrict the efficacy of herbicides.

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Keywords: Crop sequence, Cereal crops, Legume pastures, Canola, Lupins, Winter rainfall

WHEAT PRODUCTION DYNAMICS IN CROP ROTATION SYSTEMS IN THE SWARTLAND, WESTERN CAPE

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INTRODUCTION

Crop rotation is widely advocated as an essential component of conservation farming practices in the rain-fed grain production systems of the Western Cape. Crop rotations are reported to increase yields relative to monocultures. Moreover the planting of alternative crops in a c rop rotation system is potentially economically and biologically more sustainable relative to monocultures. The objective of this study was to determine the effects of different crop rotation treatments and within-treatment crop sequences on wheat yield on the shale-derived soils of the Swartland winter cereal production region of South Africa.

MATERIALS AND METHODS

Data were collected from a long-term, field-scale crop rotation experiment at the Langgewens Experimental Farm, Moorreesburg, South Africa, from 1999 to 2007 (excluding 2003). The experiment is laid out in a randomized blocks design with seven crop rotation treatments. Crop rotation treatments included the following crops: canola (C), lupin (L), medic (M), medic–clover mixture (Mc) and wheat (W). Rotation treatments (RT) were: RT1=W-W-W-W, RT2=C-W-W-W, RT3=C-W-L-W, RT4=W-L-C-W, RT5=M-W-M-W, RT6=Mc-W-Mc-W and RT7=M-C-M-W. Each rotation treatment is managed in a four-year cycle. All crops in each rotation treatment are fully represented each year to account for the effects of annual variation in climatic conditions on production dynamics of the various crops. Plot sizes range from 0.5 ha to 2.0 ha. Tillage, planting and crop protection activities were applied to each crop using standard farm implements and machinery. Whole-plot grain yields ($kgha^{-1}$) were used in the statistical analyses of the data set.

RESULTS AND DISCUSSION

Crop rotation and year affected wheat yields ($P<0.001$). Over all years RT1 (2.9 tons $ha^{-1}yr^{-1}$) and RT2 (3.3 tons $ha^{-1}yr^{-1}$) produced less wheat ($P<0.05$) than RT5 (3.7 tons $ha^{-1}yr^{-1}$) and RT7 (3.8 tons $ha^{-1}yr^{-1}$), and RT4 (3.4 tons $ha^{-1}yr^{-1}$) produced less wheat that RT7. There was a c onsistent trend of decreasing wheat production with increasing number of years where wheat followed wheat with the lowest production recorded in the wheat monoculture treatment (RT1). More wheat was produced ($P<0.05$) in 2006 (4.3 tons ha^{-1}) and 2007 (4.4 tons ha^{-1}) than in 2004 (2.0 tons ha^{-1}) and 2002 (3.1 tons ha^{-1}) mainly as a function of the distribution and amount of rainfall in each year.

Grain yields from the wheat monoculture were significantly lower ($P<0.05$) than grain yields recorded from the highest yielding crop sequences in six of the eight years. The wheat monoculture also produced the lowest yields of all crop sequences in five of the eight years. Trends within years showed that more wheat tended to be produced where wheat followed the previous year's legume pasture, lupin or canola crop and less wheat was produced where wheat followed wheat.

CONCLUSIONS

Wheat production per hectare will be lower in monocultures and cropping sequences where wheat follows one or more consecutive seasons of wheat, than in cropping sequences where wheat follows an alternative crop such as canola, lupin or legume pasture, within conservation farming practices in the Swartland. These long-term data show that the rotation treatment has an overriding effect on wheat yields despite the significant impact of climate (rainfall) on crop production potential in a specific growing season.

ACKNOWLEDGEMENTS

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

Keywords: Crop sequence, Rainfed, Cereal crops, Winter rainfall

POTENTIAL OF FLY ASH AS SOURCE OF ALKALINITY FOR AMELIORATION OF ACID SOILS OF THE SOUTH AFRICAN HIGHVELD

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INTRODUCTION

Many of the agricultural soils surrounding coal-burning power stations on the South African Highveld are acidic and require liming. The large volume of fly ash (FA) produced as a by-product from the power stations may hold agricultural potential as a liming material. A factorial field trial is underway on Beestepan farm near Middelburg, Mpumalanga, to assess the viability of using FA as a liming material, and compare its performance to other neutralizing materials that are commonly used, namely agricultural lime (L) and Calmasil® (C) and additionally observing the interaction of gypsum with these materials.

MATERIALS AND METHODS

The trial was on an Avalon soil, with beans as test crop. The L, C and FA amendments were applied to seventy-two 12x9 m plots either alone or in combination with 4 t ha^{-1} phosphogypsum at rates equivalent to 0, 50, 100 or 200% of recommended alkalinity, based on conventional lime requirement determination and the calcium carbonate equivalence (CCE) of each amendment. Each treatment was replicated three times. A basal dressing of 4:3:4 (40) (200 kg ha^{-1}) and urea (120 kg ha^{-1}) was applied to all plots.

Topsoil and subsoil samples were taken before soil amendment, 1 and 10 weeks after planting, and after harvesting in April 2008.

RESULTS AND DISCUSSION

Soil pH_{KCl} increased from 3.8 (control) to 4.1 (FA), 4.7 (L) and 4.9 (C) in response to the highest level of each amendment. Corresponding increases in NH_4OAc-extractable Ca were from 65 (control) to 135 (FA), 354 (L) and 444 (C) mg.kg^{-1} without gypsum and from 150 (control) to 223 (FA), 382 (L) and 369 (C) mg.kg^{-1} in the presence of gypsum. Correspondingly, extractable Mg increased from 9 (control) to 17 (FA), 24 (L) and 59 (C) mg kg^{-1} without gypsum and from 9 (control) to 11 (FA), 18 (L) and 30 (C) mg kg^{-1} in the presence of gypsum. Despite the highest FA level being 28 t ha^{-1}, the resultant exchangeable Ca and Mg was still sub-optimal. Addition of gypsum appeared to promote leaching of Mg which was confirmed by depth sampling at intervals of 10 cm.

Despite having less effect on soil properties than ostensibly equivalent L and C treatments, FA nevertheless produced a comparable response in bean yield which increased from 0.90 (control) to 1.72 (FA), 1.70 (L) and 1.79 (C) t ha^{-1} without gypsum and from 1.28 (control) to 2.01 (FA), 1.58 (L) and 1.98 (C) t ha^{-1} in the presence of gypsum.

CONCLUSIONS

Application of fly ash produced comparable increases in the yield of dry beans on an acidic Avalon soil when applied at rates equivalent to those of conventional liming materials. Phosphogypsum also increased bean yield. The effect of fly ash may have been partly due to the presence of P and K although the availability of these elements in coal ash is probably low. Since fly ash has a much lower neutralising value than commercial agricultural lime its economic value would be confined to short distances from power stations.

ACKNOWLEDGMENTS

Study funded by Eskom (Contract number: PR 10277819). Pistorius Lime, Calmasil Middelburg and Sasol Fertilizers all donated materials. The co-operation of Beestepan farm, Middelburg, has made this work possible.

Keywords: soil acidity, fly ash, liming, gypsum

EFFECT OF TRANSGENIC CRY1AB TOXIN ON BIOLOGICAL FITNESS OF THE MAIZE STEM BORER, *Busseola fusca* (FULLER)

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INTRODUCTION

Within six years after deployment of Bt-transgenic maize in South Africa, stem borer resistance to the Cry1Ab toxin was identified in the Christiana area (Van Rensburg, 2007). It was shown that the growth rate of resistant larvae was negatively affected. The question arose to what extent the developmental rate of surviving larvae and subsequent developmental stages might be affected, since this may affect the synchronization of refuge plantings aimed at delaying the development of insect resistance to Bt.

MATERIAL AND METHODS

Overwintering diapause larvae were collected from both Bt and non-Bt commercial maize fields. These included Ventersdorp (Bt-susceptible), Vaalharts (Bt-resistant), Warden (assumed to be Bt-resistant) and Schweizer-Reneke (assumed to be Bt-susceptible). After termination of diapause the following variables were recorded: mass of diapause larvae, mortality of diapause larvae, time taken to reach the pupal stage, larval mass loss to pupal stage, duration of the pupal stage and moth fecundity. The fitness of progenies of the Ventersdorp and Vaalharts populations were evaluated by feeding neonate larvae on leaf tissue of Bt and non–Bt hybrids. Larval survival and mass gain were recorded. Data were subjected to multiple sample comparisons based on Fisher's LSD procedure.

RESULTS AND DISCUSSION

Mass of diapause larvae was significantly higher for the Ventersdorp population than for the Schweizer-Reneke population (both non-Bt). It was much lower for the Vaalharts population but not for the Warden population (both Bt). Mortality of diapause larvae was similar for non-Bt populations, greater for the Vaalharts population but smaller for the Warden population (both Bt). Mass of diapause larvae as well as mortality rates, therefore, did not seem to relate strictly to the source of larval feeding.

Mass loss was more pronounced for both Bt populations than for the Ventersdorp population (non-Bt). For the Schweizer-Reneke population mass loss seemed to be similar for larvae collected from Bt- and non-Bt maize.

Bt-populations showed a much reduced period of development to the pupal stage compared to both non-Bt populations. There also was a considerable reduction in the duration of the pupal stage for both Bt-populations compared to the non-Bt populations.

The mean number of eggs produced per moth was lower for the Vaalharts and Warden populations, compared to both Schweizer-Reneke and Ventersdorp.

Mass of larvae of the susceptible Ventersdorp population tended to be greater on non-Bt hybrids than Bt-hybrids. For the resistant Vaalharts population larval mass did not differ significantly between Bt- and non-Bt hybrids. Larval survival of the Ventersdorp population was greater on non-Bt hybrids than on Bt-hybrids. For the Vaalharts population larval survival did not differ between Bt- and non-Bt hybrids.

CONCLUSIONS

With Bt-resistant populations a pronounced reduction in the period of development to the pupal stage and in the duration of the pupal stage largely neutralises the preceding reduction in larval growth rate, contributing positively to the synchronization of moths derived from Bt-plantings and those from refuge plantings. Whereas moth fecundity is negatively affected by the Bt-toxin, increased survival of the next generation of larvae on Bt-maize is more than adequate to compensate for the loss in egg production, presumably allowing for build-up of Bt-resistant populations.

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Keywords: Busseola fusca, Cry1AB, transgenic maize

QUANTIFICATION OF CROP-WATER RELATED EFFICIENCIES UNDER DIFFERENT TILLAGE TREATMENTS ON A FORT HARE/OAKLEAF ECOTOPE

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INTRODUCTION

In rainfed agriculture, crop-water related efficiencies are very important parameters to compare different water conservation techniques. The in-field rainwater harvesting technique (IRWH) was designed to increase grain yield and crop-water related efficiencies specifically in semi-arid areas. The technique comprises a 2 m wide no-till area that promotes runoff through natural surface crusting and a 1 m wide basin for collecting the water. IRWH improves grain yield and crop-water related efficiencies by stopping runoff completely and minimizing evaporation from the soil surface. Water use efficiency (WUE) measures the efficiency with which a particular crop can convert available water into yield. Water use efficiency (WUE_{Ev}) based on transpiration (Ev) is more efficient to use since it excludes evaporation from the soil surface, which is not directly related to the crop's ability to convert water into yield. Precipitation use efficiency (PUE) is probably the simplest way of expressing the efficiency of converting rainwater into food. It is based on the principle that the system that produces the highest yield per unit area represents the best practice. To determine crop-water related efficiency over a long-term period, Botha (2006) suggested that rainwater productivity (RWP) would be more appropriate. It was hypothesized that IRWH will have higher crop-water related efficiency than conventional tillage (CT). CT in this case is defined as ploughing of the land with a tractor using a mouldboard plough and then planting in tramlines (2 x 1 m). Under CT it is also assumed that there are no secondary cultivation activities and that the interrows are left bare.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of the University of Fort Hare in the Eastern Cape to test the hypothesis over four growing seasons, using maize as a crop. The following treatments were employed: IRWH with mulch in basin and runoff area (ObOr), IRWH without mulch in basin and runoff area (BrBb) and mouldboard conventional tillage (CT). The parameters PUE, RWP and WUE_{Ev} were used to quantify crop-water related efficiencies. Soil water content was measured by neutron water meter and the grain yield was determined. In order to determine Ev, 12 plants (biomass) per plot were harvested. The data were statistically analyzed by using NCSS 1998 Statistical System for Windows (NCSS, 1998) to determine differences between treatments.

RESULTS AND DISCUSSION

For all treatments, PUE ranged from 11 to 12 kg ha^{-1} mm^{-1}, WUE_{Ev} ranged from 25 to 27 kg ha^{-1} mm^{-1}, and RWP was between 11 and 13 kg ha^{-1} mm^{-1}. The results indicate that the ObOr and BbBr treatments performed better than CT in terms of crop-water related efficiencies.

CONCLUSIONS

It can be concluded that IRWH treatments improved both crop-water related efficiencies and grain yield over four growing seasons compared to CT.

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Keywords: precipitation use efficiency, rainwater productivity, water use efficiency

DEVELOPMENT OF HONEYBUSH TEA INDUSTRY – A CASE STUDY

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The honeybush tea industry is one of the newest indigenous industries in South Africa, the organised industry was established as recently as 1999. The first documented use of honeybush (*Cyclopia* species) as a herbal drink with good health properties, was in the early seventeen hundred. During that time honeybush was harvested in the wild and fermented in heaps in the wild, which resulted in great variations in quality. The products were only available at some road stalls in the Western and Eastern Cape Provinces.

In the early nineties of the previous century, dr Hannes de Lange initiated field studies to determine if honeybush could be cultivated commercially. He started collecting seeds of different species from different areas to produce seedlings. These seedlings were planted out in different areas where honeybush occurred naturally. Being a legume the need for inoculation with Rhizobium was investigated. To improve tea quality, dr Lizette Joubert developed controlled fermentation method and investigated the health properties of honeybush tea. The research showed that the tea was low in tannin, caffeine free, and contains antioxidants and phyto-estrogen. This research is ongoing in collaboration with Stellenbosch University and Medical Research Council.

The need to form an association was expressed during the late nineties when the ARC had information sessions in the different honeybush areas. The South African Honeybush Tea Producers Association (SAHPA) was formed in 1999 as a 'spokesperson' for the industry. The name later changed to South African Honeybush Tea Association (SAHTA) to include all the different disciplines involved in the industry.

Although honeybush is still harvested in the wild, it was soon realised that it is impossible to build an industry on wild harvesting alone, as the plants will be overexploited and become extinct in the near future. The need to expand plantations became a priority, but no guidelines for the cultivation of honeybush existed. Despite this a few farmers established plantations of different species in different areas. Research on cultivation aspect was initiated in 2000 and as research results became available, higher yields were obtained. As the production increased an over-supply developed. New markets increased the demand for honeybush tea which was higher than the production levels. This trend repeated itself. This put a big strain on the wild plantations.

The ARC established honeybush plantations at different previous disadvantaged communities from 2000. One of these communities is still successful, while one other is still cultivated honeybush. A nursery to supply seedlings for these plantations as well as to sell was established in one of the communities.

SAHTA held a farmers' day in March of 2007, this was attended well by different interest groups. Newsletters with information about the industry as well as technical data from the researchers were published. During 2007 the ARC set up web pages on the ARC website with updated honeybush tea information (www.arc.agric.za/home.asp?pid=4045). A strategic and implementation plan for the industry was done during 2007/8. The most pressing needs are marketing, health aspects, standards for honeybush tea, good agricultural practices and the decrease of wild harvesting. During 2008 a workshop on wild harvesting was held to discuss a future strategy for the protection of honeybush in the wild. A committee was formed to draw up guidelines for the future. These guidelines should be available by end of 2009.

Keywords: Cyclopia, honeybush, SAHTA, industry, health aspects, wild harvesting

NATIONAL INVASIVE ALIEN PLANT SURVEY

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INTRODUCTION

The problems and threats associated with invasive alien plant species (IAPS) in South Africa have been widely recognized for many years and in-depth local knowledge and understanding of the subject exists. However, the study by Versfeld *et al.* (1998) was the first assessment of the full extent of local invasions and primarily used local knowledge of resource experts across South Africa to determine the range and abundance of IAPS at a 1:250 000 scale.

From the start of the National Invasive Alien Plant Survey the objective was to develop a cost-effective, objective, statistically-sound and therefore repeatable monitoring system of woody IAPS at quaternary catchment level. The aim of this system is to produce a map and procedure to continuously update the national distribution map of woody IAPS. Therefore the project focus moved away from the updating of the Versfeld *et al.* (1998) map to the establishment of the Woody Alien Invasive Monitoring System.

The initial expectation for such a project would be a detailed field survey approach. However, the size of the study area (South Africa, Lesotho and Swaziland; 126.7 million hectares), wealth of biodiversity and the total range and abundance of alien plant invasives within this unique environment renders a detailed field survey or complete inventory impractical at this level. The two main reasons for this are that it is not economically viable, and the time required for the enumeration of range and abundance of different IAPS would render the data outdated by the time it could be amassed, collated and summarized.

The suggested approach is that some form of partial measurement or sampling should be applied. A careful measurement of a small percentage of the units in a population will frequently give more reliable information than rough estimates obtained from the entire population and therefore allows for better inferences about that population.

MATERIALS AND METHODS

The relationships between environmental variables (climate, soil and terrain) and species distribution and abundance (SAPIA database) were determined. These relationships were used to identify which environmental variables contribute the most to the occurrence of specific species in specific areas. The identified environmental variables were then divided into different classes per variable and combinations (interactions) thereof were investigated.

The study area was stratified according to these environmental classes and different sampling options (sampling design and number of field sample points) for the field survey were simulated in order to select the optimal sampling approach. The objective of the sampling is to determine the actual proportion of IAPS per catchment. A total of 74 187 sample points were allocated on a stratified random basis to the study area.

RESULTS AND CONCLUSIONS

The project has completed a 12-month fieldwork phase that entailed the surveying of all 74 187 sample points, and is currently in a phase of data interpretation. The objective of the latter is to compare the sampling results (actual invasion) with potential invasion and thereby determine an invaded index per enumeration area. Project progress to date will be presented.

ACKNOWLEDGEMENTS

Thank you to the Department of Water Affairs and Forestry, Working for Water Programme for the funding of the project.

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Keywords: Invasive alien plants, Survey, Monitoring programme, National scale

INFLUENCE OF LONG-TERM WHEAT RESIDUE MANAGEMENT ON ACIDITY AND SOME MACRONUTRIENTS IN AN AVALON SOIL

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INTRODUCTION

Crop residue management is known to either directly or indirectly affect soil quality, and therefore soil fertility. Soil acidity is one of the most important factors determining soil fertility. The fate of plant nutrients depends very much on the residue management practice applied. Conservational tillage in comparison with conventional tillage generally causes a stratification of especially the immobile nutrients within soils. The rate and extent of this stratification when changing from conventional to conservational tillage depends not only on residue management but also on climatic conditions, soil properties, cropping systems and fertilizer applications. This study was initiated to determine the influence of different wheat residue management practices that were sustained for about 20 years on some fertility indicators of an Avalon soil in a long-term wheat trial at the ARC-Small Grain Institute near Bethlehem in the Eastern Free State.

MATERIALS AND METHODS

This trial offered an opportunity to study the influences of wheat residue management practices on some soil fertility indicators and to establish whether differences in wheat grain yield could be attributed to changes in the soil fertility indicators. The treatments that were applied are two methods of straw disposal (burned and unburned) x three methods of tillage (ploughing, stubble mulch and no tillage) x two methods of weed control (mechanical and chemical). Soil samples were collected from the 0-50, 50-100, 100-150, 150-250, 250-350 and 350-450 mm layers, and pH as well as P, K, Ca, Mg and Na contents were determined.

RESULTS AND DISCUSSION

Burning of straw increased pH up to a depth of 150 mm, while P and K contents increased up to a depth of 450 mm. Ca contents on the other hand only increased slightly throughout the profile, although only pH and K were influenced statistically significantly. Tillage practices affected pH significantly to 450 mm depth, with no-tilled plots having the higher pH values than the mulched and ploughed plots. No tillage, and to a lesser extent mulched tillage, resulted in an accumulation of P, K, Ca and Mg in the upper 100-150 mm soil, using ploughing as reference. Chemical weeding also led to accumulation of nutrients in the upper 100 mm soil when compared with mechanical weeding. This trend was also observed in pH, although it was not significant. In the case of the nutrients, significant interactions were virtually absent, except for K, where burning combined with either no tillage or chemical weeding resulted in the highest K values in the upper 100-150 mm soil.

CONCLUSION

It seems possible to retard the acidification of this Avalon soil by introducing either mulch or no tillage instead of mouldboard ploughing. In addition the burning of wheat residue is also beneficial for combating acidification to some extent. Based on the results of this study it is clear that the contents of P and K in this Avalon soil were increased to substantial depths when the wheat straw was burned in comparison with when it was not burned. No tillage, and to a lesser extent, also mulched tillage resulted in an accumulation of P, K, Ca and Mg in the upper 100-150 mm compared to ploughing, and are not so readily available for uptake by plants due to desiccation This trend in nutrient accumulation was also observed with chemical weeding when compared to mechanical weeding. Investigations showed that on account of conservational tillage practices, stratification of P and K manifested strongly within 10 years, while stratification of Ca and Mg only manifested moderately between 10 and 20 years.

Keywords: acidity, nutrients, straw disposal, tillage practices, weed control

COWPEA PRODUCTION OUTPUT AND UTILIZATION AT GABAZA AND MAFARANA COMMUNITIES OF MOPANI DISTRICT IN THE LIMPOPO PROVINCE

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INTRODUCTION

The yield of cowpea depends upon the variety, soil fertility, irrigation facilities available and climatic conditions (Kadam and Chavan, 1998). Cowpea is produced by smallholder farmers in the Limpopo Province. However, data on cowpea production output and utilization is not available. Quantification of yield estimates could help to assess the potential of cowpea as a cash crop for the communities. This study was conducted to document the existing cowpea production output, practices and its different uses.

MATERIALS AND METHODS

The study was conducted at Gabaza and Mafarana farming communities, in the Mopani District of the Limpopo Province, South Africa. Thirty (30) farmers were interviewed in each of the two villages using questionnaires. Fifteen (15) farmers per village were selected for cowpea dry matter and yield estimates, crops were harvested from 4 m^2 / farmer. Data were analyzed using the SPSS programme.

RESULTS AND DISCUSSION

Cowpea yield and yield components

There was no significant difference in the yield of cowpea among the two villages. Cowpea grain yield varied from 162.50 kg ha^{-1} to 1305.00 kg ha^{-1} at Gabaza, while that of Mafarana ranged from 186.00 kg ha^{-1} to 1254.80 kg ha^{-1}. The seed dry weight between the two villages differs significantly. The observed mean weight of 100 seeds of cowpea at Gabaza (40.02 g) and Mafarana (41.47 g) was higher than the range of 10 g to 25 g reported by Purseglove, 1977.

Utilization of cowpea

The study revealed that majority of the respondents at the two communities produce cowpea mainly for home consumption, while only a few produce excess for sale. Different uses include, harvesting (cutting) the fresh leaves and the shoot tips for vegetable (relish) and keeping dried grains for future use.

Cropping system and production practices

Majority of the farmers practiced mixed intercropping, while 100 percent of respondents intercropped maize with cowpea. The planting dates ranged from October to January. Majority of farmers used own seed and only few used any form of fertilizer, hence reduced yield. Similar observation was reported by Ayodele and Mariga, 2006.

CONCLUSIONS

Cowpea is produced under the mixed intercropping system with other crops such as maize, pumpkin, groundnuts and Bambara nuts. Majority of farmers used own seeds and only few used any form of fertilizer. Hence reduced yield but no significant variation between the two communities. Cowpea at the vegetative stage is harvested and used as relish and dried seeds at maturity stored for future use. Cowpea production is mainly for home consumption, while only a few produce excess for sale.

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Keywords: cowpea, yield, mixed intercropping

ESTIMATING STREAMFLOW USING SOIL DRAINAGE CURVES OF SELECTED PROFILES IN CATHEDRAL PEAK VI CATCHMENT: A HYDROPEDOLOGICAL PERSPECTIVE

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INTRODUCTION

Soil plays a vital role in estimating streamflow rates and volumes because of its capacity to absorb, retain and release water, hence affecting the hydrological response of a catchment. The major components of a streamflow hydrograph are surface and subsurface water flow. It is hypothesized that reliable soil drainage curves of the upper vadose zone can help to interpret the subsurface flow as reflected in the Cathedral Peak VI catchment hydrograph. If our hypothesis proves to be correct, then better h hydrological predictions should be possible for ungauged basins by determining drainage curves for the dominant soils in the relevant catchment. However, no single research approach is expected to resolve the uncertainties of streamflow in a responsive catchment. This study aims to shed some light on the drainage characteristics of soils in relation to streamflow generation in the Cathedral Peak VI catchment.

MATERIAL AND METHODS

To test the hypothesis, a four-year hydrograph and rainfall data were used to identify appropriate draining periods of the hydrograph to which soils are a major contributing factor. Drainage curves of representative soil profiles were constructed for the identified periods from soil water content data (Everson *et al*., 1998) over four years and used to estimate changes in water content during identified periods. An estimation of water volume contributed to the streamflow was then made and compared to the actual streamflow for the same period.

RESULTS AND DISCUSSION

The results show that 1991 streamflow of the catchment was under estimated by 19%, 1993 by 8% and 1994 by 27%, while 1992 was over-estimated by 12%. The under estimation was attributed to base flow from the lower vadose zone, which could not be estimated from the soil drainage curves. The contribution of water from the lower vadose zone to the streamflow occurs concurrently with the contribution of water from the upper vadose zone and cannot be separated. The over estimation of streamflow in 1992 was attributed to less rainfall occurring in February and March preceding analysis period, which limited the baseflow. The decrease in the soil water content in the last phase of drainage was higher than measured streamflow, indicating that more water drained vertically than horizontally to the stream.

CONCLUSIONS

Soil drainage curves of representative soil in Cathedral Peak VI catchment could facilitate interpretation of the hydrograph. Future studies should investigate detailed analysis of baseflow of this catchment by estimating the contributions from the lower zone.

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Keywords: upper vadose zone, lower vadose zone, hydrograph, drainage curve, ungauged basin

Tylenchulus semipenetrans BIOTYPE IN FIVE CITRUS-PRODUCING REGIONS OF SOUTH AFRICA

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INTRODUCTION

In South Africa, the citrus industry is regarded as one of the largest agricultural industries in terms of export earnings. However, surveys have shown that the citrus nematode, *Tylenchulus semipenetrans* Cobb, occurs in all citrus-producing areas of the country and reduces citrus production through the slow decline disease. Within the citrus nematode three biotypes exist namely citrus, mediterranean and poncirus biotypes that are capable of breaking resistance in rootstocks. Since biotypes of the citrus nematode had been reported to overcome resistance in rootstocks planted in many citrus groves, information on the dynamics of biotypes within a citrus-producing region is important in choosing a rootstock to improve yield and quality. The objective of the study was to determine the citrus nematode biotype in five citrus-producing regions using differential host plants.

MATERIALS AND METHODS

The study was conducted under greenhouse conditions at the Horticultural Unit of the University of Limpopo (23°53”10’S, 29°44”15’E). Differential host plants that included 2-year-old rough lemon, trifoliate orange and olive plants were transplanted into 30-cm-diameter plastic pots, filled with 2.8 litres steam-pasteurized sandy soil and Hygromix at 3:1 (v/v). Nematode populations for inoculation were obtained from citrus roots collected from Gilead, Groblersdal, Rustenburg, Addo and Citrusdal. Treatments were arranged in aRCBD with 15 replications and inoculated with 10 000 juveniles each. At harvest, 120 days after inoculation final nematode populations were obtained from roots and soil. Data were subjected to an analysis of variance using SAS software and means separation accomplished using Duncan’s multiple-range test.

RESULTS AND DISCUSSION

Differential-host tests demonstrated that the citrus nematode populations from Gilead, Groblersdal, Rustenburg, Addo and Citrusdal had different reproductive factors (RFs). Comparisons of means within plant host in each location suggested that populations from Gilead and Groblersdal were always reproducing more on the same host plant than those from the other regions. *Tylenchulus semipenetrans* biotype from all the citrus-producing areas had RFs greater than one in rough lemon and trifoliate orange, whereas the RF in olive was lower than one. All RF values above one indicate susceptibility of the host, whereas those below one indicate resistance, which is expressed in terms of the inability of the nematode to develop and reproduce in the host plant. Using nematode reaction on differential-host, olive was consistently resistant to *T. semipenetrans* populations used in this study, whereas both trifoliate orange and rough lemon were susceptible.Because the *T. semipenetrans* biotype from the five citrus-producing regions did not reproduce on olive but did reproduce on rough lemon and trifoliate orange, the present investigation suggested that the *T. semipenetrans* biotype from Gilead, Groblersdal, Rustenburg, Addo and Citrusdal is a poncirus biotype.

CONCLUSIONS

Knowledge of the nematode biotypes present in a country is useful in the choice of resistant rootstocks and other management and regulatory practices. The identification of the *T. semipenetrans* biotype in South Africa will be helpful to recommend the most suitable rootstock and further utilization in citrus improvement programs.

Keywords: Biotype, Reproductive factor, citrus nematode

NITROGEN MINERALISATION POTENTIAL AS AFFECTED BY DIFFERENT CROP ROTATION SYSTEMS IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE: PRELIMINARY RESULTS

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INTRODUCTION

Wheat is an important winter cereal crop in the Swartland sub-region and can be included in crop rotation systems after various crops including wheat, canola, lupin and medics. Information on residual fertiliser and m ineralized nitrogen and the rate of N mineralisation in soils that were planted to abovementioned crops is not available and needs to be quantified. N availability (total mineral N and time during the growing season when available), to the current wheat crop is a function of the previous crop, climatic conditions and inherent soil factors. Understanding and quantifying soil nitrogen availability, either mineralised or fertiliser N, is therefore essential to improve fertiliser N programmes that will ensure optimum N availability throughout the growing season of the wheat crop.

MATERIALS AND METHODS

Three systems, wheat monoculture - (WWWW), wheat/canola - (WWCW) and w heat/medic (McWMcW), were used to quantify N mineralisation during the wheat phase. The nitrogen mineralisation study formed part of an extensive nitrogen management study on wheat at the Langgewens Research Farm. The trial was laid out as a factorial, arranged in a split plot design with previous crop (wheat, canola or medic) allocated to main plots and N treatments to sub-plots. Treatments were replicated four times. The fallow plots (26.4 m^2) were used to study nitrogen mineralisation potential within each system. This paper only assesses soil samples collected from the fallow plots, 30 days before the expected sowing date, at sowing and at 2-weekly intervals after sowing. Four soil cores (40 mm diameter, 200 m m deep) were taken per plot, bulked and dried as soon as possible after collection. An auto-analyser was used to determine the soil NH_4^+- and NO_3^--N content and the total inorganic N calculated as the sum of NH_4^+- and NO_3^--N.

RESULTS AND DISCUSSIONS

RESULTS from the 2008 growing season showed higher soil N contents in the McWMcW system 5 weeks before sowing. These higher levels were also observed at planting as well as three weeks after planting. Initial differences in soil N content during the 2007 pre-planting and planting seasons were not as pronounced as during the 2008 production season. No differences in soil N content were recorded between the McWMcW and WWCW systems five weeks after sowing and l ater during the 2008 growing season. Mineral N content in the McWMcW system at planting during 2008 was 99.7 mg kg^{-1} in comparison to the 77.4 and 81.4 mg kg^{-1} in the WWWW and WWCW systems respectively. A definite increase in soil-N content was observed between weeks 10 to 12 after sowing in the McWMcW and WWWW systems. Mean soil-N levels decreased from between 80 and 100 mg kg^{-1} at sowing to 20 mg kg^{-1} six weeks after planting, possibly as a result of leaching.

CONCLUSIONS

Preliminary results show that differences in nitrogen mineralisation occur between different systems and might influence nitrogen availability during the first four weeks after planting as the medic-based pasture resulted in higher initial soil N levels after planting. Final conclusions will however only be formulated after a three year period of data recording.

ACKNOWLEDGEMENT

The Winter Cereal Trust for financial assistance.

Keywords: residual-N, soil-N

EFFECT OF DEFICT IRRIGATION STRATEGIES ON YIELD AND WINE QUALITY OF SHIRAZ IN THE BREEDE RIVER VALLEY

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INTRODUCTION

Wine grapes are one of the most important crops in the Breede River valley. Due to low summer rainfall, grape growers depend on irrigation to maintain economically viable yields and to produce export quality wines. Since irrigation water is limited, growers should aim to use as little water as possible. Previous research indicated that a deficit irrigation approach might provide an optimum balance between yield, quality and water use. However, information regarding grapevine response to different deficit irrigation strategies is limited, particularly under drip irrigation. The objective of the study was to determine the effect of different irrigation strategies on yield and wine quality.

MATERIALS AND METHODS

The field trial was carried out during the 2006/07 and 2007/08 seasons in a commercial Shiraz/110R vineyard near Robertson. The loamy soil was homogeneous to a depth of 60 cm where a lime horizon occurred. Nine treatments, which consisted of different pre- and post-véraison soil water deficit combinations, were compared to a control treatment where grapevines were irrigated when 40% plant available water (PAW) was depleted. Treatments were replicated three times in a randomised block design. Normal viticultural practices were applied to grapevines under all treatments. Soil water content was determined using a neutron probe that was calibrated against gravimetric soil water content. Soil water characteristic curves were determined *in situ* by relating soil water content to matric potential, as measured using tensiometers. Midday plant water potential was measured to quantify the effect of deficit irrigation on grapevine water status. Yield was determined when the grapes were harvested at *ca*. 24°B in March. Experimental wines were prepared and subjected to sensorial evaluation. Vegetative growth was quantified by measuring pruning mass in July.

RESULTS AND DISCUSSION

Vegetative growth

Shoot growth of grapevines that were subjected to deficits stopped before middle December, whereas those of the control showed active growth until February, *i.e*. shortly before harvest. Where pre-véraison deficits were followed by irrigation at 40% PAW depletion during ripening, re-growth occurred. In both seasons, the control grapevines had higher cane mass compared to the deficit irrigated ones.

Yield

Deficit irrigation decreased berry mass compared to irrigation at 40% PAW depletion. Hence, water deficits resulted in smaller bunches which reflected in smaller yields, compared to that of the control in both seasons. During the 2007/08 season, visibly more grey rot (*Botrytis cinerea*) occurred where grapevines were irrigated at 40% PAW depletion, compared to those that were subjected to water deficits.

Wine quality

Deficit irrigation, particularly where high PAW depletion levels occurred, produced wines better in colour and having more intense berry and spicy character than irrigation at 40% depletion throughout the season. The improved wine properties resulted in higher overall wine quality compared to the control. Wine quality trends were similar during the two seasons.

CONCLUSIONS

Allowing high levels of PAW depletion between irrigations induced more plant water stress. Increased levels of PAW depletion reduced vegetative growth and yield, but enhanced wine colour as well as berry and spicy characters and, subsequently overall wine quality.

ACKNOWLEDGEMENTS

We thank the ARC and Winetech for research funding, colleagues at Infruitec-Nietvoorbij for technical support and Mr. H. Erasmus for permission to work in his vineyard.

Keywords: grapevine, deficit irrigation, yield, wine quality

INTERACTION OF ENVIRONMENT AND EXPRESSION OF HOST PLANT RESISTANCE TO RUSSIAN WHEAT APHID, *Diuraphis noxia* (KURDJUMOV)

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INTRODUCTION

The first RWA resistant cultivar; Tugela-Dn was released in 1992 and in 2008, fourteen of the eighteen dryland wheat cultivars recommended for the summer rainfall region contain resistance to RWA. Varying resistance levels within a resistant cultivar or between different resistant cultivars containing the same donor remains unexplained. This study aims to address this issue by creating "aphid-free" periods during plant growth for a set of cultivars in different environments during two seasons and comparing results with AMMI analyses.

MATERIAL AND METHODS

From 2003 to 2006 wheat trials with four cultivars varying in RWA resistance levels were planted at Bethlehem, Glen, Ladybrand and Qwa-Qwa. Seed dressing was applied as a treatment with the assumption that seed dressings will always result in aphid-free plants during the vegetative growth period or first two-months of plant development. Foliar insecticide treatments were applied between GS12 and GS13 to enable aphid-free wheat plants during the latter reproductive phases. A combination of the two strategies was also included to obtain wheat plants not subjected to aphids during any period of the season. Yield data was analysed by using the Additive Main effects and Multiplicative Interaction (AMMI) analyses available in Genstats.

RESULTS AND DISCUSSION

Percentage Russian wheat aphid infested tillers were very high to medium at Bethlehem and Ladybrand (2003) and Bethlehem and Glen (2004). AMMI analyses of variance indicate that genotype G (<0.001) and environment E (<0.001) main effects and G x E (<0.05) interaction were significant for the 2003 and 2004 seasons. The main effect of environment contributed 82.3% to the total variation in contrast to genotype and G x E interaction each contributing 8.9% to the total variation. IPCA1 explained 60.5% of the G x E interaction sum of squares in 2003 and 2004 and provided the major interpretation of G x E interaction. During the 2005 and 2006 seasons lower occurrence of RWA and more favourable climatic conditions at both Bethlehem and Qwa-Qwa resulted in higher yields by all four entries. Analyses of variance indicate that environment E (<0.001) and G x E (<0.001) interaction were significant for the 2005 and 2006 seasons. The effect of environment was highly significant and contributed 80.5% to the total variation of sum of squares compared to 16.9% of G x E interaction. Both IPCA1 and IPCA2 were significant and ASV was used to determine the most stable combination.

CONCLUSIONS

The combination of RWA resistant cultivars with insecticides stabilised yields in all four seasons. RWA resistant cultivars were more vital in securing stable yields during the occurrence of high abiotic and biotic stress as experienced in 2003 and 2004. The large effects of environment in 2003/2004 (82.3%) and in 2005/2006 (80.5%) indicate the enormous influence of the environment on cultivar response to RWA during all four seasons.

Keywords: Russian Wheat Aphid, Stability of expression, AMMI, Host plant resistance

ANNUAL WEED COMPETITIVENSESS AS AFFECTED BY PREEMERGENCE HERBICIDE IN CORN

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INTRODUCTION

Competitiveness of weeds that survive a preemergence herbicide application (escaped weeds) might be altered due to herbicide injury. As a result, potential crop yield loss may be reduced.

MATERIALS & METHODS

Field experiments were conducted at Ashland Bottoms in 2001 and 2002 and Rossville in 2002 to quantify corn growth and yield response to Palmer amaranth or velvetleaf competition, with or without isoxaflutole (0.03 kg ha^{-1}) or flumetsulam (0.004 kg ha^{-1}) application, and to determine Palmer amaranth or velvetleaf seed production as affected by preemergence herbicide. Palmer amaranth and velvetleaf were established at a density ranging from 0 to 6 and 0 to 32 plants m^{-1} of corn row, respectively.

RESULTS AND DISCUSSIONS

At Ashland Bottoms in 2002, corn height at tasseling decreased with increasing Palmer amaranth (slope = -1.58 cm $weed^{-1}$ m^{-1}) and velvetleaf (slope = -1.32 cm $weed^{-1}$ m^{-1}) density when no herbicide was applied. With flumetsulam, every unit increase in velvetleaf density reduced corn height by 0.4 cm. When corn tasseled, escaped Palmer amaranth and velvetleaf were shorter than untreated plants. When isoxaflutole or flumetsulam was applied on velvetleaf, maximum height reduction of 97% was observed at Rossville in 2002. In the absence of isoxaflutole or flumetsulam, corn yield loss increased with increasing Palmer amaranth or velvetleaf density. At Rossville in 2002, Palmer amaranth that escaped isoxaflutole or flumetsulam application caused 25% corn yield loss at a density of 6 plants m^{-1}. In contrast, corn yield loss from untreated Palmer amaranth at the same density was 38%. At Ashland Bottoms in 2002, 6 velvetleaf plants m^{-1} that escaped flumetsulam application reduced corn yield by 6% compared to 55% yield reduction with untreated velvetleaf at the same density. Herbicide treatment had no effect on Palmer amaranth or velvetleaf seed production. Palmer amaranth seed production was density-independent, averaging at 123,140 seed m^{-2} with no herbicide and 75,930 and 110,470 seed m^{-2} when isoxaflutole and flumetsulam were applied, respectively. Velvetleaf seed increased linearly with increasing density (slope = 531 seed m^{-2} $weed^{-1}$ m^{-1}), with or without flumetsulam, with the exception of 1 site-year where data were described by a rectangular hyperbola model.

CONCLUSIONS

The study showed that corn yield reduction from both Palmer amaranth and velvetleaf that escaped through a preemergence herbicide was less than from untreated weeds. However, seed production by escaped weeds was similar to untreated weeds.

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Keywords: Yield loss, Escaped weeds, Competition, Density

FACTORS CONTRIBUTING TO THE DEVELOPMENT OF LENTICEL BREAK DOWN IN 'ROYAL GALA' APPLES

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INTRODUCTION

Lenticel break down is a relatively new post harvest disorder observed on apples in the apple producing countries world wide. At present, the actual cause for this disorder is unknown, however there are several factors that possibly contribute towards the increase in severity observed lately. The effect of pre-harvest temperatures, rate of cooling, and storage temperatures and am elioration of orchard conditions were assessed during the past two seasons. The possible influence of fruit calcium content and fruit maturity were also investigated. The theory being that Ca concentration in the fruit may play a similar role to that of bitter pit incidence.

MATERIALS AND METHODS

Reducing lenticel stress during harvest/storage Fruit from the 4th harvest maturity of 'Royal Gala' from Nooitgedaght, Ceres were used in this trial. Fruit were collected from bins at harvest, concentrating on the most mature fruit, represented by a yellow calyx end. Three treatments - a control and two different waxes - were used on five replications of 18kg lugs each. Fruit were dipped in two commercial waxes after harvest and left to dry. The control received no wax or water. Thereafter, fruit were transported back to the pack shed, following the standard commercial protocol. The temperature and relative humidity of the fruit inside the bins were monitored every 10 minutes from harvest until storage. Fruit were evaluated after three months' storage. The effect of different harvest maturities and cooling rates on the incidence and time of development of lenticel break down on 'Royal Gala' apples during cold storage. A trial was conducted to determine whether different harvest maturities, in combination with different cooling rates influences the incidence and t ime of development of lenticel break down on 'Royal Gala' apples during regular atmosphere storage. The trial consisted of two components. The first component consisted of fruit cooled at fast forced-air cooling rates, cooling the fruit down to the required temperature as fast as possible. The second component was fruit cooled at a slow/stepped cooling rate bringing the fruit temperature down over a slightly longer period. There were two harvest dates from three different orchards in the Koue Bokkeveld. Fruit subjected to the two cooling rates were stored and analysed for lenticel breakdown directly after harvest and every 4 weeks thereafter until week 20.

RESULTS AND DISCUSSION

The reasons behind the increase in lenticel breakdown (LB) in 'Royal Gala' were investigated to determine the effect of vapour pressure deficit (VPD) on the development of the disorder. Trials were conducted in an orchard with a histoy of LB to try and eliminate possible reasons for the development for (LB) in 'Royal Gala'. Very little LB occurred at the experimental sites during the last two seasons. Individual fruit analysis to determine whether mineral content influences susceptibility to LB could not be completed, but the one season showed no correlation between fruit Ca content and LB. The storage trials were carried out, and even though statistical differences from the storage results indicated a possible effect of cooling rate, no conclusive results were found due to the low incidence of LB in all trials.

Keywords: Ca concentration, climate, pre-harvest stress, cold storage

EARLY ESTABLISHMENT PERFORMANCE OF LOCAL AND HYBRID MAIZE UNDER TWO WATER STRESS REGIMES

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INTRODUCTION

Many subsistence farmers in South Africa are still using local varieties. Whereas these varieties have poorer yield than hybrids under optimum management conditions, they remain an important resource for germplasm improvement (Modi, 2004). Therefore, it is not surprising that many subsistence farmers in South Africa are still using landraces. The objective of this study was to compare two landrace selections of maize with two hybrids popular among small-scale farmers in KwaZulu-Natal, for seed performance and water stress tolerance during seedling establishment.

MATERIALS AND METHODS

Seed from a local germplasm was characterized according to kernel colour. Two landraces, white (Land A) and dark red (Land B) were compared with two hybrids, SC701 and SR52, both late maturing varieties popular amongst the small scale farmers in KwaZulu-Natal. Standard germination (SG) test and electrical conductivity (EC) were used to assess seed quality under laboratory conditions. Seedling emergence was performed in seedling trays using pine bark at 25% and 75% field capacity (FC), respectively, over a period of 21days.

RESULTS

All seed types showed a total germination percent greater than 93%, with no significant differences among them. Land A had the highest germination percentage (98%), followed by SR52 (97%), Land B (95%) and SC701 (94%). There were highly significant differences ($p<0.001$) among seed types with respect to daily germination and germination speed. Land A had the lowest germination speed, while SR52 germinated fastest. There were highly significant differences ($p<0.001$) in mean germination time (MGT), with Land A having the highest MGT. There were no significant differences in root length while there were significant differences ($p<0.05$) in shoot length. Landraces showed a 20% better root length than hybrids. SC701 had the highest and significant ($p<0.001$) electrolyte leakage while Land A had the lowest electrolyte leakage. There were no significant differences in mean emergence time when seedlings were grown at 75% FC, but there were significant differences ($p<0.001$) at 25% FC. There were highly significant ($p<0.001$) differences in final emergence between 25% and 75%FC. At 25% FC seedling emergence was drastically reduced, but Land A was showed about 48% better emergence than other seed types. Plant height, leaf number and area, and root length were all significantly ($p<0.001$) reduced by water stress. For all seed types, root growth was much less inhibited by water stress than shoot growth. This reduction was more pronounced in hybrids than the landraces.

CONCLUSION

Seed performance and seedling establishment are important determinants of crop germplasm performance. This study showed that landraces may have the same viability as hybrids. The strength of the hybrids was more isolated to their ability to germinate and emerge faster and more uniformly than the landraces whilst the landraces showed a degree of water stress tolerance. Future studies will investigate performance of landraces and hybrids under a wide range of field conditions and whether or not hydro-priming can be used to increase the germination and emergence speed of landraces.

Keywords: conductivity, emergence, germination, landraces

EFFECT OF PLANT SPACING ON GROWTH AND YIELD COMPONENTS OF FOUR LEAFY LETTUCE (*Lactuca sativa* L.)CULTIVARS IN A SOILLESS PRODUCTION SYSTEM

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INTRODUCTION

The commercial importance and production level of lettuce, which is the most popular of the local salad crops, is increasing in South Africa. Moniruzzaman (2006) indicated that plant population or density is among the factors that affect yield and quality of in-soil cultivated lettuce. Ideal plant density can lead to optimum yields, whereas too high or too low plant densities could result in relatively lower yields and quality. An understanding of a crop's response to plant density is crucial for maximizing leafy lettuce yield. Furthermore, due to cultivar differences in vigor and vegetative growth, the optimal plant spacing might be cultivar dependant. The objective of this study was to examine the effect of plant spacing on vegetative growth and yield components of four commercially grown leafy lettuce cultivars.

MATERIAL AND METHODS

The plantlets were transplanted 28 days after seeding, utilizing a gravel-film technique hydroponic system as described by Maboko & Du Plooy (2007). Twenty treatment combinations were used, namely four cultivars ('NIZ 44-675', 'Nougatine', 'Tango' and 'Natividad' from Ferax Seed Company, S.A.) combined with five plant spacings (10x20, 10x25, 15x20, 20x20 and 20x25 cm inter- and intra-row, respectively). The experiment was laid out as a randomized complete block design with three replicates. During harvesting, plant height (cm), leaf area (cm^2), fresh and dry leaf mass (g) and number of leaves were measured. A decrease in the fresh mass of the harvested lettuce was calculated after storage at 4^oC for 7 and 14 days. The leaf area (cm^2) of harvested leafy lettuce was measured using a leaf area meter.

RESULTS AND DISCUSSIONS

Spacing significantly affected plant height, fresh and dry leaf mass, leaf area and leaf number, with significantly higher values at the closest spacing (high plant population). The results indicate that an increase in plant population results in a significant increase in yield and yield components of leafy lettuce. This is maily the result of competition for photosynthetic active radiation which stimulate the growth. Cultivar differences observed showed that 'NIZ 44-675' and 'Tango' performed better compared to 'Nougatine' and 'Natividad', mostly due to higher leaf area, fresh mass, plant height and leaf number.

CONCLUSIONS

The results indicate that the best plant spacing used in this trial for these leafy lettuce cultivars is 10 x 20 cm (50 plants m^{-2}) compared to other spacings. This is because of higher number of plants m^{-2} which improved fresh mass and dry leaf mass. Two cultivars 'NIZ 44-675' and 'Tango' were found to grow more vigorous which can be ascribed to differences in genetic makeup. The indication that the growth season might be shortened by increased plant density will be investigated in a follow up trial.

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Keywords: fresh mass, leaf area, plant height, plant population

IMPROVING DRYLAND WATER PRODUCTIVITY OF MAIZE THROUGH VARIETY SELECTION AND PLANTING DATE OPTIMIZATION IN MOZAMBIQUE

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INTRODUCTION

Mozambique is a semi-arid area with unreliable rainfall distribution, therefore optimal planting dates are critical to ensure that maize is not stressed during critical stages. However, because of food shortages in most small family holdings, farmers tend to sow whenever enough rain has fallen. This often leads to complete crop failure. For optimisation of yield, planting at the appropriate time to fit the cultivar maturity length and growing season is critical. Two open-pollinated maize varieties that are adapted to the area, Changalane and Tsangano, were selected to represent early and late maturities. The research objective was to study the effect of sowing date and cultivar on maize (*Zea mays L.*) yields in Mozambique.

MATERIALS AND METHODS

An experiment was conducted during the 2007/08 season at the Chókwè Agricultural Research Station, Mozambique. The two cultivars, Changalane and Tsangano, were sown on three different dates: 5 December 2007 (PD1), 25 December 2007 (PD2) and 15 January 2008 (PD3). A randomised block design with six treatment combinations (3 sowing dates x 2 cultivars) and three replications was used. Measurements of leaf area index (LAI), total dry matter yield (TDM), leaf area duration (LAD) and grain yield were made.

RESULTS AND DISCUSSION

Sowing date had a significant effect ($p<0.05$) on yield and yield components. The 25 December planting (PD2) out yielded (4.3 ton/ha) the 5 December (PD1) (2.5 ton/ha) and 15 January (PD3) (1.5 ton/ha) sowings for Changalane (difference of 43.1 and 66%, respectively). However, for Tsangano, PD1 out yielded PD2 and PD3 by 28.6 and 77.3%, respectively. Cultivars varied significantly in yield potential. Changalane on average out yielded Tsangano by 7.4%.

The trend for TDM yields was similar for both varieties and all planting dates. PD2 had the highest TDM values between 68 and 75 days after sowing (0.95 kg m^{-2} for Changalane). Although PD3 for Changalane also attained high TDM values, this was not reflected in the final grain yield.

LAI curve trends were similar for the same planting date in both varieties. For Changalane, the highest value of 2.76 was observed for PD2, while for Tsangano the highest value of 2.94 was recorded for PD1. Delayed planting (PD3) resulted in lowest LAI values.

LAD was longer for PD2 in both Changalane and Tsangano. Changalane had the longest LAD, compared with Tsangano. PD3 gave lowest LAD for both varieties. When compared with PD2, the reduction in LAD was 69 and 46 day m^2 m^{-2} for Changalane and Tsangano, respectively.

CONCLUSIONS

The results from this single season trial can not be used to draw final conclusions regarding the best planting window, variety selection and its impact on grain yield of the studied maize varieties. However, the study clearly revealed that planting date had a significant effect on grain yield of maize.

A modelling approach is suggested for optimizing planting dates of different varieties to ensure most efficient use of limited rainfall. The field data collected in this trial will be useful for the calibration of such crop models.

Keywords: dryland maize, planting dates, varieties, yield, water productivity

NEW PROPAGATION METHODOLOGY FOR AMADUMBE (*Colocasia esculenta*)

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INTRODUCTION

Amadumbe is an edible aroid and one of mans oldest cultivated crops, yet virtually unknown in most of the South African provinces. The crop is one of the most important staples consumed in Africa, the Pacific, Caribbean Islands and many parts of Asia . In Soth Africa, it is widely cultivated by small scale farmers in Kwazulu-Natal, Eastern Cape and Mpumalanga Provinces . The crop is propagated primarily by separation of offsets termed cormels from the primary corm. Availability of quality propagation material often limits cultivation of the crop. The ARC-VOPI succeeded with in *vitro* propagation of amadumbe in 2006/7. Since the application of tissue culture (*in vitro*) techniques by farmers (especially small scale farmers) is limited and the multiplication rate is relatively low (1.7 - 2.5 per month), alternative propagation methodologies were investigated. The effects of storage temperature, and type of propagation material on yield were investigated in a 40% white shade net structure.

MATERIALS AND METHODS

Four different sizes of amadumbe corms (10 -20 g, 20 - 30 g, 30 - 40 g and 40 - 50 g) were stored in paper bags at three different temperature regimes (9^{o}C, 17^{o}C and 25^{o}C constant temperatures). After three month storage the corms were removed, sterilized with 1% sodium hypochlorite and placed in plastic bags filled with 140 g moistened vermiculite in a growth cabinet at 25/30^{o}C. Additionally, corms were cut into several vertical and horizontal sections that were sterilized and treated similarly to the stored corms. .After one week in the growth cabinet at 25/30^{o}C the rooted corms and corm sections were transplanted into a shade net structure to determine growth and final yield in comparison to plantlets from tissue culture and unsprouted corms.

RESULTS AND DISCUSSION

Yield obtained with tissue cultured plantlets were comparable with yield from whole corms, indicating that tissue culture can be utilized as a propagation method. Storage temperature of the propagation material had no significant effect on the final yield obtained. Whole sprouted corms, top halves and unsprouted corms out-yielded bottom halves and quarters when used as propagation material. Small corms which were first sprouted in different temperatures gave significantly higher yield than larger or medium corms. This contradicts previous findings from earlier experiments where yield increased with larger corms as planting material.

CONCLUSIONS

Sprouted as well as unsprouted corms and top halves of amadumbe corms can be used as planting material. Yield was better with small (10 - 20 g) than with medium to large corms although these results need to be confirmed.

Keywords: propagation, corm sections, in vitro

RESPONSES OF *Mimusops zeyheri* SEEDLINGS TO CLAY, LOAM AND SANDY SOILS UNDER GREENHOUSE CONDITIONS

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INTRODUCTION

Attempts are underway to domesticate *Mimusops zeyheri* in Limpopo Province, under food security programmes, due to its edible and aesthetic attributes. Most food security programmes are geared towards improving the standard of living in rural communities. The natural habitat of *M. zeyheri's* suggests that the tree is well-suited to marginal soils such as rocky-mountains and sandy soils. However, the influence of soil type on this fruit tree is not documented. The objective of the study was to determine the effects of three soil types on biomass production of *M. zeyheri* seedlings.

MATERIALS AND METHODS

Loam, clay and sandy soils were locally collected and analyzed for soil particle distribution using the rapid Bouyoucous method. Greenhouse-raised four-month-old *M. zeyheri* seedlings were transplanted into 30-cm diameter plastic pots containing each soil type and arranged in a randomized complete block design, with 18 replications. Seedlings were irrigated weekly with one litre of tap-water and fertilised monthly with 1 g 2:1:2 N:P:K (43 % active). At harvest, 12 months after transplanting, plant height, leaf length, leaf petiole, leaf width, stem diameter and number of leaves were measured. Data was subjected to analysis of variance using SAS software and means separation accomplished using the FLSD test.

RESULTS

Generally, all six plant variables measured were significantly higher in clay and loam soils than in sandy soil. Compared with clay soil, seedlings grown in sandy soils were recorded as having reduced plant height, leaf length, leaf petiole, leaf width, stem diameter and number of leaves by 51 %, 30 %, 31 %, 16 % and 54 %, respectively. However, the stem diameter and the number of leaves in seedlings growing in clay soil, were significantly higher than those growing in loam soil.

DISCUSSION

Growth of *M. zeyheri* seedlings was good and poor in clay and sandy soils, respectively. Generally, fruit trees with tap root systems grow poorly under clay soils due to their sensitivity to water-logging conditions and root rots. In this study, *M. zeyheri* with its fibrous root system appeared to be well-suited for clayey soils.

CONCLUSION

Most rural communities in Limpopo Province were historically settled in areas with soils of low agricultural potential, where clay and sandy soils predominate. The results of this study suggested that *M. zeyheri* would be adapted to sites with clay soils where rural communities are established and where food security programmes are prioritised.

Keywords: Mimusops zeyheri , soil type

ALLELOPATHIC POTENTIAL OF *Conyza* SPP

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INTRODUCTION

Conyza spp, commonly known as horseweed, is a serious weed in many parts of the world. It has been documented in 70 countries and in 40 different crops around the world. It also commonly grows in gardens, along roadsides, irrigation ditches, railroads, and other rights of way. The aim of the study was to determine if *Conyza* possesses allelopathic potential, specifically the ability to suppress crop growth, through the release of allelochemicals from the roots.

MATERIALS AND METHODS

In an hydroponic system in a greenhouse at the University of Pretoria, *Conyza* plantswere grown to assess if the weed affects lettuce and tomato plants due to exudation of allelochemicals from the weed roots into the growth medium of the two test species. In one experiment lettuce was grown either together with the weed in a complete nutrient solution. Controls for both the weed and lettuce involved growing the two species separately. *Conyza* plants were collected on the university experimental farm at the seedling (rosette) stage and transferred to the nutrient solution. Lettuce was commercially obtained at seedling stage. In a second experiment *Conyza* were grown to maturity in the glasshouse in a pure quartz sand medium. In separate pots, lettuce and tomato seedlings were transplanted to the quartz sand medium and regularly watered with leachate collected from 15 pots in which *Conyza* plants were cultivated. After four weeks the test plants were harvested and fresh and dry mass of tops and roots measured. Mean separation was done with the least significant difference test of Tukey at P= 0.05.

RESULTS AND DISCUSSION

In the lettuce bioassay (Exp 1) the roots of control lettuce plants appeared healthier and had grown significantly better than lettuce which grew together with *Conyza.* The roots of lettuce grown together with *Conyza* were significantly reduced in weight, volume and length. In the lettuce and tomato bioassay the two species responded differently to allelochemicals purported to have been released from the roots of *Conyza*. Apparent growth stimulation was observed in shoot and leaf parameters for tomato, but roots tended to be negatively affected. Growth stimulation of the test species was not observed in lettuce leaves, and both leaf and root growth were suppressed by leachate from *Conyza*.

CONCLUSIONS

The reduction in the size of the lettuce roots implicated or at least suggested the presence of phytotoxic (allelopathic) compounds in the growth medium, and that *Conyza* was the source. Root exudation of these compounds by *Conyza* is proposed. The test species' responses to this effect differed, indicating that plants differ in their sensitivity towards the allelochemicals involved. The research is ongoing and a range of bioassays involving different test species are planned.

ACKNOWLEDGEMENTS

This work was supported by the National Research Foundation (NRF).

Keywords: Allelopathy, *Conyza*

CONSUMER PREFERENCE OF PEARS WITH EMPHASIS ON OVERALL EATING QUALITY

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INTRODUCTION

South Africa produces 330,000 tons of pears annually of which about 50% is exported to Europe for fresh consumption. Due to increasing competition from Chile and Argentina, the availability of new cultivars that are preferred by consumers is becoming of great importance to local pear growers. Appearance, most notably colour, has a major influence on consumer perception and acceptance of fruit quality. Colour can attract potential consumers as it creates the first impression they encounter and influences the acceptance or rejection of the product. Eating quality, however, ultimately determines consumer satisfaction with the product and whether they will buy it again. With this in mind, fruit breeders at the ARC Infruitec-Nietvoorbij pear breeding programme need to identify the drivers of consumer preference for appearance and eating quality of pears.

MATERIALS AND METHODS

Ten European pear (Pyrus communis L.) and one Asian pear (P. pyrifolia Nakai) genotypes consisting of nine established pear cultivars and two selections were selected for this study. All selected genotypes were harvested at their optimum firmness, between 6 - 8 kg, between 9 January 2007 and 15 February 2008. Assessments were conducted on two dates, 17 March and 14 April 2008. The fruit was used for maturity indexing, descriptive sensory analysis and consumer sensory analysis. The total soluble solids, titratable acidity and firmness were measured as well as the lightness, chroma and hue colour values. The descriptive sensory analysis consisted of a trained sensory panel. The judges agreed on a consensus list of attributes for describing pear flavour and texture and analysed the eleven samples during four sessions. Approximately 200 local and mostly female consumers participated in the study. A representative sample of each genotype was presented to the consumers who were asked for their degree of liking of the external appearance of the pear genotypes, including the colour and the shape. The degree of liking of taste was also assessed by the consumers on each genotype.

RESULTS AND DISCUSSION

Preference of appearance was the highest for a lightly blushed skin colour, but the yellow or green genotypes also received a high preference by the consumers. Consumer preference for taste strongly correlated with the sensory attributes pear flavour and melting character. Juiciness and sweetness also correlated with consumer preference, but were of lesser importance. These attributes can be seen as the motivating force for preference among the consumers included in this study. On the negative side, consumers disliked sour and hard pears with a russetted skin. The shape of the pear seemed to play an important role in the degree of liking of appearance. Round or very elongated shapes were rejected by the consumers. A pyriform or typical pear shape was preferred.

CONCLUSIONS

The ideal pear has a lightly blushed, yellow or green colour, a conventional 'pear shape', a strong typical pear aroma, a soft and melting texture, prominent juiciness, and high sweetness. This research was performed on local residents who are all assumed to be South African. Therefore, a suggested follow up on these results would be to perform a similar study, based on appearance and colour on European citizens only. However, the results of this study are congruent with similar studies conducted in Canada and Oceania. This would suggest that the ARC pear breeders can make use of local sensory and consumer panels to screen new selections for consumer preference.

Keywords: sensory analysis

EFFECT OF N, P AND K ON KENAF (*Hibiscus cannabinus* L.) DRY MATTER YIELD AND FIBRE DEVELOPMENT

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INTRODUCTION

Kenaf is a stem fibre. Although previously produced in South Africa, cultivation stopped in the 1960's. Presently, there is world wide interest in kenaf as people become more environmentally conscious. This has resulted in the establishment of a kenaf plant in KwaZulu Natal with the aim to supply the automotive industry with bast fibres for the production of vehicle trimmings.

Previous and current research, were and are focused on cultivar adaptation and optimal agronomic practices with the aim of increased dry matter and fibre yields. Very little information is, however, available on how different agronomic factors, especially nutrition, impact on fibre development. The objective of this study was therefore to investigate the effect of N, P and K, on dry matter yield and fibre development.

MATERIALS AND METHODS

A glasshouse pot trial was conducted in Pretoria (November 2007 - January 2008). Kenaf "Tainung 2" seeds were sown into a sandy soil. Plants were thinned out to two plants per pot.

Pots were irrigated twice a week, bringing the soil water content back to field capacity. Clean water with no added nutrients was used.

The treatments were five N (50, 100, 150, 200 and 360 kg N ha^{-1}), three P (0, 50 and 100 kg P ha^{-1}) and three K (0, 100, 200 kg K ha^{-1}) levels. The pots were fully randomized and all treatment combinations were replicated four times.

Plants were destructively harvested six weeks after emergence. Before harvesting, stem diameter was measured. Fresh mass was determined before it was dried in an oven at 68°C for 72 h to determine dry mass.

For a microscope study of the fibres, a 1 cm stem sample from the middle of the stem was collected. From these samples, microscope slides were made and studied with a light microscope. For record keeping, digital photos of the slides were taken.

RESULTS AND DISCUSSION

There was a significant increase in stem diameter when the amount of P was increased from 0 kg P ha^{-1} to 50 or 100 kg P ha^{-1}. There was no significant increase in stem diameter when the K level was increased from 0 to 100 to 200 kg K ha^{-1}, regardless of amount of N and P ha^{-1}.

When plants received 50, 100 and 200 kg N ha^{-1}, 0 kg P ha^{-1} and 50, 100 and 200 kg K ha^{-1}, the plants were statistically lighter than when receiving the same amounts of N and K, but increasing the P rates to 50 and 100 kg P ha^{-1}.

The microscopy study revealed that where no P was added, the plants produced only one ring of fibres, but where it increased to 50 or 100 kg P ha^{-1} it trebled.

CONCLUSIONS

The application of P did have a significant impact on stem diameter. The reason for this came apparent from the microscope study where three rings of were observed with 50 or more kg P ha^{-1},regardless of N and K level, in comparison to a single ring where no P was applied.

Most of the parameters were positively affected by higher N applications rates, if there was some P applied. Where there was no P applied, an increase in N application rate often resulted in a reduction in the specific parameter. Potassium was also necessary for good growth and yield per plant, but did not have such a dramatic impact as P.

Keywords: stem diameter, microsope, fibre bundles

EFFECT OF PLANT DENSITY AND NITROGEN ON KENAF (*Hibiscus cannabinus* L.) GROWTH AND YIELD

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INTRODUCTION

Kenaf has the potential to become an important cash crop in South Africa. A kenaf processing plant is already established in KwaZulu Natal, unfortunately the production of kenaf is experiencing problems due to the lack of registered herbicides, restricted cultivar availability and the lack of agronomic guidelines.

In this presentation we will concentrate on the effect of plant density and nitrogen application rate on the plant length, stem diameter, dry matter yield and bast/core % of kenaf.

MATERIALS AND METHODS

At the end of November 2007, a dry land field trial was established on the Hatfield Experimental Farm, Pretoria, using "Tainung 2" seed. Treatments consisted of five plant densities (200 000, 400 000, 600 000, 800 000 and
1 000 000 plants ha^{-1}) and four nitrogen levels (0, 100, 200 and 300 kg N ha^{-1}). The main plots (60 m^2) with plant density as factor were divided into four sub plots (15 m^2) representing the N levels. Main plots were randomized, with N levels also being randomized within the main plots. Treatment combinations were replicated four times and data was statistically analyzed using SAS.

Dry matter yield was determined after 14 weeks. Before harvest, plant height and stem diameter at each treatment combination were recorded. A sub-sample of 1 m^2 was harvested from each sub plot. After 18 weeks, plants from each treatment combination were harvested and separated into core, bast and pods/flowers.

RESULTS AND DISCUSSION

Plant density had a significant impact on stem height. Plant height tended to decrease with increased plant density. Plant height is correlated with fibre yield; therefore it is important to bear it in mind when deciding on a planting density.

Plant density and nitrogen significantly impacted on stem diameter. At the lowest plant density (PD1) significantly less thin and significantly more medium and thick sized stems were harvested than at the other densities. As the plant density increased, increases in thin stems harvested were observed. At PD4 and PD5, no stems exceeding 20 mm in diameter were recorded.

The amount of thin stems decreased as the nitrogen application rate increased, the amount of medium and thick stems increased over the same range. At zero nitrogen applied, the amount of thin stems differed significantly from the amount recorded at 300 kg N ha^{-1}.

The highest dry matter yield was 22 t ha^{-1} (PD3) with 200 kg N ha^{-1}. At the lowest plant density (PD1) and 0 kg N ha^{-1} dry matter yield (13 t ha^{-1}) significantly differed from the other treatment combinations.

Most of the dry matter (± 52%) is located in the core, followed by the bast (± 37%) and flowers/pods (10%).

CONCLUSIONS

Indications are that plant density has a major impact on stem diameter of kenaf plants. Manipulating plant density as well as the N amount applied the producer will be able to manipulate the crop and produce a larger percentage of plants with a desirable stem diameter.

Stem height also plays an important role in the fibre quantity as more fibre bundles can be expected in taller than in short plants. By adjusting the plant density, a producer can have some control over the plant height, with taller plants being expected at lower plant densities.

Too high N application rates at plant densities higher than 750 000 plants ha^{-1}, is not recommended as it negatively affects dry mass.

Keywords: plant height, stem diameter, core, bast

CROP AND WEED RESPONSE TO RESIDUE RETENTION AND WEEDING METHOD IN A HOE-BASED MINIMUM TILLAGE SYSTEM

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INTRODUCTION

Residue retention and effective weed management are major factors limiting the uptake of conservation farming (CF) by smallholder farmers in southern Africa. This study investigated the effect of retaining different rates of harvested maize (Zea mays L.) and sorghum (Sorghum bicolor (L). Moench) residue and two weed control methods on crop and weed yield.

MATERIALS AND METHODS

The experiment was conducted at Matopos Research Station in Zimbabwe on clay loam and sandy soils during the 2004/05 and 2005/06 cropping seasons. The study investigated the effect of retaining different rates of harvested maize and sorghum residue (0, 25, 50, 75 and 100 %) and two weed control methods (hoe weeding and glyphosate applied with the Zamwipe®) on crop and weed yield. Experimental lay-out was a split plot with three replicates. Residue retention rate was the main-plot factor and weeding method the sub-plot factor. Maize was planted in hoe-made basins while sorghum was dribbled along furrows at first effective rains. Weed biomass at 7 and 11 weeks after planting (WAP) and crop yield was measured under each treatment.

RESULTS AND DISCUSSION

The 2004/05 season had below average rainfall whereas the following season received about twice the station's mean annual rainfall. There was no significant difference in weed biomass and crop yield between residue treatments on both soil types. This indicates that surface mulching neither conferred neither a yield advantage nor a weed suppressive effect over the two years of study. The Zamwipe® was ineffective in controlling weeds and this was observed as significantly higher weed biomass in both maize and sorghum crops compared to hoe weeding. Efficacy in plots where glyphosate was applied was observed to be variable probably due to poor herbicide flow from the weed wipe. In addition, the significant ($P=0.017$) residue X weeding method interaction in sorghum grown on sandy soil at 7 WAP in the second season showed that weed biomass increased with residue retention rate in the Zamwipe® treatment. This suggests that the presence of residue may have reduced the effectiveness of the weed wipe through probably reduced glyphosate-weed contact leading to low weed kill. The significantly lower maize and sorghum yield in the Zamwipe® plots can be attributed to high weed competition. The differences in yield were highly significant on sandy soil where the infertile soil resulted in poor crop stands and growth.

CONCLUSIONS

In the short-term surface mulching did not significantly reduce weed biomass nor enhance crop yield on two contrasting soils over two very different seasons. The Zamwipe® was less effective in controlling weeds than hoe weeding and results suggest that the presence of residue can interfere with herbicide application. Further mechanical improvements are needed on Zamwipe® to enhance glyphosate flow. More studies are also needed to understand the implications of crop residue retention in mixed crop-livestock systems.

Keywords: Conservation farming, crop residues, hoe-weeding, Zamwipe® , maize, sorghum

GENOTYPE-ENVIRONMENT EFFECTS IN EIGHT BAMBARA GROUNDNUTS FOR YIELD AND YIELD COMPONENTS

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INTRODUCTION

Bambara groundnut is an African indigenous crop that is popular in Africa especially in poor communities. It is tolerant to drought, able to produce reasonable yields when grown on poor soils and an alternative source of protein. Yields of crops are affected by agronomical practices and environmental conditions such as temperature, soil type, rainfall and have to be understood in order to achieve increased yield. Genotype-environment interaction is a phenomenon that is important and of significance to plant breeders, agronomist and farmers all over the world. Breeding materials are selected and assessed on the basis of their different responses to environments. Genotype-environment interaction is the change in a cultivar's relative performance over environments, which results from differential response of the cultivar, to various edaphic, climatic and biotic factors. The genotype-environment interaction poses a serious problem in breeding programs since it can influence any stage in the program. Varieties that show low genotype-environment interaction and have high stable yields are desirable for crop breeders and farmers, because the environment has less effect on it and higher yields are contributed by genetic composition. The objective of the study was to evaluate genotype, environment and its effects of eight bambara groundnut genotypes.

MATERIALS AND METHODS

Six yield trials were planted in Taung, Potchefstroom and Vaalharts. Eight genotypes from the ARC-GCI were planted in a randomised complete block design with three replications. Data collected was grain yield, number of pods per plant, haulm yield and 100 seed weight. Data from each location was analysed separately by doing a single ANOVA and then pooled to perform the combined analysis of genotypes across locations. The combined ANOVA was done to partition the variation due to genotypes, environment and genotype-environment interaction.

RESULTS AND DISCUSSION

The results from the combined analyses showed highly significant ($P \leq 0.01$) variances for locations, genotypes and the interaction. This is an indication of the large differential responses of genotypes to environments, across the six localities for nearly all the traits. Genotype and genotype-environment interaction effects were highly significant ($P \leq 0.01$) for grain yield, 100 seed weight; and significantly ($P \leq 0.05$) different for the number of pods per plant. Gxe effects were highly significant ($P \leq 0.01$) for all measured traits. Since the interaction between genotype and environment is significant, it could be attributed to the different reaction of the genotypes to environments or due to differences among the environments. The magnitude of environment was greater than both genotype and genotype-environment variance in determining yield and yield components by contributing 62% of the total variation, thus complicating selection of genotypes. SB4-4's performance was the best across locations with the highest grain yield of 2451kg/ha. In South Africa yields of over 3000 kg/ha have been obtained in irrigated field experiments. In regard to 100 seed weight, SB1-1 had the highest value, followed by SB4-4 and SB19-3 respectively. SB20-2A had the most pods per plant. Rankings of the genotypes were not constant among the locations and in relation to yield and yield components.

CONCLUSIONS

Environment played a major role than both genotype and genotype-environment interaction in determining yields of the genotypes complicating selection of genotypes. This was an indication of the need for conducting stability analysis studies.

Keywords: Genotype-environment interaction

INFLUENCE OF HOT WATER AND MOLBDENUM DIPS ON THE PRODUCTION OF TOTAL ANTIOXIDANTS DURING COLD STORAGE AND THE ABILITY OF SUCH COMPOUNDS TO SCAVENGE REACTIVE OXYGEN SPECIES

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INTRODUCTION

Lemon fruits are sensitive to chilling injury. Long distance shipping requires low temperature storage, and cold injury is particularly of concern if cold sterilization is necessary for phytosanitory purposes. Prolonged cold storage makes fruits susceptible to oxidative stress, which results in physical chilling injury. Oxidative stress is a result of imbalances between the production reactive oxygen species (ROS) and scavenging thereof by antioxidants. High ROS concentrations accelerate deteriotion of membranes, cause lipid peroxidation and DNA mutation, leading to metabolic and structural dysfunction and cell death. Previous work has indicated that hot water (HWD) and molybdenum (Mo) dips have a potential in reducing chilling injury of citrus fruits, particularly lemons (cv. Eureka). Therefore, the aim of this work was to investigate the physiological effects created by hot water and molybdenum dips with focus on membrane electrolyte leakage, lipid peroxidation, total antioxidant production and scavenging of ROS.

METHOD AND MATERIALS

Fruits from two growing areas were dipped postharvest into Mo solutions at 1, 5 or 10µmol for 30min and HWD at 47^{o}C and 53^{o}C for 2min. The fruits were stored at -0.5^{o}C and sampled at 0, 7, 14, 21, and 28 days for evaluating chilling injury immediately after storage and 5 days after withdrawal from cold storage. After evaluation fruits were peeled and the peel freeze-dried, milled under liquid nitrogen and stored at -21^{o}C for further use. Lemon rind total antioxidant capacity (TAC) was determined by FRAP assay, and ROS quantified spectroflourometrically.

RESULTS AND DISCUSSION

The Ukulinga fruits had higher TAC compared to Sun Valley fruits. Mo dips influenced TAC especially for Ukulinga fruits. Generally there was a relationship between TAC and the removal of ROS, such that when TAC was at maximum ROS was at minimum. The relationship was established within 7 days of cold storage. HWD at 53^{o}C stimulated production of TAC more than HWD at 47^{o}C. Hot water and Mo dips appear to be useful in stimulating TAC and decrease the potential for chilling injury, but fruit origin plays a critical role in response.

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Keywords: Chilling injury, Hot water, Molybdenum, Reactive Oxygen Species, Total antioxidants

AGRONOMIC METHODS FOR STRIGA (*Striga asiatica*) CONTROL IN DRYLAND MAIZE IN LIMPOPO PROVINCE

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INTRODUCTION

The witchweed (*Striga asiatica*) is a parasitic weed that plagues cereal crops including maize. This weed competes for water and nutrients as a root parasite, literally sucking the life out of the crop on which it germinates. In doing so, crop growth is stunted (Sallah and Afribeh, 1998) and yields are generally reduced. Striga control through agronomic practices is the key to maize production predominantly in small holder farmers who cannot afford chemical weed control. Striga has affected maize yield in many areas in Limpopo Province, South Africa. A field experiment was conducted over one season at three sites to determine the effect of weed control method on striga on maize.

MATERIALS AND METHODS

A randomized complete block design experiment was laid out consisting of two factors; (i) two maize cultivars i.e. Zm 1421 and Zm 423 (ii) three agronomic practices: hand hoeing alone (as the control factor), hand hoeing plus inorganic fertilization using lime ammonium nitrate (LAN-28%N) at the rate of 56kgN per ha, and hand hoeing plus inter-row intercropping of maize with cowpea (Bechuana White).

RESULTS AND DISCUSSION

The results indicated that the effect of the method of weed control on the number of striga plants was significant at the 5% level of significance at all locations except at Mushwana's where at 105 days after planting (DAP) there were no significant treatment differences. Striga numbers were lower in hand hoed plus inorganic fertilizer plots compared to hand hoed alone and hand hoed plus intercropping. The grain yield obtained at Shingwenyana's field showed significant difference due to weed control method, but no significance at the other two sites. The effect of weed control methods on grain yield was significant only at Shingwenyana's field. The effect of weed control method on shelling %, hundred seed weight, number of cobs per plant and lodging % was not significant. The effect of weed control method on number of plants per plot was significant at Mushwana's field only. There was significant difference of striga numbers among maize varieties at Nyathi's field at 105 DAP.

CONCLUSIONS

It is recommended that farmers improve the fertility status of their soils in order to control striga problem.

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Keywords: Striga, Weed control method, Maize, Smallholder

EFFECT OF SPECIES, CUTTING POSITION AND EXOGENOUS ROOTING HORMONE ON ROOTING OF HONEYBUSH (*Cyclopia* SPP.) CUTTINGS

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INTRODUCTION

Honeybush (*Cyclopia* spp., Fabaceae) is indigenous to the coastal fynbos botanical biome of the Eastern and Western Cape of South Africa. The increase in the international demand for honeybush tea for health benefits, concern over exploitation of wild populations and the lack of published agronomic information, especially propagation, necessitated this study.

MATERIALS and METHODS

The effect of species (Cyclopia intermedia and *C. genistoides*), cutting position (terminal or sub-terminal) and r ooting hormone was studied for three seasons (summer, winter and s pring) in a randomized block design. Cuttings were collected during the early hours of the day, and kept in a cold room before treatments. The cuttings were treated with Seradix® 2 powder (active ingredients - 4-indole-3-butyric acid at 3 g kg^{-1}), Dip & Root™ liquid rooting stimulator (active ingredients – a mixture of 4-indole-3-butyric acid at 10 g L^{-1} and 1-Naphthy-Acetic Acid at 5 g L^{-1}), 2 g L^{-1} IBA and 4 g L^{-1} IBA solutions and a control. Terminal and sub-terminal cuttings of *C. intermedia* and *C. genistoides* treated with different rooting hormones were rooted under glasshouse conditions where night and day temperature (20/25 and treated with different rooting hormones were rooted under glasshouse conditions where night and day temperature (20/25°C) of the glasshouse was controlled. Intermittent mist was used as a m eans of moisture supply to the cuttings for 45-60 seconds every 30 minutes, daily. The number of cuttings rooted, percentage rooting, number of roots and root lengths were assessed after 62 days of growth, and data was statistically analyzed.

RESULTS AND DISCUSSION

Cuttings of *C. genistoides* rooted significantly better compared with *C. intermedia* as measured by rooting percentage, number of roots per cutting, length of longest root and mean root length during the summer season. Cutting position had a significant effect on rooting of the cuttings in summer compared with winter and spring seasons. Cuttings taken in summer rooted better than cuttings taken either in winter or spring, irrespective of the species. The interactive effect of species, treatment and cutting position resulted in 86% of terminal cuttings rooting in summer of *C. genistoides*, while only 4% of cuttings rooted in both winter and spring seasons. In terms of number of roots per cutting, the highest number of roots (3.3 and 3.6 respectively) from terminal cuttings of *C. genistoides* was obtained using 2 and 4 g L^{-1} IBA, but and these were not significantly different from each other. Similarly, the greatest root length per cutting (29.8 and 30.0 mm respectively) was obtained from terminal cuttings of *C. genistoides* treated with 2 and 4 g L^{-1} IBA.

CONCLUSION

Vegetative propagation by means of rooting of cuttings with the use of rooting hormones is possible. This will benefit breeding and selection programmes. Although variation in seasonal responses of rooting of cuttings was clear, more detailed trials can improve the procedures. Species varied in rooting response with *C. genistoides* producing on average more number of roots compared to *C. intermedia*. Terminal cuttings overall provided better rooting results than sub-terminal cuttings. No significant differences weer found between the four hormone treatments with winter and spring cuttings responding poor to treatments.

ACKNOWLEDGEMENTS

Financial support from ARC; ASNAPP, National Department of Agriculture and use of Infrastructure at Welgevallen Research Farm, University of Stellenbosch is acknowledged.

Keywords: honeybush, cutting, cutting position, rooting, *Cyclopia* species

CHEMICAL CONTROL OF *Pyroderces rileyi* (PINK BUD MOTH) IN QUEEN PINEAPPLE, *Ananas comosus*

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INTRODUCTION

The larvae of the pink bud moth (*Pyroderces rileyi)*, a pest of the Queen pineapple *(Ananas comosus)*, feeds in the floral cavity, leaving droppings and causing glassiness and rot around the floral cavity. These symptoms produce a negative appearance of the fruit when it is cut into slices or pieces. The moth is also associated with the occurrence of black spot, one of the major diseases of both Queen and Smooth Cayenne pineapples causing major losses in the South African pineapple industry. When feeding on floral parts inside the floral cavity the pink bud moth can cause minor fruit flesh wounds that can serve as ports of entry for pathogens, causing infection and subsequent rotting of fruit.

MATERIALS AND METHODS

Two trials were done to determine the most effective chemical control method for the pink bud moth in Queen Pineapple. The influence of moth infestation on the occurrence of black spot and the influence of the moth control program on pineapple pests such as mealybug, *Dysmicoccus brevipes,* and red mite*, Dolichotetranychus floridanus,* populations were also determined. Treatments applied in trial 1 were: Control = no chemical applied, Polytrin (profenfos and lambda-cyhalothrin) at 400 and 800 ml.ha^{-1}, Sorba (lufenuron) at 800 and 1600 ml.ha^{-1}, Insegar (fenoxicarb) at 300 and 600 g.ha^{-1} and Proclaim (Emamectin benzoate) at 200 and 400 g.ha^{-1}. Treatments applied in trial 2 were: Control = no chemical applied, Karate (lambda-cyhalothrin) at 120 and 240 ml.ha^{-1}, Sorba at 800 and 1600 ml.ha^{-1} and Polytrin at 400, 800 and 1600 ml.ha^{-1}. Double and triple dosages were applied to test chemical phytotoxicity on plants.

RESULTS AND DISCUSSION

Larvae infestation as well as the occurrence of feeding symptoms were evaluated at dead petal stage (fruit set) and at harvest. Of the four different insecticides tested, Polytrin (pirethroid plus organophosphate) and Sorba (insect growth regulator) gave the best results in trial 1. Polytrin at 800 ml.ha^{-1} had 100% clean fruit at dead petal stage. The highest infestation occurred in the control and the Insegar treatments.

Larval infestation in the control treatment in trial 2 was significantly more than in all the other treatments . The pyrethroids, Polytrin and Karate, controlled moth infestation the best. Polytrin at 800ml.ha^{-1} and 1600 ml.ha^{-1} being the best, followed by Karate at 240ml.ha^{-1} and Polytrin at 400 ml.ha^{-1}. Black spot infection was very low in both trials and controlling the moth had little influence on the incidence of black spot. No treatment controlled mealybug and red mite populations. No phytotoxic effect was found on the plants.

CONCLUSION

Pink bud moth does play a role in facilitating the entrance of pathogens into fruit, but results show that it is not a major factor influencing the occurrence of black spot on Queen Pineapple fruit

Keywords: Black spot, *Dysmicoccus brevipes*, mealybug, *Dolichotetranychus floridanus*, red mite, pyrethroid

EFFECT OF DIFFERENT SOIL SURFACE MANAGEMENT PRACTICES ON THE MYCORRHIZAL STATUS OF AN APPLE ORCHARD SOIL

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INTRODUCTION

The zone immediately surrounding the roots, the rhizosphere, is loaded with root exudates and is populated by a diverse assemblage of micro-organisms. Under any given set of soil conditions some of these are likely to be beneficial to fruit trees, others are not. Arbuscular mycorrhizal (AM) fungi is a group of beneficial fungi that colonise fruit tree roots to form an intricate relationship with their hosts. Development of mycorrhizal fungi is triggered by the constant supply of root exudates. It is known that fruit trees that have been colonised by AM fungi display better overall growth, higher drought tolerance, disease resistance and better nutrient uptake. The consortium of mycorrhizal fungi in this zone, their activity, plus the biochemical products of their metabolic processes, is finely balanced and dynamic, but little is known about their behaviour or response when practices like mulching, growth of cover crops, cultivation and irrigation, are applied to the soil. The primary objective of this work was to determine whether any changes occur in the mycorrhizal status after the application of different soil surface management practices in an apple orchard soil.

MATERIALS AND METHODS

The investigation was conducted as a factorial field trial in an orchard at Elgin Experiment Farm involving 8 year old Cripps Pink/M7 (Pink Lady) apple trees. Treatments consisted of two management practices applied to the tree row, namely chemical weed control or mulching. These were applied in combination with different treatments applied in the work row. The latter included (a) full surface mulching or (b) cover crops during winter, killed chemically or slashed during summer or (c) weed growth during winter, killed chemically or slashed during summer. Each treatment had four replicates applied to randomly isolated plots. Soil samples were taken at the interface between the tree row and work row at 10-20 cm depth in spring 2007 and summer 2008. Spores were counted after extraction using sucrose gradient centrifugation, the roots were stained and the colonisation level measured under a compound microscope. The easily extractable and total glomalin contents of the soil were determined with the Bradford method.

RESULTS AND DISCUSSION

Levels of root colonisation associated with chemical weed control treatments on the tree row (23 to 26%) were significantly lower than those associated with mulch treatment combinations, which received no chemical treatments. The highest level of colonisation (77%) was associated with the treatment consisting of mulch applied to the tree row and slashed weeds in the work row, which also exhibited the highest spore count (121 spores/100g soil). Lower levels of root colonisation associated with chemical weed control treatments could be due to negative effects of weed-killers on the development of mycorrhizal fungi. Soil under the treatment consisting of chemical weed control in the tree row and weeds slashed in the work row generally contained less total glomalin (2.46 mg/g) than soil under mulch treatments (2.76 to 3.37 mg/g). The same trend was found for EEG, viz. 1.68 mg/g and 1.77 mg/g to 2.75 mg/g for the respective groups of treatments. These indicate a negative impact on orchard soil health.

CONCLUSIONS

Chemical weed control clearly had negative impacts on the root colonisation levels of mycorrhizal fungi, compared with mulching. Chemical weed control also had a negative impact on glomalin levels in the soil, indicating a negative impact on orchard soil health.

ACKOWLEDGEMENTS

DFPT and the ARC are acknowledged for funding the project, and Frikkie Caltitz for statistical analyses of the data.

Keywords: colonisation, glomalin, spore number , mulch, chemical control, tree row

HISTORICAL AND FUTURE IMPACTS OF WARMING ON CHILL UNIT ACCUMULATION IN THE WESTERN CAPE

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INTRODUCTION

The Western Cape region of South Africa has been identified as highly vulnerable to climate change. Apples are generally grown under conditions of insufficient chilling, which necessitates the use of chemical rest-breaking agents for satisfactory budburst, yield and fruit quality. In the event of further climate warming of 1-2°C within the next 30 years, we would expect further reductions in chill accumulation, eventually reaching a critical threshold at which apple production would no longer be commercially sustainable in currently marginal regions. We investigated the recent historical temperature record, and implications of warming scenarios on chill accumulation for the main apple regions, one with colder and one with warmer winters.

MATERIALS AND METHODS

Recent historical temperature and chill unit trends in the Western Cape

Daily minimum (T_{min}) and maximum (T_{max}) surface air temperature, and monthly means of T_{min} and T_{max} were obtained for 11 meteorological stations for 1967-2007. Chill unit accumulationwas modeled using daily T_{min} and T_{max} and the "Daily Positive Utah Chill Units" (DPCU) model (also known as the 'Infruitec' model). The model was verified against actual chill unit accumulation based on hourly data and the correspondence was good (generally R^2>0.9). Monthly and total seasonal chill units were calculated for May to September. Time series analyses for monthly means of T_{min} and T_{max} and monthly and seasonal chill units were conducted using the AUTOREG procedure of SAS. Significance was set at P£0.05.

Implications of future warming for chill unit accumulation

Climate change projections for the region show that a warming of 1-2°C can be expected. We conducted a preliminary sensitivity analysis of the chill unit model to symmetrical (both T_{max} and T_{min}) warming, by running the model using the 1967-2007 database for De Keur (moderately cold winters) and Elgin (warm winters), under warming scenarios of +0.5°C, +1.0°C, +1.5°C and +2.0°C for the period May to September. The predicted percentage decrease in monthly and seasonal chill unit accumulation was calculated and fitted against historical values.

RESULTS AND DISCUSSION

Significant warming of 1°C on average has occurred in the fruit-producing regions of the Western Cape, South Africa, over the last 40 years. Chill unit accumulation has decreased by 26%, with a 47% reduction in autumn (May). Further decreases in chill units under warming scenarios will be stronger in May/September and in the warmer production regions. May is the critical time for entrance into dormancy, and the warmer this period is, the longer it takes for buds to reach maximum dormancy. The high sensitivity of May chilling to warming will have a disproportionately negative effect on bud dormancy and phenological patterns in relation to other winter months and the seasonal total. This could mean that even the colder De Keur region could experience too little chill in May in the near future. A similar high sensitivity to warming in September is much less concerning since rest-breaking agents are routinely applied by mid- to end-August. Total seasonal chill is nonetheless important: in Elgin, the threshold level of chill for commercial apple production (800 units) would be frequently breached with 1°C warming, and never achieved with 2°C warming. The De Keur region would continue to receive sufficient chill under the warming scenarios tested.

Keywords: chill hours, chill model, climate change, dormancy, global warming , apple

FIELD EVALUATION OF COWPEA F2 POPULATION FOR THE DEVELOPMENT OF GRAIN, DUAL-PURPOSE AND FODDER COWPEA LINES

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INTRODUCTION

Cowpea (*Vigna Unguiculata* (L.) Walp) is one of the important grain legumes in Africa, due to its high protein content. It is consumed in many forms; young leaves, green pods and green seeds are used as vegetables, whereas dry grains are used in a variety of food preparations. Cowpea production in South Africa is unsustainable since most of the cultivated varieties are local, low yielding and susceptible to pests. Food security and nutrition will be enhanced among rural farmers through the cultivation of improved varieties that have important agronomic traits, seed quality characteristics and good adaptation.

MATERIALS AND METHOD

The potentials of cowpea F_2 genotypes arising from crosses made from 55 exotic cowpea parental lines introduced into South Africa in 2005 and 2006 from IITA were determined. Thirty families were developed from the crosses. F_1 genotypes derived from crosses were advanced to F_2 population in the glasshouse, and F_2 segregating populations were evaluated in the field. The trial was planted on ridges in a randomized complete block design with 4 replicates. Inter-ridge spacing was 1m apart with intra-row spacing of 20 cm. Ridge length was 7m giving a plant population of 35 plants or genotypes. Data were collected (on single plant-basis) on number of days to flowering and pod maturity, pod weight, number of pods per plant, grain and fodder yields as well as harvest index. Data was analyzed using Agrobase II and GenStat.

RESULTS AND DISCUSSION

F_2 populations planted in the field exhibited significant differences between families and within families in all the parameters studied. The number of days to flowering ranged from 61 to 71 for hybrids and 51 to 80 for parental lines, indicating improvement for earliness among genotypes. F_2 hybrids obtained a significant increase in the number of pods per plant as compared to the parents, which had a range of 28 to 47 and 23 to 41 for the parental lines indicating the potential of hybrids for higher yield or pod production. The harvest index obtained for the parents varied between 0.06 (fodder type cowpea) and 1.68 (for grain type cowpea) while the hybrids varied between 0.16 and 0.60 (dual-purpose cowpea type). This indicates that the hybrids are mostly medium cowpea types with dual–purpose characteristic for producing both grain and fodder. In general, significant heterosis was exhibited among F_2 families compared to their better parents. Seven F_2 families exhibited heterosis for pod length, 4 for grain yield and 17 for fodder yield out of 30 families that constituted the segregating population.

CONCLUSIONS

There are several promising genotypes in the pathway of development that are well adapted and high yielding to enhance food security, nutrition and poverty alleviation in South Africa.

Keywords: Vigna unguiculata, segregating population, heterosis, grain yield

YIELD RESPONSE OF INDIGENOUS VEGETABLES TO FERTILIZER APPLICATION

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INTRODUCTION

In South Africa indigenous leafy vegetables such as amaranthus, corchorus and cleome are considered economical sources of nutrients essential for a balanced human diet. Recently, vegetable production is becoming a job creation and income generation venture, thus neglected vegetables need to be promoted and commercialized. These crops require less cultivation inputs and management. However, proper fertilization management is essential when growing this crops in order to improve yield, quality and nutritional value (Palada and Chang, 2003). Corchorus productivity can be improved by fertilizer application especially nitrogen. Cleome also responds positively to increased soil fertility. For good yields, application of nitrogenous fertilizer is recommended. Very little information is available on fertilizer requirements as well as nutrient deficiencies of indigenous vegetables. Before these vegetables can be promoted for commercialization it is important to determine their nutrient requirements. ARC-VOPI has identified a need to research the fertilization requirements of three indigenous leafy vegetables (amaranthus, corchorus and cleome).

MATERIALS AND METHODS

The trial was conducted at ARC-VOPI Research Station in the north of Pretoria from February to May 2008. The trial was laid out in a randomized complete block design with three replicates. The fertilizer sources used were LAN (28% N), super phosphate (10.5% P) and potassium chloride (50% K). The treatments consisted of four fertilizer combinations (N-P-K, N_0-P-K, N-P-K_0, N_1-P-K_1) based on soil analysis and the control (N_0-P_0-K_0). Amaranthus tricolor seedlings were transplanted in rows spaced 35 cm apart with in-row spacing of 20cm. For Corchorus olitorious and Cleome gynandra the spacing was 30 cm between the rows with in-row spacing of 15 cm. Irrigation was 6mm/day during establishment and thereafter, it was scheduled to be applied when 40% of plant available water was depleted. Plants were ready for harvesting from two weeks after planting. Harvesting was done every two weeks to determine the yield.

RESULTS AND DISCUSSION

The yield increased from two to six weeks (optimum yield) after transplanting. There was a gradual decline in yield from ten weeks after transplanting and dying off started from thirteen weeks. Cleome out yielded corchorus and amaranthus. Applying N-P-K fertilizer combination resulted in the highest yield. Eliminating nitrogen reduced the yield whereas phosphorus or potassium elimination did not show any negative effect on the yield. Plants were stunted and the leaves were pale green and narrow where fertilizers were not applied. Although amaranthus, corchorus and cleome are low management crops and can grow in poor soils, yield was increased with fertilizer application. All these crops responded positively to increased soil fertility.

CONCLUSIONS

There was a beneficial effect of applying fertilizers (particularly nitrogen) on yield of amaranthus, corchorus and cleome. These results were preliminary and a follow-up trial will be conducted for data validation. The effect of fertilizer application on growth performance, yield, quality and nutritional value of the indigenous vegetables will be evaluated.

Reference

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Keywords: Amaranthus, Corchorus, Cleome, Fertilization

PHYSIOLOGICAL DETERMINATION OF THE EFFECT OF NITROGEN FERTILISER ON DRYBEAN SEED QUALITY

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INTRODUCTION

Optimum fertiliser supply is important for production of high quality seed. The correlation between fertiliser supply and mineral nutrient content is known, butstudies of the effect of mineral nutrition on seed physiology are scanty (Modi & Cairns, 1994). Seed germination capacity is likely to be affected by seed mineral content, because seed mineral element accumulation and storage is associated with the precursors of ATP in the globoids (Modi and Asanzi, 2008). The effect of mineral nutrition on enzymes associated with seed germination has not been shown. Germination has been shown to be is closely correlated to catalase (CAT) activity (Bailly *et al*., 2002). It was demonstrated Cat1 responds to osmotic stress and its activity increases during seed desiccation in maize (*Zea mays* L.) and beans (*Phaseolus vulgaris* L.), which occurs during maturation drying (Guan *et al*., 2002). Thus, low seed water potential is correlated with desiccation tolerance, which is lost as the process of germination progresses towards radicle protrusion. Lack of desiccation tolerance genes in dry seeds could lead to reduced longevity and render seeds to low performance after storage. The objective of this study was to determine the effect of nitrogen fertiliser on seed quality during germination of one-year old dry bean seeds.

MATERIALS AND METHODS

Seeds of two dry bean cultivars (Kranskop and Mthatha) were produced with two nitrogen fertiliser regimes [60 kg ha^{-1} (low-N) and 120 kg ha^{-1} (high-N)] during the 2006/2007 season, and stored at 25°C for one year. Seed germination and vigour tests were performed at harvest maturity and one year after storage (ISTA1999). Seed water activity (Modi *et al.,* 2004), catalase activity (Guan *et al.,* 2000), and globoid-associated cations were determined at different stages of imbibition and at the final count of germination one year after storage. Seed vigour was determined using the speed of germination test and seedling dry weight at the final count according to the Association of Official Seed Analysts rules (AOSA, 1993).

RESULTS AND DISCUSSION

Seeds harvested from plants fertilised with 120 kg N ha^{-1} displayed a higher, albeit not statistically significant, germination capacity compared with seeds derived from plants fertilised with 60 kg N ha^{-1}. Seed vigour of high-N seeds was significantly ($P < 0.05$) higher than that of low-N seeds. Whereas the rate of imbibition and water activity were similar between cultivars and N treatments, catalase transcript expression and activity were significantly higher in high-N seeds. Seeds of Kranskop displayed significantly ($P < 0.01$) higher cation content than those of Mthatha, suggesting that the phytin content may be higher in Kranskop (Modi & Asanzi, 2008). Catalase activity decreased with progress in imbibition and its expression was lowest in germinated seeds. The change in catalase activity and expression was more dramatic in low-N seeds compared with high-N seeds, suggesting that the former may lose longevity earlier during storage.

CONCLUSIONS

Excessive N application may have a negative effect on standability, but it increases yield and seed quality. In this study, increased catalase activity in response to High N application suggests that seed longevity in drybeans may be negatively affected by poor N application. However, dry bean response to high N application, in terms of seed quality, is cultivar related.

Keywords: Catalase, vigour

CROP WATER SATISFACTION ANALYSIS FOR TWO MAIZE TRIAL SITES IN MAKHADO DURING THE 2007/08 SEASON

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INTRODUCTION

High variability of rainfall together with high evaporative demand impact negatively on plant growth and yield in the dryland farming areas of Limpopo Province. Water availability to crops is the main limiting factor for optimum crop production in most areas of South Africa, caused by varying seasonal rainfall. Although the total seasonal rainfall amount may be sufficient, its poor distribution throughout the season is often the cause of crop failure (Barron *et al.*, 2003). This paper presents water satisfaction analysis for two dryland maize fields in the Makhado Municipality agricultural during the 2007/08 cropping season.

MATERIALS and METHODS

The simple water balance model incorporated in INSTAT software was used in the assessment of drought in relation to maize (INSTAT, 2007). To obtain the crop water requirements, crop coefficients (K_c) together with reference evapotranspiration (ET_0) were used at different growth stages of the crop (Doorenbos & Pruitt, 1977; Sharma, 2006). The Water Requirement Satisfaction Index (WRSI) model was run using dekadal rainfall, evapotranspiration and crop coefficients as inputs. The life-cycle was taken as 12 dekads/120 days because the maize variety (ZM423) that was planted at the trials takes 100 to 120 days to mature. The WRSI was determined from the onset of rains (2nd dekad of September 2007) to the 1st dekad of February 2008, representing 12 different planting dates. This was done to see how the WRSI will differ at different planting dates compared with the actual planting date of the 3rd dekad of November in both trials.

RESULTS AND DISCUSSION

For the Mashamba trial site, the WRSI ranged from 29% to 99% with the WRSI for the 2nd dekad of September to the 1st dekad of November being over 75%. At Makhitha the WRSI ranged between 17% and 75% with the highest indices of 65% and 75% being obtained in the 3rd dekad of September and 1st dekad of October respectively.The final WRSI values for Makhitha and Mashamba were 37.2% and 65.3%, respectively, corresponding to the planting date of 22nd November 2008.

CONCLUSIONS

The results of the WRSI show that, in the 2007/08 cropping season, early planting in both trials would have resulted in better yields. The WRSI at Mashamba was always higher than that obtained at Makhitha for all the planting dates, and thus maize was expected to perform better as evidenced by the yields of 3.1ton/ha and 0.9ton/ha, respectively.

ACKNOWLEDGEMENTS

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Keywords: Water Requirements, Drought, Maize, Rainfall

THE EFFECT OF NITROGEN FERTILIZATION ON YIELD AND QUALITY OF HEMP (*Cannabis sativa* L) GROWN IN THE EAST AND WESTERN CAPE PROVINCES OF SOUTH AFRICA

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INTRODUCTION

Hemp (*Cannabis sativa* L.) is an industrial crop but the acceptance by South African farmers is limited. Its medicinal purposes for centuries have produced a contrasting report about this crop. It was declared illegal in in 1928 due to its high cannabinoid content and potential psycho activity. Although hemp and marijuana are from the same plant species, however, they have different uses and physical characteristics. There is a renewed interest in the special properties of this bast fibre crop because it could provide an income for the small-scale farmers.

MATERIALS AND METHODS

The experiment were planted at the Agricultural Research Council's Addo and Robertson experimental stations in 2006/2007 and 2007/2008 cropping seasons in a randomized complete block design with four nitrogen levels (0, 50, 100 and 150 kg/ha) and two hemp cultivars (Kompolti and Novosadska) on a plot size of 4 by 1.5 m^2 with an inter-row spacing of 0.25m. Agronomic traits were observed on the harvest areas that consisted of the middle rows of each plot.

RESULTS AND DISCUSSIONS

There were significant differences between applied treatments. Fertilizer levels showed significant differences on traits observed. The highest biomass and plant height were obtained with 100 and 150 kg N ha^{-1} applied at Addo for 2006/2007 season as well as Addo and Robertson for 2007/2008 season than control. Kompolti showed much higher biomass yield than Novosadska in both growing seasons. Highest stem diameters were found with 50 and 100 kg.ha^{-1} nitrogen fertilization applied on Kompolti. Highest fibre percentages were found at Addo on hemp plants with 150 kg.ha^{-1}. Kompolti had a higher significantly percentages than Novosadska in both localities.

CONCLUSIONS

Variable existed among different factors tested. Nitrogen fertilization application of (100 and 150 kg N ha^{-1}) can be recommended. Kompolti performed much better. Usage of correct recommended rates of fertilization could lead to high yields and good fiber quality.

Keywords: Nitrogen , Fertilization, Hemp cultivars, Addo & Robertson

COMBINING ABILITY ANALYSIS AMONG MAIZE INBRED LINES AND TOP CROSS HYBRIDS FOR *Stenocarpella madis* EAR ROT RESISTANCE

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Stenocarpella ear rot caused by *Stenocarpella maydis* (Berck) Sutton is one of the most important diseases of maize. The disease is sporadic which makes it difficult for farmers to prepare for its occurrence and consequently of the control measure. The objective of this study was to identify lines with suitable agronomical traits and good combining ability towards *Stenocarpella* ear rot resistance and grain yield. The study was conducted using a randomised complete block design with three replications at three locations viz. Bethlehem, Cedara and Potchefstroom. Fifty-four inbred lines and fifty-four top crosses were included in the study using line 'SAM 1066' as a tester. At Potchefstroom both top crosses and inbred lines were artificially inoculated for comparison. Among the tested inbred lines entry 47 was relatively better in grain yield followed by entry 4. Entry 47 had a grain yield of 2.84 tons ha^{-1} at Bethlehem and 4.42 tons ha^{-1} at Potchefstroom. Entry 4 had a grain yield of 2.19 tons ha^{-1} at Bethlehem and 4.58 tons ha^{-1}at Potchefstroom. The two lines, however, were poor combiners for both grain yield and *Stenocarpella maydis* ear rot resistance when compared with other lines. The average grain yield response of top crosses at Bethlehem, Cedara and Potchefstroom were 5.94, 7,15 and 9.95 tons ha^{-1}, respectively. A top cross entry 28 showed grain yield of 5.80 tons ha^{-1} both at Bethlehem and Cedara. This entry provided a yield of 9.35 tons ha^{-1} at Pothefstroom. Entries 28, 29 and 52 were the best combiners for increased yield and *Stenocarpella maydis* resistance that may be utilized in maize breeding for Stenocarpella ear rot resistance.

Keywords: maize, Stenocarpella maydis , ear rot

IS THERE ANY POTENTIAL RISK OF CONSUMING HOME-PRODUCED VEGETABLES IRRIGATED WITH A MIXTURE OF WASTE WATER AND SLUDGE IN LESOTHO?

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INTRODUCTION

Heavy metals, such as Zn, Cu, Cd, Pb, Ni and Cr are present in all soils but are usually found at low concentrations. 'Baseline' concentrations vary depending on soil type, soil parent material, and type of heavy metal, but are usually in the range 0.1–200 mg/kg (McLaughlin et al., 2000). Prolonged exposures to heavy metals have been reported to cause deleterious health effect. In Lesotho, as well as many low income countries in the sub-Saharan Africa. The use of waste water sludge (WWS) for irrigation is increasing in view of increasing demand of water for irrigation in agriculture and other domestic uses. The aim of the study was to firstly assess the contents of heavy metals in selected soils and WWS sources used for irrigation and secondly, to evaluate the tissue contents of heavy metals in two widely grown and consumed vegetables (Swiss chard cultivars) when grown on these soils and irrigated with WWS.

METHODS

About 200 kg of two soil types (Typic Hapludolls (or *Matela* series) (S-1) with sandy loam texture and Cumulic Hapludolls (S-2) (or *Maseru* dark series) with clay loam texture were randomly collected. Twenty liters each of WWS were collected from sewage settling ponds (i.e. P-1, P-2 and P-3). These were used for irrigation. Pre-analyses of the water samples were performed to determine content of Zn, Cu, Cr, Ni, Zn, using ICP-OES method. In addition, the pH, nitrate-N, and water soluble P were determined.

About 6kg of soils S-1 & S-2 was placed in 5 L pots and irrigated with de-ionized water and allowed to homogenize for two weeks. Subsequently, they were planted with two species of Swiss chard (cv Ford hook Giant and Star 1801). The experimental design was a 2 x 2 x 4 factorial experiment with four replicates and treatments were arranged in a randomized fashion. The factors were two soil types, two Swiss chard and four WWS levels (P-1, P-2, P-3 and control P-0 or de-ionized water). Following successful establishment of seedlings, at 4 weeks after planting (WAP), treatments of WWS were imposed and this continued till 8 WAP. Data such as plant height, leaf count and fresh weight (FWY) and dry weight (DWY) were collected. Some of the dried plant samples were then pulverized prior to being analyzed for heavy metals.

Data collected was analyzed statistically using the general linear model procedure (PROC GLM) of the Statistical Analysis Systems (SAS) (SAS Inst., 1998). The means from the latter procedures were separated using the Duncan's multiple range test (DMRT) at 5%.

RESULTS AND DISCUSSION

RESULTS of the soil samples compared to critical values for plant growth revealed low concentrations of heavy metals compared with the typical background concentrations in agricultural soils. Similarly, the heavy metal content in the WWS compared with the irrigation water quality (IWQ) was very low (Pescod, 1992). Effect of the WWS on the mean plant height/plant and mean number of leaves/plant from each of the two vegetable cultivars tested showed that the three ponds significantly ($p<0.05$) increased these two parameters compared to the control. Summary statistics of the effect of irrigating with WWS on a weekly basis showed that Cr, Cu, Ni, and Cd were not even detected in the DMY from 4 WAP to 6 WAP, except Zn which was detected at 6 WAP through 8 WAP. In addition, irrigating with WWS increased DMY/pots.

CONCLUSIONS

The study concludes that in spite of heavy metals in the sewage sludge water, the heavy metals were not absorbed by the two Swiss chart cultivars except Zn at 4 and 6 WAP.

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Keywords: Exposure irrigation vegetables soil-plant uptake, health risk heavy metals

EFFECTS OF *Allium sativum* EXTRACTS AGAINST PLANT PATHOGENS *Alternaria solani* AND *Sclerotium rolfsii*

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INTRODUCTION

Allium sativum (garlic) is considered as a vegetable and as a herbal crop throughout the world, including South Africa.South African communities use this crop as a treatment for fever, colds, asthma, tuberculosis and many more other ailments. Use of fertilizers to obtain high yield and good quality is an important factors in today's agricultural sector. Both yield and quality can be improved through nitrogen (N) and sulphur (S) nutrition. An increase in S supply has been reported to increase alliin (active ingredient) content in both leaves and bulbs of *A. sativum* crop, whereas nitrogen fertilization was reported to have only a minor influence on crop quality. The aim of this study was to determine the influence of ammonium sulphate and calcium nitrate fertilization on the bioactivity of *A. sativum* plants ageinst *Alternaria solani* and *Sclerotium rolfsii*.

MATERIALS AND METHODS

An experiment was conducted from April to October 2006. The experimental layout was a randomized complete block design with four replications. *A. sativum* plants were treated with ammonium sulphate and calcium nitrate fertilizers applied as a topdressing at a total of 0, 50, 100, 150 and 200 kg ha^{-1}, divided into three applications at three week intervals. Data was collected monthly, during the five-month growing period. Crude extracts were prepared separately from the leaves and bulbs of *A. sativum*.

RESULTS AND DISSCUSSION

The results obtained indicated that leaf extracts from *A. sativum* plants that were harvested at 54, 82, 112 and 140 days after planting (DAP) inhibited the growth of *S. rolfsii* and *A. solani*.
Leaf extracts of the plants which were treated with calcium nitrate fertilizer demonstrated low bioactivity when compared to plants that were treated with ammonium sulphate. At 82 and 112 DAP plant leaves had grown to an optimal size and higher bioactivity was reached from leaf extracts. At 140 DAP leaf bioactivity started to decrease and the lowest leaf bioactivity was found at 175 DAP.

A. sativum bulb extracts were found to have very low bioactivity at 54 DAP, regardless of N source supplied to the plants. Highest percentage of inhibition was found from bulbs that were harvested at 175 DAP and treated with 200 kg ha^{-1} ammonium sulphate.

CONCLUSIONS

The results obtained from this study showed a correlation between sampling date and percentage bioactivity of *A. sativum* leaf and bulb extracts. Ammonium sulphate improved leaf bioactivity and the greatest bioactivity was obtained at 82 and 112 DAP. Instead of using only the bulbs, *A. sativum* leaves can be harvested between 82 and 112 DAP when leaves reach their optimum size, while bulbs can be utilized at 175 DAP.
Calcium nitrate failed to improve the medicinal properties of *A. sativum* while ammonium sulphate enhanced the bioactivity.

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University of Pretoria.

Keywords: Allium sativum, ammonium sulphate, bioactivity, calcium nitrate

TEMPERATURE EFFECT ON GROWTH AND DEVELOPMENT OF *Moringa oleifera* LAM. (HORSERADISH TREE) TREES

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INTRODUCTION

Moringa oleifera Lam. is a tree with great potential as it is fast growing and drought tolerant with numerous additional uses, such as for fuel, nutritious food, animal forage, green manure, water purification and traditional medicine. Temperature is a significant climatic factor influencing both geographical plant distribution and growth, and since *M. oleifera* trees are naturally found in tropical climates around the world, the extent of their adaptability to cooler climates was the main objective of this study.

MATERIALS AND METHODS

M. oleifera trees were cultivated from seed and germinated in a controlled greenhouse environment at the Experimental Farm of the University of Pretoria. After germination, 50% of the seedlings were hardened off by placing them outside under ambient growing temperatures, while the rest remained in the greenhouse. At trial commencement, 132 of both the hardened and non-hardened seedlings were planted into 10 liter plastic bags and randomly placed into three temperature-controlled greenhouses, each with a different fluctuating night/day temperature regime, namely 10/20°C ± 2°C, 15/25°C ± 2°C and 20/30°C ± 2°C. During the 224-day trial period, bi-weekly measurements of tree height, stem diameter and leaf area estimates of each individual tree within all three temperature regimes were taken. Irrigation was applied manually three times a week until field-capacity was reached.

RESULTS AND DISCUSSION

The 20/30°C temperature regime was the most favorable for overall tree growth, as the highest values were obtained across all measured parameters. The increase in temperature resulted in significant ($P \leq 0.05$) growth rate increases of over 650% between the 10/20°C and 20/30°C temperature regimes, and 250% between the 10/20°C and 15/25°C night/day temperature regimes. As the effects of additional, higher temperature regimes were not investigated in this study, the possibility of improved growth at even higher temperatures cannot be excluded. However, the growth rate increases seem to stabilize at the 20/30°C temperature regime.

The hardening-off pre-treatment resulted in an significant ($P \leq 0.05$) increase of both final tree height and stem diameter of 309%, 144% and 123%, compared to their non-hardened off counterparts under the 10/20°C, 15/25°C and 20/30°C temperature regimes, respectively.

Tree height, stem diameter and average tree leaf area demonstrated increases with the increase in temperature regime. However, leaf area expressed more variability with an increase in the temperature regime. Frequent cycles of leaf drop and renewed flushes were prevalent at both the 15/25°C and 20/30°C temperature treatments, as the moisture demands of the rapidly increasing leaf area exceeded the water supply by the roots.

Leaves from the 10/20°C and 20/30°C treatments were on average 0.239 mm and 0.136 mm thick, respectively, a significant ($P \leq 0.05$) reduction of 43.1% as a result of a 10°C increase in temperature. Leaves were thicker mostly due to thicker mesophyll layers, an adaptation to minimize photoinhibition especially under lower growing temperatures.

CONCLUSION

Tropical climates with night/day temperatures of between 20-30°C are thus ideal for the cultivation of *M. oleifera.* However, satisfactory growth during the hot summer months in sub-tropical climates is achievable if temperatures remain above 0°C during winter, as trees are frost tender.

ACKNOWLEDGEMENTS

Thank you to the NRF (National Research Foundation) for funding this project.

Keywords: Temperature, *Moringa oleifera*

THE INTRODUCTION OF ECO-TECHNOLOGIES IN LIMPOPO PROVINCE USING ACTION RESEARCH

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INTRODUCTION

Limpopo Province is made up of six districts of which Sekhukhune is the poorest. Sekhukhune district is mainly rural, with 94.7% of the total population residing in rural areas and 5.3% in urban areas. Food security has become an important issue in the province. Continuing soil degradation is threatening food security and the livelihood of thousands of farm households. The main causes include not only intensive soil preparation by hoeing or ploughing, but also deforestation, the removal or burning of crop residues, poor rangeland management and inadequate crop rotation – practices that do not maintain vegetative cover or allow appropriate restitution of organic matter and plant nutrients (FAO, 2001).

The prevailing land use system in the area is a reflection of the agro-ecological potential in conjunction with cultural, socio-economic factors and policies. The natural resources are degraded in such a way that a sound management system is required. A range of eco-technologies were introduced in different villages in the Sekhukhune district in order to conserve and improve scarce natural resources.

MATERIALS AND METHODS

The project introduced the following eco-technologies in the area: conservation agriculture (CA), rainwater harvesting, grazing management, vegetable production and wise use of wetlands. An action research model developed by Smith (2006), which consists of six phases (i.e. Stakeholder analysis, Diagnosis, Planning strategically, Implementing and managing, Learning and adapting, and an Exit strategy), was used during the study. The implementing and managing phase of the eco-technologies has on-farm, collaborative and farmer-managed experimentation as a key action research methodology, which intends to improve the awareness and innovation capacity among various stakeholders, a critical ingredient for sustainable land management. Collaborative trials mainly improve awareness among various stakeholders, whereas farmer-managed trials improve experiential learning, which leads to increased adoption and adaptation of the new eco-technologies.

RESULTS AND DISCUSSION

Experimentation was applied during the planting season of 2007/08. In collaborative trials using CA for example, researchers worked together with farmers and extension from the planning stage until harvesting. In farmer-managed trials, farmers were experimenting with what they learned in the collaborative trials and training courses, while sharing this knowledge with other farmers in their villages. A total of 26 lead farmers participated in collaborative trials and established farmer-managed trials across nine villages in Ward 31, Sekhukhune district. Farmers have shown some improvement in practising new technologies and, based on the yield increases and their understanding of the natural resource status in their area, they have started to extend the land under eco-technologies.

CONCLUSIONS

The application of experimentation as a key action research methodology helped to empower all participants with knowledge and skills, facilitating the scaling-out of eco-technologies in resource-poor farming communities in Limpopo Province.

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Keywords: Eco-technology, Action research, conservation agriculture , rainwater harvesting, grazing management, vegetable production

STUDIES TO REDUCE THE SIZE OF THE NAVEL END OPENING

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INTRODUCTION

The presence of a secondary fruit within the primary fruit is a feature of navel oranges. This causes fruit to have an opening at the navel end which is undesirable. Large protruding navels cause fruit to be culled in the packhouse, thereby reducing earnings for the grower. The size of opening at the navel end is used as a criterion for external fruit quality. Fruit with big open navel ends are more liable to attack by insects which burrow or hide in the open navel and are more prone to split.

Work done r ecently in Chile on Lane Late navels has shown that the application of 2,4-dichlorophenoxyacetic acid (2,4-D) at full bloom reduced the size of the navel end opening and increased the number of fruit with closed navel ends. The objective of the study was to determine if 2,4-D had the same effect under South African conditions and to determine the best concentration and timing of application without detrimental effects of external and internal fruit quality criteria.

MATERIALS AND METHODS

2,4-D was applied on Palmer (Addo, Eastern Cape), Newhall, Navelina, Washington (Citrusdal, Western Cape) and Robyn (Clanwilliam, Western Cape) navels at full bloom, petal drop, two weeks after petal drop and four weeks after petal drop at concentrations ranging from 15ppm to 45ppm. The percentage of fruit set was determined after each application. At harvest, navel end size, fruit size and yield per tree were measured. Samples were taken for assessment of external and internal fruit quality.

RESULTS AND DISCUSSION

Application of 2,4-D at full bloom caused an increase in the number of closed navel ends and significantly reduced the navel end size. There were no differences in navel end size or percentage closed navels amongst the different concentrations at full bloom. There were no negative effects on yield, fruit set and fruit internal or external quality. Treated trees developed leaf damage on the spring flush with more damage at high concentrations of 2,4-D. The petal drop and later than petal drop treatments were not different from the control.

CONCLUSION

The application of 2,4-D can reduce the size of the open navel end in navel oranges. This will reduce the number of fruit culled due to large open navels in the packhouse resulting in an increased packout for growers and more income. Insects will not have places to burrow or hide if navel ends are closed making it easier to control them. Fruit splitting due to large open navels will also be reduced.

Keywords: navel end size, secondary fruit, fruit quality, leaf damage, fruit set, yield

COWPEA (*Vigna unguiculata* L.) AS AN ALTERNATIVE CROP FOR SMALLHOLDER CONSERVATION AGRICULTURE SYSTEMS

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INTRODUCTION

Conservation agriculture, recently introduced in smallholder agriculture of Zimbabwe, is a system that encourages minimum soil disturbance and the use of mulching for soil water and weed management among other benefits. It emphasizes rotation of cereals and legumes in a permanent grid of planting positions. A fixed grid of planting positions is established during the dry season and nutrients are applied to those fixed planting stations. However the challenge lies with accommodating legumes and cereals in similar planting positions every growing season without compromising on the minimum soil disturbance principle and yield of either cereal or legume crop. This trial was designed to determine the effect of planting basin, ripper and conventional tillage systems and mulching on cowpea yields and soil water regimes in semi-arid southern Zimbabwe.

MATERIALS and METHODS

The experiment was run for 2 seasons at the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Matopos Research Station. The experiment was set up using split plot design with three replications. Tillage method (planting basins, ripper and conventional plough) was main plot factor with mulch level (0, 0.5, 1, 2, 4, 8 and 10 t ha^{-1}) as a subplot factor. Planting basins were dug at 0.6 m ´ 0.9 m spacing and each basin measured 0.15 m (length) ´ 0.15 m (width) ´ 0.15 m (depth). Rip lines were opened at 0.9 m inter-row spacing using a ripper tine. Planting furrows were opened at inter-row spacing of 0.6 m in the conventional tillage system. An in-row spacing of 0.2 m was used in the conventional and ripper systems. Four cowpea plants were grown in each basin and one plant per station in the ripper and conventional systems.

RESULTS AND DISCUSSION

During the relatively wet 2005/06 season tillage and mulch treatments had no significant influence on grain yield. Grain yields were 1 841, 1 938 and 1 196 $kgha^{-1}$ for conventional, ripper and basin tillage respectively. In the 2006/07 season, which had below-normal rainfall, conventional ploughing gave lower ($P = 0.003$) grain yield than ripper and planting basin treatments. Grain yields were 288, 553 and 543 $kgha^{-1}$ for conventional, ripper and basin treatments respectively. Cowpea in the conventional system was heavily attacked by aphids during the dry spells experienced in January and February 2007. In the 2006/07 season grain yield increased ($P = 0.021$) with increase in mulch cover with the highest yield was recorded at 4 t ha^{-1} mulch cover. Grain yields achieved in our study were greater than the national yield average of 0.3 tha^{-1} for Zimbabwe's smallholder farming sector. Soil water changes in the different tillage and mulching treatments followed a similar pattern during 2005/06 and 2006/07 seasons. Under the three tillage treatments the 4 and 10 tha^{-1} mulch cover maintained higher profile water content particularly during drying cycles.

CONCLUSION

Cowpea yields achievable under conservation agriculture systems are quite comparable or even better than those achieved from a well managed conventional system. The wider crop spacing in the planting basin system can be compensated for by having more cowpea plants growing per basin. On a clay soil water patterns under conventional ploughing, ripper and planting basin systems are quite similar even in drought years. Smallholder farmers in semi-arid southern Zimbabwe could use 4 tha^{-1} mulch level if crop residues are available.

Keywords: Conservation agriculture

EFFECTIVENESS OF VERMICOMPOSTING AND COMBINED THERMOPHILIC AND VERMICOMPOSTING ON THE BIODEGRADATION OF DAIRY MANURE AND PAPER WASTE MIXTURES

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INTRODUCTION

Thermophilic composting is generally accepted as a better alternative approach for organic wastes management but vermicomposting is also becoming increasingly popular. The two techniques, however, have their inherent advantages and disadvantages. A relatively new approach of combining the two composting methods borrows and combines positive attributes from each of them to enhance the overall biodegradation process and improve the products quality. The objective of this study was to compare the effectiveness of vermicomposting and the combined thermophilic/vermicomposting on the biodegradation of dairy manure and paper wastes of different C/N ratios.

MATERIALS AND METHODS

Dairy manure was mixed with shredded waste paper to give materials with C/N ratios of 30 and 45 (CV30 and CV45). Thermophilic composting of wastes was done for 28 days and then the wastes were vermicomposted for another 28 days. Red wiggler earthworms (*Eisenia fetida*) were used in the vermicomposting processes. Samples were analysed for microbial and chemical parameters at the beginning and end of the two thermophilic composting processes and after 8 weeks of combined composting.

RESULTS AND DISCUSSION

Total nitrogen and total phosphorus as well as available N and P of composts were influenced by C/N ratio and composting method and there was a significant interaction between the two factors. Wastes with C/N 30 that were vermicomposted had the highest amounts of both total and available N and P, though not significantly different from combined composted wastes with C/N 30. Though not significantly different, ash content was higher while volatile solids were lower in combine composted wastes than vermicomposted wastes. Combining the two systems also resulted in total elimination of the pathogen *Escherichia coli* 0157 from the final composts.

CONCLUSIONS

Mixtures with C/N ratio of 30 were more suitable for composting as they produced more stabilised composts characterized by higher ash content, greater humification and had less volatile solids than wastes with a C/N ratio of 45. Combined composting and vermicomposting of dairy manure and waste paper mixtures of C/N ratio of 30 was equally effective as vermicomposting in terms of stabilisation of organic matter as well as nutrient content of the final composts. However, it was more effective than vermicomposting in the elimination of the pathogen *E. coli* 0157:H7.

Keywords: Combined approach, Thermophilic composting, Vermicomposting; C/N ratio; Dairy manure; Waste paper, *Eisenia fetida*; *E. coli* 0157, Biodegradation, Organic fertiliser

DECOMPOSITION AND NUTRIENT RELEASE PATTERN FROM LEAF LITTER OF THREE SUB-TROPICAL FRUIT TREES AT NELSPRUIT, MPUMALANGA PROVINCE

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INTRODUCTION

There is very little information available on the decomposition and nutrient release pattern from litter of sub-tropical fruit trees despite their potential for soil fertility management especially under small scale farming sector of South Africa. Decomposition is the process whereby organic residues are physically broken down and the component nutrients are released. The potential benefits of litter from fruit trees for soil fertility management under small scale farming sector can only be achieved if their decomposition and nutrient release patterns are known so that synchrony of nutrient release with crop nutrient demand can be improved. The aim of this study was to determine the decomposition and nutrient release pattern of three common sub-tropical fruit trees, viz, Avocado (*Persea americana*), Litchi (*Litchi chinensis*) and Mango (*Mangifera indica*).

MATERIALS AND METHODS

The study was conducted in the Agricultural Research Council- Institute for Tropical and Sub-tropical Crops at Nelspruit. Mass loss and nutrients release in decomposing leaf litter were determined using a litter bag technique. Fallen leaves were collected from five randomly selected individuals of each of the three species in September 2006. The dried materials were weighed and analyzed for ash, polyphenols, cellulose, nitrogen, carbon, phosphorus, potassium and sulphur. Analyses of variance were performed on data using the GLM (General linear model) procedure of SAS. Means were separated using Tukey procedure for multiple comparisons at 5% level of significance. A single exponential decay function was used to determine decomposition rate *((W0 – W1)/W0) x 100*, where: *W0 = weight of leaf litter in the bag before incubation*, *W1 = weight of leaf litter after incubation*.

RESULTS AND DISCUSSION

The results showed significant differences ($P<0.05$) in mass loss for the three trees at all sampling intervals. A loss of litter mass was more rapid in *P. americana* (67.4%) and *M. indica* (70.9%) than on *L. chinensis* (57.3%) over the 12 months period. The lower mass loss for *L. chinensis* was attributed to poor litter quality shown low N (1.16%), high C:N ratio (41.2), high polyphenols (2.07%) and high cellulose (24.4%) compared with the other litters. The nutrients (N, P, and K) and polyphenols in the litter of the three tree species decreased within the time of incubation while ash, cellulose and carbon content remain relatively stable over the study period. The concentration of sulphur however increased with time. Differences in chemical quality of the litter from the three tree species were most marked for polyphenols and nitrogen. Decomposition rate (k) among the studied species after 12 months varied significantly in an order of magnitude: *M. indica* (0.61) > *P. americana* (0.63) > *L. chinensis* (0.77).

CONCLUSION

These findings suggest that the quality of litter from three species differs and this affects the release of nutrients into the soil. The uptake and utilization of these nutrients by crops is being investigated.

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Keywords: Soil fertility, Leaf litter decomposition, Litterbag technique, Nutrient release pattern

COVER CROP SPECIES AND FERTILISER EFFECTS ON BIOMASS, CARBON AND NITROGEN YIELDS AND WEED DYNAMICS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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INTRODUCTION

Production of large biomass yields from cover crops has been a major challenge affecting success and uptake of conservation agriculture technologies by farmers in the Eastern Cape province of South Africa. Inappropriate cover crop species selection and low soil fertility are some factors leading to the low biomass, nitrogen and carbon yields from cover crops. The objectives of this study were; i) to determine biomass production as well as the C and N content of different winter cover crop species, ii) to determine effect of fertilisation with N, P and K on cover crop biomass production, and iii) to evaluate the effect of different cover crop species on weed dynamics.

MATERIALS AND METHODS

A field study was carried out at the University of Fort Hare Research farm in the winter seasons of 2007 and 2008. This study evaluated biomass, C and N yields of *Vicia faba, Lupinus angustifolius, Avena sativa* and *Vicia dasycarpa* at two fertiliser levels (no fertiliser and fertiliser applied at optimal rates for each cover crop). Control plots were included with no cover crop grown. This gave a 5 X 2 factorial experiment laid out in a randomised complete block design with three replications. Cover crop dry weights, nitrogen and carbon accumulation, weed species and dry weights were some of the measurements taken.

RESULTS AND DISCUSSION

Biomass yields of cover crops were significantly affected by species ($p < 0.01$) and fertiliser ($p < 0.05$). The cover crop species X fertiliser interaction effect, on biomass yield, was also significant ($P < 0.05$). *Avena sativa* and *Vicia dasycarpa* accumulated the highest biomass yields of 14.8 t/ha and 9.1 t/ha respectively, while *Lupinus angustifolius* had the lowest biomass yield of 5.5 t/ha. *Vicia dasycarpa* was the only cover crop that did not respond to fertilisation.

Avena sativa and *Vicia dasycarpa* also reduced weed density by 90 % and 80 %, respectively while *Lupinus angustifolius* only reduced weed density by 23 %. Cover crop fertilisation did not significantly affect weed density. The C/N ratio of *Avena sativa* increased significantly as the plants matured while the C/N ratio of *Vicia dasycarpa* only increased marginally. Amount of biomass produced by a cover crop was more important in weed suppression than cover crop species grown. There was a significant ($p < 0.01$) negative correlation ($r = 0.81$) between cover crop dry weight and weed dry weight. There was a general decline in weed dry weight as cover crop dry weights increased, irrespective of cover crop species.

CONCLUSION

Avena sativa and *Vicia dasycarpa* produced the highest biomass yields compared to *Vicia faba* and *Lupinus angustifolius.* Appropriate cover crop species selection and soil fertilisation with inorganic fertilisers may be used to improve biomass yields. The amount of biomass produced by a cover crop is an important factor with respect to weed suppression.

Keywords: conservation agriculture, cover crops, biomass yield, weed dynamics

EFFECT OF SOIL TYPE ON CABERNET SAUVIGNON GROWTH, YIELD AND WINE QUALITY IN THE OLIFANTS RIVER REGION

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INTRODUCTION

Although wine grapes are the primary crop in the Olifants River region, information on the response of grapevine yield and, particularly wine quality to soil type is limited. The objective of this study was to determine the effect of soil type on growth, yield and wine quality of Cabernet Sauvignon, which is an important cultivar for the production of export wine.

MATERIALS AND METHODS

At each of four localities situated between Klawer and the Atlantic Ocean, one plot was selected in sandy loam soil, whereas a second was in sandy soil further away from the river. Each of the eight main plots were divided into two plots where grapevines were either irrigated according to the grower's schedule or subjected to water deficits to obtain a total of sixteen plots. In the sandy soils, water deficits were induced by irrigation when soil matric potential (Ψ_m) in the root zones reached -0.075 MPa. Grapevines in the deficit irrigation plots in the heavier soils were irrigated at the first visual signs of water stress. At that stage Ψ_m was *ca*. -0.11 MPa. Grapes were harvested when juice sugar content reached 24°B. Wines were prepared from grapes of each plot and subjected to sensorial evaluation. Vegetative growth was quantified by measuring pruning mass. Data were collected during the 2006/07 and 2007/08 seasons.

RESULTS AND DISCUSSION

Vegetative growth

Grapevines in the normal irrigated plots did not show any signs of water stress, irrespective of soil type. On average, vegetative growth was 59% lower in the sandy soils which increased leaf and bunch exposure to sun light compared to the heavier sandy loam soils. At some localities, grapevines in deficit irrigation plots in the sandy soils, showed water stress symptoms such as yellowing of older leaves early in December, whereas ones in the heavier soils showed no signs of water stress throughout the season. Water deficits had little effect on vegetative growth in the heavier soils, but reduced growth by 30% in the sandy soils compared to more frequent irrigation.

Yield

Berry mass decreased as the number of bunches per grapevine increased. This suggested that berry mass was reduced by a competition effect caused by higher bunch numbers. Smaller berries resulted in smaller bunches. Differences in bunch masses contributed to the variation in yield between plots. On average, deficit irrigation reduced grapevine yield in the sandy soils by 31%, whereas yield of grapevines in the heavier soils was only 7% lower.

Wine quality

Since the tempo of sugar increase was higher as the distance from the ocean increased, the harvest dates varied over a two month period between plots. Distance from the ocean did not have a significant effect on wine quality. However, within a specific locality, grapevines in the sandy soils tended to produce better wines compared to those in the sandy loam soils. Water deficits tended to improve wine overall quality, irrespective of soil type. Wine quality improved with increasing colour, fullness and berry aroma. Wine colour and berry character increased with a decrease in vegetative growth.

CONCLUSIONS

Grapevine growth and yield in the sandy soils were more sensitive to water deficits compared to ones in the heavier soils. The less vigorous vegetative growth of vineyards in the sandy soils played an important role in producing better wines compared to those in the heavier, sandy loam soils.

ACKNOWLEDGEMENTS

ARC and Winetech for research funding, as well as colleagues at Infruitec-Nietvoorbij and Namaqua Wines for technical support.

Keywords: Soil, Grapevine, Yield, Wine, Water deficits

ALLELOPATHIC EFFECTS OF THREE SELECTED SOUTH AFRICAN SPRINGWHEAT CULTIVARS ON GERMINATION AND GROWTH OF SELECTED WEED SPECIES

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INTRODUCTION

Over-reliance on chemical weed control practices resulted in the development and evolution of herbicide resistance in weed species. The implementation of integrated weed management (IWM) practices is crucial to continue sustainable cropping practices in the Southwestern Cape. One of the principles of IWM is the production of crop species and cultivars that are more competitive with higher allelopathic potential. Wheat (*Triticum aestivum* L) contains chemicals that inhibit the growth and germination of other plants. This characteristic could be used in IWM strategies. The objective of this experiment was to determine the allelopathic effect of the three selected South African springwheat cultivars on germination and growth of selected weed species.

MATERIALS AND METODS

Shoots and roots of three selected South African springwheat cultivars namely SST 88, PAN 3492 and Tankwa were collected, dried and milled to pass through a 1 m m sieve. Aqueous extracts were prepared from the abovementioned three springwheat cultivars and it was diluted to result in five concentrations viz. 100% (undiluted), 75%, 50%, 25% and 0% (control = distilled water). Seeds of six weed species namely *Lolium* species*, Raphanus raphanistrum, Oncosiphon suffruticosum, Stellaria media, Bromus diandrus* and *Avena fatua* were germinated in petri dishes to which one of the different concentrations was added. The rate of germination and total final germination percentage were calculated after two weeks, when no further germination took place. Secondly, seedlings of the same weed species were established in 8 cm x 8 cm square plastic pots. The pots were watered from the bottom with a balanced feeding solution (Steiner). After the seedlings were well established, seedlings were watered daily with 10 ml of the aqueous solutions described above and harvested after two weeks to determine different vegetative growth parameters. Statistical analysis of the data was performed using the Statistica package (Software, version 8.02).

RESULTS AND DISCUSSION

The results obtained showed that aqueous extracts of spring wheat cultivars exhibited significant ($P<0.05$) inhibitory effects on seed germination and seedling growth of all weed species tested except that of *R. raphanistrum*. *R. raphanistrum* germination was stimulated at lower extract concentrations but was inhibited as extract concentration increased. Extract concentration affected the degree of toxicity of the extracts with increased inhibition as the extract concentration increased. Overall the allelopathic potential of the wheat cultivars decreased in the order SST 88>PAN 3492>Tankwa. The results also demonstrated that weed species differed significantly in their growth response to springwheat aqueous extracts with *Lolium* spp. being affected the most followed by *A. fatua* and *R. raphanistrum* with *B*. *diandrus* being least affected. This may imply that wheat allelochemicals are selective in influencing the growth of certain weeds. It is therefore suggested that substantial residues and stubbles of spring wheat cultivars such as SST 88 as well as PAN 3492 can be used under no - till or minimum tillage systems to decompose and leach into the soil to inhibit seed germination and seedling growth of weed species such as *Lolium* ssp. in order to reduce the weed density.

CONCLUSION

Springwheat cultivars differ in terms of allelopathic potential and these attributes should be kept in mind when selecting cultivars to establish on fields with severe herbicide resistant ryegrass problems.

ACKNOWLEDGEMENTS

Financial support by the Namibian government as well and DAAD is gratefully acknowleged.

Keywords: allelopathy, herbicide resistance, wheat, weed species

PHYSIOLOGICAL ANALYSIS OF WATER USE EFFICIENCY AND ITS APPLICATION IN GROUNDNUT (*Arachis hypogaea* L.)

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INTRODUCTION

Groundnut is grown word wide in semi-arid tropics. These environments are characterised by water scarcity. This has emphasised the need to improve drought tolerance in cultivated species by finding ways to increase productivity per unit of water used. Hence, efficient cultivars are needed to harness the maximum benefits by increasing the water use efficiency (WUE). The mechanisms used by plants to cope with changes in the environment are changes in leaf morphology, root architecture and maintenance of leaf water content including the biochemical traits (Nautiyal *et al.*, 2002). The objective of this study was to improve complex trait such as yield under stressed environments by performing selection for WUE and harvest index (HI).

MATERIALS AND METHODS

To study WUE and harness its benefits several experiments including field trials were conducted. Germplasm lines were screened for WUE by the carbon isotope discrimination ($^{13}C/^{12}C$, delta) technique. The physiological analysis of drought tolerance or WUE was performed by evaluating drought tolerance index and HI based on total biomass production under normal and water-deficit conditions. Changes in leaf relative water content (Barrs and Weatherley, 1962) and water potential was accessed following the standard procedures. Root architecture was analysed under normal (100% cpe) and water deficit (50% cpe) conditions in root study blocks. Breeding programme was launched to develop WUE lines based on the traits: T, TE and HI and advanced breeding materials was tested at different locations in a farmer's participatory (FPRE) approach.

RESULTS AND DISCUSSION

Seventy-five germplasm accessions including the cultivars screened for WUE showed wide genetic variability. Selected lines were used in analysing physiological parameters associated with WUE or drought tolerance, and donor parents were identified. An inverse relationship between specific leaf area (SLA) and WUE (delta) was found and used as surrogate for the selection for WUE in segregating population and advanced breeding materials. The analysis for drought tolerance or WUE showed that low SLA lines are better in maintaining RWC and water potential during water deficit conditions. In addition, the drought tolerant index was higher in lower SLA lines. Also, the early seedling vigour was associated with the lower SLA and higher 100-seed mass. Root length density was correlated with drought tolerance and higher root: shoot ratio. The high WUE lines based on trait selection (WUE, TE and HI) were developed and tested at different locations and recommended for cultivation by the farmers in the FPRE approach.

Some of the most important physiological traits associated with drought tolerance or WUE in groundnut seem to be lower SLA, ability to maintain higher leaf RWC and water potential, higher root length density and higher root: shoot ratio to comply with changing demands of the availability of soil moisture.

CONCLUSIONS

Thus it is possible to develop groundnut cultivars suitable for cultivation under rain-dependent system by incorporating WUE by combining the traits such as WUE and HI. Water use efficient lines could be improved further based on root traits.

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Keywords: Groundnut, Water use efficiency

SEQUENTIAL FRACTIONATION OF PHOSPHORUS IN PHALABORWA PHOSPHATE ROCKS

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Investigations that make use of chemical extractants, commonly as sequential fractions that separate soil P into readily available and recalcitrant pools are becoming a common place in soil phosphorus studies. The key advantage being that they give a complete account or budget of the P forms present. In order to model P release from rock phosphate in direct application procedures, we carried out a sequential P extraction experiment with foskorite, pyroxenite, Foskor Limited tailings material and Phalaborwa Mining Company tailings materials. The fractionation steps were composed of a DMT-HFO water extractable and $NaHCO_3$ extractable P in order to estimate the readily available labile P, the Al-oxide and Fe-oxide associated (NaOH extractable), Ca-associated (HCl-extractable) inorganic P as well as the recalcitrant P forms.

In line with other rock phosphates and carbonatites, these materials were alkaline in nature, with little difference between water and KCl pH. In pyroxinite, the measured pH was higher in water compared to its KCl counterpart. The dominant P fraction was the HCl-P, which represents the apatite associated P. The DMT-HFO P, Bic-P and NaOH-P fractions were the minor fractions in these minerals. Most of the P is held in the residual P fraction. Comparison of the P stocks of the feed materials and that of the tailings material indicated that the industrial process in Phalaborwa accesses the P in the residual pool. P accumulation in the finer fractions of these PR materials was not significant, implying that screening or milling of these materials beyond the biggest fraction will not result in any significant increase in P output. This study confirmed the difficulty of use of rock phosphates in direct applications. P transformation amongst these pools will result in its accumulation in the labile fractions and increase plant response.

Keywords: sequential fractionation, phosphorus chemistry, rock phosphate, plant nutrition

THE EFFECT OF CROP ROTATION ON THE YIELD OF MAIZE UNDER MARGINAL CONDITIONS

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INTRODUCTION

Dryland monoculture maize production in the western part of the Highveld is subject to risk due to erratic and low rainfall (less than 550 mm per annum) and variable prices. Crop rotation is often recommended, regardless of rainfall and soil type, for combatting the risks associated with monoculture maize through the improvement of maize yield and diversification of enterprise. Some realities, however, restrain many farmers from adopting crop rotation. In the past, alternative crops were usually not economically competitive with maize and experience has shown that the yield of maize does not necessarily improves as expected when preceded by alternative crops, but in fact, is often worse. Clean fallowing for one season, is viewed by farmers as successful for improvement of maize yields. To quantify these observations, an investigation was initialised to determine the effect of crop rotation with various alternative crops and fallow on the yield of maize and of fallow on the yields of alternative crops under marginal conditions on the western Highveld in a field trial.

MATERIALS AND METHODS

Four seasons of dryland crop rotation were conducted at the farm Holfontein and for another five years on the farm Noodshulp, both close to Ottosdal. Soil profiles from both localities were classified as Hutton, with an effective depth of >1.5 m at Holfontein and 1.25 m at Noodshulp. Crop systems consisted of cowpea, groundnut, soybean and sunflower in two-year rotation with maize as well as a continues monoculture maize control crop and two-year fallow system involving all five crops.

RESULTS AND DISCUSSION

At Holfontein the mean maize yield was 1949 kg ha^{-1}. Calculated across four seasons the yield of maize preceded by fallow, a cowpea, soybean or sunflower crop did not differ from that of maize grown in monoculture. The yield of maize preceded by a groundnut crop was 25% higher than that of the monoculture maize. Sunflower was the only alternative crop which yield was affected by crop system. The yield of sunflower grown in rotation with maize was lower, equal or higher in individual seasons, than the yield of sunflower grown in the two-year sunflower fallow crop system.

The mean maize yield at Noodshulp was 3389 kg ha^{-1}. Across seasons, the yield of maize preceded by soybean was 11% higher, and that of maize grown after fallow was 9% higher than that of maize grown in monoculture. The yield of maize preceded by sunflower was 5% lower than that of maize grown in monoculture. The yield of maize preceded by cowpea and soybean was not significantly different from that of maize grown in monoculture. Seasonal yields of cowpea and sunflower crops were lower, equal or higher when grown in rotation with maize than that of cowpea and sunflower grown in the two-year sunflower fallow crop system. Seasonal yields of groundnut and soybean crops grown in rotation with maize were either lower or equal than the yield of these crops grown in rotation with maize.

Rainfall use efficiency (RUE) of maize varied from 0.15 to 10.98 kg ha^{-1} mm^{-1} among crop systems and seasons. RUE's of maize grown in the two-year fallow system varied from 0.21 to 7.06 kg ha^{-1} mm^{-1} compared to the 0.53 to 10.98 kg ha^{-1} mm^{-1} of monoculture maize.

ACKNOWLEDGEMENTS

This project was financially supported by the Maize Trust.

Keywords: Crop rotation, fallow, maize yield, marginal conditions

PEPPER AND TOMATO SEED PERFORMANCE IN RESPONSE TO IMBIBITION AND DEHYDRATION

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INTRODUCTION

The International Seed Testing Association and the Association of Official Seed analysts define seed vigour as the ability of a seed lot to perform during the germination process and crop stand establishment under a wide range of environmental conditions (Copeland and McDonald, 1997). There many ways to determine seed vigour, but few satisfy the requirements of being simple, inexpensive and reproducible, among others required to permit the seed industry to adopt seed vigour as an indicator of seed quality when they sell seeds. Hence, the standard germination test, which is performed under uniform and favourable conditions, is generally used to indicate seed quality when seeds are marketed. The objective of this study was to determine the performance of tomato and pepper seeds in response to pre-germination hydration and dehydration relative humidities (12%, 49% and 75%).

MATERIALS AND METHODS

Before hydration, seeds were hydrated at three temperatures (10°C, 20°C and 30° C). Hydration was performed imbibing pre-weighed pepper and tomato seeds for 2 h in 10 ml of distilled H_2O per 100 seeds at 10°C, 20°C and 30°C, respectively.Dehydration was performed by change in seed mass determined during a 72-hour dehydration at 12%, 49% and 75% RH. Seed performance in response to imbibition and dehydration was determined by leakage of electrolytes from seeds during imbibition, laboratory germination capacity and seedling emergence under simulated nursery conditions in shadehouse. A pot experiment was conducted to determine the effects of seed treatment on yield.

RESULTS AND DISCUSSIONS

Seed mass increased by about 50% during the 2-hour of hydration. Dehydration was hastened by decreasing the RH, and 12% RH significantly ($P < 0.05$) reduced post-imbibition seed moisture content compared with 49% and 75% RH. The latter two relative humidities reduced seed moisture content to about 10% and 15%, respectively, for all cultivars, irrespective of imbibition temperature. Low temperature (10°C) imbibition significantly ($P < 0.01$) increased electrolyte leakage, compared with 20°C and 30°C, which were not significantly different. At all hydration temperatures, low RH (12%) caused a significant ($P < 0.01$) decrease in seed germination whereas 49% RH and 75% RH apparently had a priming effect on seeds. There was no significant difference between imbibition temperatures, with respect to seed germination, but 10°C caused a significant decrease in germination index, a measure of seed vigour. Seedling emergence was significantly ($P < 0.01$) reduced by low both low temperature imbibition and 12% RH dehydration. The negative effects of low temperature imbibition and rapid dehydration at 12% RH were also observed in stunted seedling growth. Principal component analysis and linear regression were used to determine a statistical model to predict seedling emergence from germination percent. The model predicted emergence consistently, but it overestimated it by about 2% to 3%.

CONCLUSIONS

It is concluded that low imbibitions temperature and rapid dehydration can be used to simulate stress to determine seed performance in pepper and tomato. The study provided evidence to confirm the previous finding (Modi, 2005) that dehydrating seeds at 12% RH following imbibition causes stress that reduces seed performance. In addition, this study showed a positive correlation between low temperature (10°C) imbibition and 12% RH in causing stress on tomato and pepper seeds.

Keywords: Germination, Desiccation, Vigour

AN INTEGRATED NATIONAL CROP ESTIMATION SYSTEM FOR SOUTH AFRICA

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INTRODUCTION

Following the deregulation of the agricultural markets in the late 1990's, the requirement for a statistically sound and reliable grain crop estimation system became apparent. Initially a stratified point frame sampling system was developed whereby field surveyors conducted personal interviews with the decision makers on randomly selected farming enterprises. Over three seasons the response rate to interviews has decreased as refusals increased to such an extent that it prompted the developers to look for alternatives, while at the same time retaining the confidence of a Coefficient of Variation of below 5% at national level.

METHODOLOGY

In combining and integrating satellite imagery, remote sensing, point frame statistical platforms, GIS and aerial observations, a Producer-Independent Crop Estimation System (PICES) was developed. As a first step satellite imagery (initially Landsat 5 and more recently SPOT imagery) was used to capture field boundaries for all cultivated fields. The field boundaries that were mapped were used as a frame for a random geographic systematic selection of sample points across each province. These selected points were sampled to determine the crop type for each field/point by aerial observations using a Very Light Aircraft (VLA). For the aerial survey trained observers (predominantly farmers), that could identify different crop types, were employed to record crop information for selected points on a digital tablet computer with a touch screen in combination with a GPS navigation instrument. The observers also recorded additional information while in transit between the selected sample points, including fields with clearly visible crops.

Information gathered during the aerial survey was firstly used to calculate a statistical area for each crop type per province. Secondly it was used as training sets for satellite imagery during classification procedures to generate a crop type for each individual field. During the growing season both Landsat 5 and Spot 2 and 4 images were recorded and used to perform a crop type classification. From the classified satellite imagery, the crop type was assigned to individual field boundary polygons to provide a complete set of classified fields for each province.

The system also facilitates the collection of objective yield data where a subset of sample points is extracted once the crop types of the fields in which the initial sample point fell have been analyzed. The yield estimation data are collected in-field and include the measurement of row width, number of plants per metre, number of cobs per plant and kernels per cob as well as dry weight of a sample of kernels.

With the estimated area based on the aerial observation of crop type and the yield estimation by objective yield measurement, the production per province is calculated.

RESULTS

Fields planted with maize covered 80% of the summer grain fields, while sunflower covered only 10% and soya beans 5% with other crops less than 2%, according to the ratio of crop types generated from the aerial field surveys. When production estimates made in May each year over a four-year period using the results of the area and yield estimations from the system are compared with the reconciled crop size estimated at the end of the season by the Crop Estimation Committee, the May estimate differs on average by less than 2% of the final crop.

DISCUSSION AND CONCLUSIONS

Through integrating and combining technology it was possible to calculate statistical area estimates for each province through aerial surveys, while also generating a map showing the spatial distribution of crop type patterns. It is now possible to extract information on sub-provincial level such as agro-climatic zones or district level, or any polygon boundary of importance. This provides decision makers with spatial analysis possibilities not previously available.

ACKNOWLEDGEMENT

Funding by the Department of Agriculture and the Maize Trust is acknowledged.

Keywords: Earth observation, Objective yield, Remote sensing, Crop area estimation

UPLAND COTTON (*Gossypium hirsutum* L.) FIBER QUALITY RESPONSE TO MOISTURE STRESS

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INTRODUCTION

Cultivated cotton (*Gossypium hirsutum L.*) is a perennial plant with an indeterminate growth habit that has been adapted to annual crop cultivation. Plant breeders have placed enormous selection pressure on cotton fiber quality over the years as it influences the price of the cotton. Fiber quality is a general term given to set of measurements that describe a sample of fibers extracted from a bale of cotton. The crop fibre quality response to water stress varies depend on the stage of growth at which the stress occurs, the degree of stress, and the length of time the stress is imposed. Moisture stress can also reduce fiber micronaire, but this effect is probably due to reductions in the photosynthetic capacity of the canopy. The objective of the study was to determine the response of fiber quality (fiber length, uniformity, elongation, strength, Short Fiber Index (SFI), micronaire and maturity) to moisture stress.

MATERIALS AND METHODS

Twelve cotton varieties were evaluated at the Agricultural Research Council-Institute for Industrial Crops (ARC-IIC), Rustenburg-Kroondal, during 2005/2006 growing season. Six varieties based on the results of 2005/2006 growing season were selected and e valuated during 2006/2007. A split plot design, with three replications, was used in 2005/2006, whereas in 2006/2007 growing season the treatments were replicated four times. The main factor (plot) was assigned to rainfed and irrigated conditions, and the 12 upland cotton varieties were sub factors.

RESULTS AND DISCUSION

Cotton fiber length, SFI and micronaire were not significantly influenced by moisture stress, whereas uniformity, elongation, strength were significantly influenced by moisture stress at Kroondal during 2005/2006 growing season. In Loskop during 2006/2007 growing season, only elongation was not influenced by moisture stress, whereas all other fiber qualities were statistically influenced by moisture stress. Moisture stress significantly influenced strength, micronaire and maturity in Makhatini Research Station in 2006/2007 growing season.

Keywords: Rainfed, Irrigated, Moisture, Cotton, Varieties, Stress

THE USE OF ADJUVANT EXP100 TO ENHANCE THE EFFICACY OF PARAQUAT

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INTRODUCTION

Successful crop production depends to a large extent on successful weed control within the crop. Paraquat and glyphosate are the two major non-selective herbicides that are extensively used in South Africa to achieve total weed control in many crops. They are used as a tool to combat herbicide resistance and are often applied in rotation with one another. Since it is important to prolong the lifespan of these two pre-emergence herbicides, it is important to achieve adequate weed control to reduce chances of possible herbicide resistance developing. Paraquat is registered for use with non-ionic surfactants to increase the level of weed control. An experimental adjuvant was tested to determine if paraquat could be further enhanced by the addition of adjuvants, other than the current registered non-ionic surfactants. This paper reports on an activator adjuvant that was tested in combination with the registered non-ionic surfactant to optimize paraquat efficacy.

MATERIAL AND METHODS

Numerous different greenhouse trials were conducted over a period of two years to determine the efficacy of the activator adjuvant EXP100. All treatments were arranged in a completely randomized design with four replications and all experiments were repeated at least twice using standardized experimental techniques. The test species for all experiments was the oats cultivar, Potberg. An ammonium sulfate adjuvant was used throughout; humectants including Swift and sodium lactate were used and Agral 90 ® was used as a standard tank-mix surfactant in all the experiments. Initial trials were conducted with differing rates of paraquat and the registered non-ionic surfactant Agral 90 ® using different rates of the experimental adjuvant EXP100 to determine the optimum mixture of paraquat and EXP100 that is affordable to producers but has a high percentage weed control. Follow-up trials were conducted to compare EXP100 with registered humectants Swift and sodium lactate to determine whether EXP100 contains humectant properties. Plants were harvested 2 weeks after treatment by cutting the plants at soil level. Fresh plant weight was measured on a high decimal precision scale (Precisa 1600C SwissQuality No. 67368). Data was subjected to analysis of variance and significant differences between means, at the 5% level of Tukey Test probability, measured.

RESULTS AND DISCUSSION

EXP100 increased the activity of paraquat consistently throughout all conducted experiments and improved paraquat efficacy significantly in comparison with other adjuvants. EXP100 was thus found to be more effective than other adjuvants including ammonium sulfate and humectants. This occurred at all rates and in all conditions tested, including different environments and with various water carriers.

CONCLUSIONS

EXP100 is a good candidate to further enhance paraquat efficacy and is currently being evaluated for possible commercialization.

ACKNOWLEDGEMENTS

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Keywords: paraquat, herbicide efficacy, EXP100

EFFECTS OF CONSERVATION AGRICULTURE MANAGEMENT PRACTICES ON SOIL QUALITY PARAMETERS OF TWO SANDY CLAY LOAM SOILS IN THE EASTERN CAPE PROVINCE, SOUTH AFRICA

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INTRODUCTION

Land degradation is increasingly threatening the productivity of South Africa's arable lands and hence national and household food security. Major causes of degradation are organic matter depletion and soil sterilization which in turn cause soil compaction/crusting, erosion, infertility and desertification in some cases. Conservation agriculture (CA) is one strategy that is actively being promoted as a means of reversing the negative impact of agricultural land degradation.There is, however, inadequate information on the potential impacts of CA practices on soil properties, particularly in semi-arid areas of the Eastern Cape Province.

MATERIALS AND METHODS

The study was carried out in 2005 at Burnshill and Lenye villages within ZIS. The two sites are located between latitudes 32^{o} 45′ 35″ and 32^{o} 45′ 40″ S, longitudes 027^{o} 04′ 41″ and 027^{o} 04′ 42″ E, at an altitude of 531 - 550 meters above sea level. The experiment was laid out in split-split plot arrangement in randomized complete block design with 4 replicates. The trials involved three factors, namely tillage, sub-soiling and rotational cover-cropping. Main plots were conventional tillage (CT) and no-tillage (NT); subplots were sub-soiling (S1) and no sub-soiling (S2), while rotational cover-cropping treatments (maize monoculture (MM), maize followed by wheat (MW) and maize followed by oats (MO)) were the sub-subplots. Eighteen soil parameters were determined for each management practice at 0-5 and 5-20 cm depths.

RESULTS AND DISCUSSION

Soil aggregate stability (expressed as mean weight diameter (MWD) of aggregates) was significantly higher in NT than CT plots indicating that NT improved the soil physical conditions of the soils. Soil oxidisable C (SOC), extractable Mg, potential carbon mineralization (PCM), soil respiration (SR), microbial biomass C (MBC) and N (MBN) in NT plots were also significantly higher than in CT plots. This was attributed to improved soil organic matter (SOM) accumulation which in turn stimulated greater microbial activity in NT than CT plots. It is possible that disruption of soil aggregates by subsoiling especially under NT exposed previously inaccessible SOM to biological oxidation with the resultant increase in plant nutrients. Under NT system, surface soil layer (0-5 cm) had significantly higher SOC, PCM, MBC, MBN, SR, extractable P and K than the subsurface soil layer (5-20 cm).

CONCLUSION

Conservation agriculture practices improved soil physical, chemical and biological parameters of the two soils studied. Sub-soiling significantly increased PCM, MBN, SR, electrical conductivity (EC) and extractable P. Soil microbiological parameters (MBC, MBN, PCM and SR) were identified by both ANOVA and PCA as the most sensitive parameters to the imposed CA treatments.

Keywords: Soil degradation, Conservation agriculture, Multivariate, Soil quality

IDENTIFICATION AND DOCUMENTATION OF INDIGENOUS AND TRADITIONAL LEAFY VEGETABLES IN NORTHERN KWAZULU-NATAL, SOUTH AFRICA

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INTRODUCTION

Indigenous and traditional leafy vegetables (I/TLVs) are those plants whose parts are acceptable as food (Jansen van Rensburg *et al*., 2004). They contain essential elements which enhance people's nutritional status (Flyman and Afolayan, 2006). Most of these vegetables are classified as weeds and thus neglected for research (Odhav *et al.*, 2007).

Northern KwaZulu-Natal is situated in the Maputaland Centre of Plant Endemism and Diversity, with a high species diversity of indigenous vegetables (Guagris and Van Rooyen, 2007). However, there are no records of these vegetables. The vegetable checklist will serve as a template for further crop improvement research.

The aim of the research was to identify and document the indigenous knowledge on the utilization of the I/TLVs occurring in the area.

MATERIALS AND METHODS

The survey was conducted in three districts. Three areas per district were visited and fifty household per area were interviewed using structured questionnaires. Voucher specimens were collected and are housed in the University of Zululand Herbarium (ZULU).

RESULTS AND DISCUSSION

Based on the Zulu names, 106 I/TLVs are utilized in northern KwaZulu-Natal. Umkhanyakude district had the highest number of utilized vegetables (76). Most of these vegetables occur as weeds (e.g. amaranths and Black jack), while a few are cultivated (e.g. pumpkins and cow pea). The most utilized vegetables are Amaranths (96.71%), Black Jack (91.45%), and Pumpkins (92.76%). Leaves (100%) and young shoots (96%) are mostly consumed parts. These vegetables are used for hunger alleviation, income generation as well as for their medicinal value.

Keywords: Indigenous and traditional leafy vegetables, Pumpkins, Amaranths

DROUGHT STRESS, DESICCATION STRESS AND SEED VIGOUR IN COWPEA; IS THERE A RELATIONSHIP?

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INTRODUCTION

Cowpea is a drought tolerant crop; however, there is no evidence to associate plant drought tolerance and seed quality. The relationships between desiccation tolerance, drought stress and seed vigour have been barely explored. This study investigated the effect of water stress on cowpea seed quality development with respect to germination capacity and vigour. Patterns of the raffinose family of oligosaccharides (RFOs) during seed development to mature dry stage were used to physiologically relate seed performance to water stress. The effect of water stress on the accumulation of the late embryogenesis abundant (LEA) proteins in relation to seed quality development and germination was also investigated. RFOs and LEA proteins are known for their roles in desiccation sensitivity, but no studies have shown their significance in drought tolerant crops such as cowpea.

MATERIALS AND METHODS

Seeds of three cowpea cultivars were planted in a pot experiment under controlled conditions and sampled during three developmental stages. Plants were subjected to: Terminal stress (at soil matric potentials < -400 kPa throughout plant growth and seed development); Intermittent stress (< -400 kPa during the vegetative growth phase only); and control. Seeds were subsequently analyzed for changes in RFO accumulation during development using gas chromatography. The effect of water stress on the accumulation of stress LEA proteins in relation to seed quality development was also investigated. Mature seeds were tested for germination capacity and vigour.

RESULTS AND DISCUSSION

No significant differences in quality were observed between seeds from stressed and non-stressed plants. Stachyose was found to be the predominant member of the RFOs in cowpea. Stachyose accumulation under Terminal and Intermittent stress was higher than the control. It is suggested that stachyose accumulation under water stress could be used as an indicator of stress tolerance in cowpea. Group 2 LEA proteins were observed in seeds subjected to Intermittent stress at 2 weeks after pod formation. Both group 1 LEA and group 2 LEA (dehydrin) were shown to increase in concentration in response to water stress. In addition group 1 LEA was found to be relatively abundant in cowpea seeds.

CONCLUSIONS

Cowpea seed quality as determined by germination capacity and vigour is not detrimentally affected by water stress. A vegetative-reproductive stage linkage is implied by the appearance of dehydrin-like proteins after two weeks of development in cowpea plants subjected to stress during the vegetative phase only.

ACKNOWLEDGEMENTS

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Keywords: drought tolerance, RFOs, LEA proteins, vigour

SOIL IN LAND SUITABILITY EVALUATION FOR WHEAT AND MAIZE ON TEN BENCHMARK SOILS OF LESOTHO

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INTRODUCTION

Land is the important natural resource both to the agricultural and non-agricultural sectors. Agricultural land is a special item of nature and has to have certain qualities before it can be considered suitable for agricultural use and this is why agricultural lands are classified and evaluated to ascertain their relative suitability for one use or several uses before they are cultivated. Maize and Wheat are commonly grown in Lesotho as staple food by both small scale and large scale farmers.

METHODOLOGY

The Kingdom of Lesotho covers a land area of 30,355 sq km and it is divided into four agro-ecological zones based on climate and elevation: lowlands, Senqu valley, foot-hills and mountains. Data from ten soil benchmark soils of Lesotho (climate, soil fertility, topography) were collected from the comprehensive land resource study of Lesotho. The capability of this land for production of these crops was assessed by matching the land qualities with the land use requirements of these crops following the two methods: Land S uitability Evaluation (FAO, 1976) and a par ametric method (Ogunkunle 1993). Data on the General properties of selected Benchmark soils of Lesotho, climatic, morphological and soil analytical data for these soils were collected.

RESULTS

Results of the overall/aggregate suitability ratings (using the conventional approach) -currently and potentially, showed that the suitability of these pedons ranged between highly suitable (S1) to non-suitable (N1) for cereals cultivation. The major constraints implicated were sub-optimal climate (rainfall and solar radiation) coupled with low ECEC which could lead to poor nutrient availability that may result in low yield. However in terms of the parametric approach, all the soils are not suitable (N1) for cereals cultivation and the major constraints are climate (rainfall and s olar radiation) as well as low fertility which could be a reason for low production.

CONCLUSION

This study concludes that it is important to evaluate the soils of Lesotho qualitatively and quantitatively. Major limitations are climate and soil infertility problems especially sandy soil texture, deficiency of P, K and acidic soil pH.

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Keywords: Suitability evaluation, benchmark soils, maize, wheat, land qualities, climate

IRRIGATION SCHEDULING DEMONSTRATION TRIALS: A MEANS TO INCREASE IRRIGATION WATER USE EFFICIENCY OF SUGARCANE

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INTRODUCTION

In water scarce countries such as South Africa, effective irrigation scheduling is a prerequisite to optimising the use of expensive irrigation water. Unfortunately accurate irrigation scheduling is not widely practiced despite many scheduling tools available to growers. As a result very low irrigation water use efficiencies (IWUE, tons cane/100mm irrigation water applied) are achieved. The main objective of this project was to increase IWUE and/or yield of irrigated sugarcane by evaluating, promoting and implementing irrigation scheduling technology. Specific objectives were: (1) to demonstrate the advantages of irrigation scheduling by comparing different methods of irrigation scheduling, and (2) to provide information and advice on the practical implementation of specific irrigation scheduling methods/tools for sprinkler and drip irrigation systems.

MATERIALS AND METHODS

An irrigation scheduling demonstration trial was conducted on the Mpumalanga Research Station (25° 37'S; 31° 52'E, altitude 187m a.s.l) to evaluate several scheduling methods of varying sophistication. Two weather based (Irrigation calendars and SA-Shed water budget spreadsheet) and one soil based (Wetting front detector) irrigation scheduling method was evaluated in a sprinkler irrigated trial. One weather based (Canesim crop model), one soil based (Tensiometer) and one plant based (Stalk extension) scheduling method was evaluated in a drip irrigated trial. Performance and suitability were evaluated in terms of cane yield and quality, irrigation applied, ease of use, practical constraints and cost.

RESULTS AND DISCUSSIONS

Much less water was applied where irrigation was scheduled compared to the standard farm practices, without negatively affecting the cane yield or quality. For example in the sprinkler irrigated ratoon trial, savings ranged from 7% (87 mm) for the wetting front detector, to 25% (329 mm) for the SA-Shed water budget spreadsheet. Similarly in the drip irrigated ratoon trial, savings ranged from 18% (252 mm) for the SQR-Canesim scheduling software to 50% (710 mm) for the stalk extension treatment. Increases in IWUE were observed in all irrigation scheduling methods tested, the highest being 13.3 tc/100mm irrigation for the SA-Shed water budget spreadsheet and 17.5 tc/100mm of irrigation for the stalk extension treatment in the sprinkler and drip irrigated trials respectively. Similar trends were observed in the plant crop.

CONCLUSIONS

Irrigation calendars are recommended for use under sprinkler irrigation due to their simplicity and ease of use. A simple rainfall rule can be applied to account for rainfall. Although user-friendly, the SA-Shed water budget spreadsheet is more time consuming than calendars and relies on availability of reliable weather data. Wetting front detectors are cheap, but malfunction in older cane due to preferential stem flow of irrigation water. Although relatively expensive, tensiometers are recommended for use in drip irrigation, provided the correct installation and maintenance procedures are followed. Computer based scheduling software such as SQR-Canesim and SA-Shed is perceived as being too difficult to use by growers. Manual stalk extension measurements are very labour intensive and therefore not recommended. Agricultural extension and demonstration trials are being applied with success to promote and implement scheduling technology within the sugar industry.

Keywords: wetting front detector, tensiometer, SQR Canesim crop model, SA-Shed water budget spreadsheet, stalk extension, irrigation calendar

FACTORS CONTRIBUTING TO THE LOSS OF KERNEL VALUE IN THE SOUTH AFRICAN MACADAMIA INDUSTRY

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INTRODUCTION

Between 2005 and 2007, the price of macadamia kernel declined 42%. Contributing factors included the perception that macadamias were overpriced compared to other nuts. This problem was compounded by a relatively strong Rand, increasing labour costs and large increases in fuel and fertilizer prices. To remain profitable, growers need to rationalize their costs and increase the value of their product. A primary factor affecting value of macadamias is the amount of kernel breakage. In 2007 whole kernel received up to 60% more income than broken kernel.

A number of factors contribute to kernel breakage. Research in Australia has shown that rough handling of nuts in both the orchard and the on-farm drying facilities reduces whole kernel and also leads to shoulder damage, chipping and bruising of the kernel. It has also been shown that the machinery used to remove the fleshy husk (dehusking) from harvested nuts may induce shoulder damage in kernel, and that the ratio of whole:half kernel is cultivar dependent. It has also been hypothesised that excessive drying may contribute to kernel breakage.

MATERIALS AND METHODS

This study was conducted using nuts of the “Beaumont” cultivar. Several factors were investigated, namely:

Dehusking

Five different dehuskers were used to dehusk uniform samples of freshly harvested nuts. The effect of multiple passes through a single dehusker was also examined.

The effect of rough handling

Nut in shell at 20%, 10% and 1% moisture content was dropped 1 – 3 times from heights ranging from 0.5 – 2m onto a hard surface. The nuts were then dried and the kernel examined for breakage and other damage.

The effect of drying temperature / drying rate

Nut in shell was dried at temperatures between 23°C and 50°C, as well as in the presence of silica gel. Following drying, the kernel was examined for breakage.

RESULTS AND DISCUSSION

Rough handling appeared to contribute very little to the ratio of whole:half kernel under the trial conditions selected. Similarly, the equipment used to dehusk nuts appeared to contribute very little to kernel breakage. It was found that the drying temperature had an effect on breakage, with high temperatures resulting in more whole kernel. However, temperatures above 40°C resulted in kernel with an oily sheen on the surface, indicating damage to the kernel on the cellular level. This free oil would rapidly become rancid during storage.

CONCLUSIONS

It would appear that certain aspects of the post-harvest handling and processing of macadamia nuts may contribute to kernel breakage. This is particularly true of the drying regime used. These processes need optimization in order to reduce losses in kernel value.

ACKNOWLEDGEMENTS

The Southern African Macadamia Growers’ Association is gratefully acknowledged for funding this trial, as are the individual growers who provided trial material. The work could not have been carried out without the assistance of Elvis Nkwana and Yvonne Nxundu, employees of the ARC.

Keywords: Macadamia, quality, value, post-harvest

STUDIES IN CITRUS CREASING/ALBEDO BREAKDOWN

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INTRODUCTION

Creasing is a physiological disorder caused by cell separations in the albedo tissue resulting in grooves in the albedo and the collapse of the flavedo which shows as creases on the surface of the fruit. It is a recurrent problem in citrus orchards, especially on Navel and Valencia oranges. Although the contributing factors are known such as crop load, fruit size, rootstock, the mechanism of creasing development is unresolved. Gibberellic acid (GA_3) is known to reduce creasing incidence. However, there is a trade-off between its effectiveness and delayed colour development. New chemical interventions that can counteract the cell separations in the albedo may reduce creasing incidence.

Therefore, the effect of CPPU [N-(2-chloro-4-pyridyl)-N-phenylurea], MaxCel (6-Benzyladenine), a mixture of CPPU and calcium, Aminoethoxyvinylglycine (AVG) (an ethylene inhibitor) and Messenger (a harpin protein) on creasing incidence, and the best application timing of GA_3 were evaluated. To further understand the physiology of creasing, light manipulation techniques viz. covering leaves behind fruit with a s hade cloth, pruning, covering fruit with bags, as well as carbohydrate manipulations such as removing leaves from behind fruit, girdling and hand thinning were assessed. Lastly, the effect of the position of fruit on a tree in relation to the albedo mineral content and creasing incidence was also investigated.AVG) (an ethylene inhibitor) and M essenger (a harpin protein) on creasing incidence, and the best application timing of GA were evaluated. To further understand the physiology of creasing, light manipulation techniques viz. covering leaves behind fruit with a s hade cloth, pruning, covering fruit with bags, as well as carbohydrate manipulations such as removing leaves from behind fruit, girdling and hand thinning were assessed. Lastly, the effect of the position of fruit on a tree in relation to the albedo mineral content and creasing incidence was also investigated.

MATERIAL AND METHODS

Palmer navel orange trees in the Addo region were used to investigate the effect of the position of fruit on the tree on creasing incidence. Each tree replicate was divided into four sectors, *viz.* north, south, east and west. In each sector, fruit was sampled from four different sub-sectors, the inside and outside of the top and bottom part of the tree canopy. All other experiments were conducted in commercial orchards in the Citrusdal region on navel orange trees. The experiments were laid out in a randomized complete block design with each block represented by a single tree and replicated eight times. All treatments were applied after physiological fruit drop. The fruit were sampled at commercial harvest time in June 2007 (fruit bearing position trial) and May 2008 for all other experiments. Fruit were evaluated for creasing incidence (%), colour, diameter and peel thickness. Mineral concentrations of the albedo tissue were also determined.

RESULTS AND DISCUSSION

In general, creasing incidence was high in Addo in 2006/2007 and low in Citrusdal in the 2007/2008 season. Creasing incidence was significantly higher on the south side than on the north side of tree with a tendency of bottom fruit to have a higher incidence of creasing than top fruit. No correlations between creasing incidence and albedo mineral nutrients were observed at harvest.

A significant increase in creasing incidence was observed in bagged fruit. Creasing incidence was reduced by half by the application of GA_3, irrespective of the timing of application. CPPU and MaxCel applied alone significantly reduced creasing incidence to 20% from 51%. Messenger and AVG did not reduce creasing incidence compared to the control. Early applications of GA_3 had little effect on fruit colour and later application of GA_3, MaxCel and CPPU in combination with calcium resulted in a delay in fruit colour development.

CONCLUSION

The position of fruit on a t ree influences creasing incidence. Even though there was no relationship between albedo mineral concentrations and creasing incidence, the tendency of shaded fruit to be more creased and the greater incidence of creasing when fruit were bagged indicate the possible involvement of minerals, light or temperature in the development of creasing. Cytokinins have the potential to reduce creasing, but GA_3 gave the best results irrespective of the time of application.

Keywords: Creasing, Albedo breakdown

RYEGRASS (*Lolium* SPP.) NUMBERS AS INFLUENCED BY CROP MANAGEMENT PRACTICES

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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. Ryegrass (*Lolium* spp.) has developed resistance to a wide range of herbicides registered for its control. Under these conditions the implementation of integrated weed management (IWM) practices becomes crucial. In this study, the effect of different crop management systems on the occurrence of ryegrass on the Langgewens experimental farm in the Swartland region of the Western Cape was investigated.

MATERIALS AND METHODS

The study was carried out on the Langgewens experimental farm of the Western Cape Department of Agriculture on a long-term soil tillage trial where different soil tillage treatments in combination with crop rotation are being investigated, and on a long-term rotational cropping trial where a wheat monoculture treatment and various rotations of wheat with other cash crops and annual pastures are investigated.
In June 2008, August 2008 and October 2008 ryegrass counts were made in three subplots in each replication of all the treatments in both trials. The ryegrass numbers m^{-2} was calculated and statistical analyses were carried out.

RESULTS

There were no significant ($P>0.05$) interactions between tillage treatments and rotation treatments in terms of the number of ryegrass seedlings in the different treatments in June 2008. There were no significant differences between the rotation treatments. There were however, significant differences between different tillage treatments. The mouldboard plough treatment had significantly ($P<0.05$) less ryegrass plants (2 plants m^{-2}) than the minimum tillage treatment (252 plants m^{-2}) and the minimum tillage followed by three years of no tillage treatment (235 plants m^{-2}) in spite of the use of pre-plant glyphosate applications in minimum and no-tillage treatments. The annual rotation between no tillage and minimum tillage had the second lowest ryegrass numbers (73 plants m^{-2}) which was also significantly less than those of the minimum tillage treatment.
In August 2008 there were again no significant interactions between rotation and tillage treatments. However, this time the rotational cropping plots had significantly less ryegrass plants (165 plants m^{-2}) than the wheat monoculture plots (236 plants m^{-2}). The mouldboard plough treatment again had significantly less ryegrass plants (23 plants m^{-2}) than the minimum tillage treatment (340 plants m^{-2}) and the minimum tillage/no tillage combinations (234 to 269 plants m^{-2}). The continuous no tillage (166 plants m^{-2}) and tine tillage (116 plants m^{-2}) also had significantly lower ryegrass plant numbers than the minimum tillage treatment.
In June 2008 the long-term rotational cropping trial showed clear differences between the wheat monoculture and wheat in rotation with other cash crop systems (ryegrass numbers varying from 141 to 303 plants m^{-2}) compared to systems where annual legume pastures were included as rotational crop (0 to 20 ryegrass plants m^{-2}). In August 2008 the wheat monoculture treatment had significantly ($P<0.05$) more ryegrass plants (363 plants m^{-2}) than the rest of the treatments. The annual pasture treatments had more ryegrass plants than in the first assessment but the numbers were still lower (0-45 plants m^{-2}) than the numbers in the cash crop rotations (100–200 plants m^{-2}). These differences were not all significant at the $P=0.05$ level though.
The October 2008 data have not been analyzed but will be reported on at the congress.

CONCLUSION

These results confirm that cropping practices may contribute significantly to ryegrass management in an IWM system where herbicide resistance in ryegrass is hampering effective chemical ryegrass control. Other agronomic advantages and disadvantages must however be kept in consideration before management systems are changed.

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Keywords: Crop management, herbicide resistance, ryegrass

INDUCTION OF WHEAT RESISTANCE TOWARDS LEAF RUST BY CRUDE PLANT EXTRACTS

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INTRODUCTION

Consumer resistance towards the use of synthetic chemicals has escalated and chemical treatment of crop plants is continuously criticized in the media by Green Revolution supporters. Wild plants have evolved highly specific bio-active compounds that provide a rich source of novel crop-protecting agents and elicitors of resistance mechanisms against disease causing organisms (Cowan, 1999; Carte & Johnson 2001). Disease resistance in plants can be systemically induced (SIR) and, in recent times, there has been an elevated interest in the potential to manipulate crops exogenously by means of natural compounds from wild plants (Schnabl *et al*., 2001).

MATERIAL AND METHODS

Standard methods were applied to follow the *in vivo* induction of resistance towards leaf rust (*Puccinia triticina,* pathotype UVPrt9) infection in a susceptible (Thatcher) and resistant (Thatcher / *Lr*15) wheat cultivar under the influence of three plant extracts. The *in vitro* activity of resistance-related enzymes (PR-proteins), isolated from infected and non-infected susceptible and resistant wheat after treatment, was initially followed spectrophotometrically. Subsequently, an apoplastic protein profile was obtained for each treatment by means of gel electrophoresis and immunoblotting. The latter supplied the rationale for examining the expression of pathogenesis related (*PR*) genes using the RT-PCR technique. Finally, the active compound involved was identified via NMR spectroscopy.

RESULTS AND DISCUSSION

Of all the treatments, only the *A. africanus* extract significantly inhibited the germination of *P. triticina* spores and prevented further germ tube development. This resulted in the reduction of pustule and necrotic lesion formation in both the susceptible and resistant wheat cultivars. Moreover, foliar application of only the *A. africanus* extract significantly activated β-1,3-glucanase, chitinase and peroxidase enzyme activities in both susceptible and resistant wheat cultivars, whether uninfected or infected. The rest of the study concentrated on the *A. africanus* extract only.

Clear differences between SDS-PAGE profiles of intercellular proteins from resistant and susceptible as well as untreated and treated plants were observed throughout a 144 h period after treatment with the *A. africanus* extract. The latter confirmed an induction pattern of apoplastic proteins by the extract. In general, resistant and treated plants contained higher amounts of a 31 kDa protein confirmed to be β-1,3-glucanase via Western blot analysis using a polyclonal antibody against β-1,3-glucanase from wheat.

The RT-PCR technique assisted in confirming expression of the *PR2*, *PR3* and *PR9* genes in resistant and susceptible wheat treated with the *A. africanus* extract 48 h prior to infection. Two different sized fragments were amplified when using *PR9* specific primers. After sequencing, the larger fragment was confirmed to be peroxidase while the smaller fragment shared very high sequence similarity to a retrotransposon gene.

Subsequently, activity directed isolation and purification of the active compound lead to the isolation of a saponin, identified by means of ^{1}H-NMR and ^{13}*C*-NMR spectroscopy.

CONCLUSIONS

It can be concluded that a crude *A. africanus* extract contains an active compound, (*25R)-5α* spirostane-*2α, 3β, 5α*-triol *3-O*-{*O-α*-L-rhamnopyranosyl-(1→2)-*O*-[*β*-D-galactopyranosyl- (1→3)]- *β*-D-glucopyranoside}, that has the ability to express PR-protein genes as well as a retrotransposon gene in wheat. This forms part of a resistance mechanism in wheat towards leaf rust (*Puccinia triticina;* pathotype UVPrt9).

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Keywords: Resistance, Wheat, Leaf rust

Abstract # 914: A Paper on Hort cultivation practices / Tuinbou bewerkingspraktyke presented by Prinsloo Gerhard

DETERMINING THE EFFECTS OF ORGANIC FERTILISER ON THE GROWTH AND BIOLOGICAL ACTIVITY OF AN IMPORTANT MEDICINAL PLANT *Rumex crispus*

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INTRODUCTION

There are more than 27 million consumers of medicinal plants in the country, and due to residential development and urbanisation, an increase in harvesting pressure on natural environments is experienced. This is a concern to the medicinal plant trade as many of these plant species face extinction if the plants are not cultivated to provide a sustainable supply of plants to the market. Less than 50 tonnes of the 20 000 tonnes of medicinal plants traded annually as traditional medicines are cultivated.

It is, however, known that when plants are removed from their natural environment, changes in their chemical composition can be observed. These changes can be enhanced by cultivation factors such as irrigation and fertilisation. This project investigated the effects of fertilisation on important medicinal plants used in traditional healing practices.

MATERIALS AND METHODS

Six species were included in the project namely *Eucomis autumnalis, Artemisia afra, Ruta graveolens, Siphonochilus aethiopicus, Agapanthus africanus* and *Rumex crispus.* According to the soil analysis it was recommended that bone meal, gypsum and an organic nitrogen source were to be added to the soil. It was, however, difficult to make a recommendation as there are no guidelines available for fertiliser requirements for medicinal plants. From these three recommended sources, six treatments were designed by combining the different fertiliser sources.

The chemical changes were observed by using chromatographic techniques such as Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC). TLC was very useful to determine if there were any changes in the chemical composition of the plants and to determine major changes in concentration of individual compounds.

HPLC profiles were produced to compliment the TLC results, as the HPLC results could quantify the changes in concentration of the compounds in the extracts. To determine if the changes influenced the medicinal properties of the plant, the extracts were subjected to a bioassay using three human pathogens. A microtitre dilution method was used to determine the biological activity of the extracts on *Escherischia coli, Enterococcus faecalis* and *Staphylococcus aureus*. A stock solution of 50 mg/ml was used and the extract was serially diluted to obtain concentrations of 12.5 mg/ml to 0.098 mg/ml on the microtitre plate.

RESULTS AND DISCUSSION

The results clearly showed that *Rumex crispus* was affected by the different fertiliser combinations. The unexpected results of the fresh mass increases were very difficult to explain as organic fertilisers were used. Furthermore, numerous changes in the chemical composition were observed and no correlation could be found between the single fertiliser treatments and combined fertiliser treatments. Biological activity is, however, linked to the chemical composition of the plants, and subsequently a decrease in biological activity was observed in some of the fertiliser treatments.

CONCLUSION

From this project it was realised that it is difficult to explain organic fertiliser results on plants with little information available on their growth and cultivation. It was, however, clear that the addition of fertilisers does affect the medicinal properties of medicinal plants, and should be considered when recommendations for cultivation of medicinal plants are made.

Keywords: Medicinal plants, cultivation, *Rumex crispus*, organic fertiliser

OPTIMISING SUGARCANE PRODUCTION IN FROST POCKETS THROUGH VARIETY CHOICE

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INTRODUCTION

Frost is a severe and frequent constraint to the production of sugarcane in the Midlands region of Kwa-Zulu Natal (KZN), leading to substantial yield and quality losses to the industry. Sugarcane is conventionally harvested on a 24-month cutting cycle at high altitudes due to lower temperatures and reduced growth rates. However, the occurrence of frost in low-lying areas in the Midlands may limit productivity, as growers are compelled to harvest younger, immature cane following frost damage. Variety choice is seen as a tool to optimise profitability in frost pockets, with the strategy being to choose a variety with a high ERC content (quick maturing) and rapid stalk elongation rate, on a 12-month cutting cycle. The objective of this study was to evaluate the performance of new and existing sugarcane varieties in terms of their suitability to production in frost pockets and to determine their responses following frost events.

MATERIALS AND METHOD

Five new test varieties (N36, N37, N39, N41, N44), two conventional longer cycle varieties (N12 and N31), and two varieties previously recommended for frost pockets (N16 and N21) were tested in a field trial on a site prone to frosting in the Midlands region of KZN. The trial was established in October 2004 on a Kranskop soil form and harvested annually for 3 seasons (Plant crop, 1st ratoon, 2nd ratoon). The trial was conducted in a randomized complete block design with six replications, and the variables cane yield (t/ha), estimated recoverable crystal (ERC%), tons ERC yield (TERC) and purity (%) were analysed using the Restricted Maximum Likelihood (REML) method. Variety and ratoon were the fixed terms, while replicate and row were considered as random terms.

RESULTS AND DISCUSSION

Highly significant ($P<0.001$) differences were observed between varieties and ratoons for all four variables. The variety x ratoon interaction was significant for cane yield ($P=0.002$) and ERC% ($P=0.001$), and highly significant for TERC. The test varieties N41 and N44 produced significantly higher cane yields compared to the conventional varieties when averaged over three crops. Four out of the five test varieties demonstrated significant improvements in ERC% and TERC compared to the traditional Midlands varieties. The top performing variety N41 represented a 25, 40, 71, and 89% improvement in TERC relative to the standard varieties N16, N21, N12 and N31, respectively. The higher TERC of varieties N36 and N37 was due to their ability to maintain ERC% nine weeks after the frost event, while other varieties exhibited rapid deterioration. The higher purity levels of test varieties suggest a greater likelihood of achieving the mill thresholds with appropriate adjustments to nitrogen fertilization and topping height.

CONCLUSION

Significant financial profits can be realised through the appropriate choice of new commercial varieties N41, N39, N37, and N36, which outperformed the traditional varieties recommended for production in frost pockets in the Midlands. Correct management of the new varieties for the attainment of acceptable mill purity levels is essential. The study has demonstrated the value of post-release variety testing in niche environments and the effects of appropriate variety choice on productivity and profitability.

Keywords: Frost, Sugarcane, Variety

GREEN MANURE FALLOW DURATION: DOES IT MATTER?

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INTRODUCTION

Green manures are commonly used in the South African sugarcane industry to improve soil health and break the pest and disease cycle. Fallow periods typically range from three to twelve months, and growers often enquire as to the optimal green manure fallow duration. Australian research suggests that maximum benefit is achieved at 12 months, and that green manure fallows longer than this do not provide additional benefit. The current study was initiated in order to test this research outcome under South African conditions, with differing green manure crops.

MATERIALS AND METHODS

A trial was established in November 2005 on the south coast, KwaZulu-Natal. Three different green manure crops – black oats (*Avena strigosa*), sunn hemp (*Crotalaria juncea*) and a mixture of white oats (*Avena sativa*) and cowpeas (*Vigna unguiculata*) (MIX) – were planted as different treatments. Halfway through the trial, the blacks oats and sunn hemp were replaced with Rhodes grass (*Chloris gayana*) and velvet beans (*Mucuna deeringiana*) respectively. Sugarcane was grown on control plots.
Four different fallow duration periods were superimposed onto each of these crops: green manures were grown for three, six, twelve and eighteen months. The planting dates of the fallow duration treatments were staggered so that all fallow periods ended at the same time.
Soil samples, to a depth of 200 mm, were collected at the end of the green manure fallow. These samples were analysed for chemical (P, K, Ca, Mg, Na, Al, clay %, mineral N, total N, total C), physical (aggregate stability; sample density), and biological (microbial biomass; microbial respiration; nematode counts) characteristics. The data were analysed using ANOVA (JMP version 5.0, SAS).

RESULTS AND DISCUSSION

Chemical

There were few noticeable differences in soil chemistry when fallows were grown for less than 6 months. The white oats/cowpeas (MIX) treatment, grown for 12 and 18 months, both increased soil P levels significantly over the sugarcane control, as did the black oats/Rhodes grass (BO/RG) treatment at six and 12 months and the sunn hemp/velvet bean (SH/VB) treatment grown for 12 months. Most crops decreased soil K to levels below that of the control. The BO/RG treatment grown for six, 12 and 18 months, as well as the SH/VB 12 and 18 month treatments, significantly increased Ca over the control. SH/VB (six months) significantly increased soil C, while the MIX 18 month treatment significantly increased total soil N.

Physical

Soil aggregate stability (0.5 – 5 mm) was significantly increased by SH/VB (12 months) and BO/RG (18 months). As fallow duration increased from three to 18 months, so the soil aggregate stability increased in the BO/RG plots. The MIX (three and 18 month) treatments significantly decreased soil aggregate stability. This was expected as the MIX crops needed to be replanted (and hence the soil disturbed, unsettling aggregate stability) every three months.

Biological

Surprisingly, no significant differences were found between soil microbial biomass or respiration under the various treatments. All three crop regimes significantly decreased numbers of the plant parasitic nematode, *Pratylenchus*, when grown for 18 months. *Helicotylenchus*, a mitigating nematode species, was increased by the SH/VB (12 month) treatment. Velvet beans also showed beneficial effects by increasing free-living nematode numbers under the SH/VB (18 month) treatment; no other crop species significantly changed free-living nematode numbers. As BO/RG fallow duration increased from three to 18 months, so numbers of *Paratrichodorus* and *Tylenchorhynchus* decreased.

CONCLUSION

Based on these soil results, green manure fallow duration should be at least 12 months. A fallow of up to 18 months is beneficial, though growers need to take the economics of an extended fallow into consideration. The benefits of this fallow to the following cane crop is still under investigation and these results will help to refine recommendations.

Keywords: green manures, fallow duration, soil biology, soil chemistry, soil physics

Abstract # 874: A Paper on Crop production / Gewasverbouing presented by Robbertse, Hannes

STEM GROWTH AND FIBRE FORMATION IN KENAF (*Hibiscus cannabinus*)

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INTRODUCTION

Kenaf is a well-known fibre plant. The bast (phloem) fibre is used extensively for the manufacture of different products like bio-degradable car dash boards, car mats and insulation materials. We were approached by a private company to assist them in optimizing a dry retting process required for their new factory. Before getting involved in the retting process, it was essential to first determine how the fibres are produced during the growing stages of the plant, to determine the ratio of fibre to core in stems of different diameters and to compare the quality of dry retted fibres with that of wet-retted fibres. Kenaf has a long history of cultivation in different countries like India, Bangladesh, Thailand and certain parts of Africa where it was grown for more than 4,000 years (http://en.wickipedia.org/wiki/Kenaf).

MATERIALS AND METHODS

Plants were grown in a field trial on the experimental farm of the University of Pretoria. The plant population was 400 000 plants ha^{-1} and the "Tainung 2" plants were fertilized with 200 kg N ha^{-1}. Sections of the basal, middle and top parts of the stem were collected at different developmental stages of the plants and fixed in mixture of formalin, acetic acid and 70% alcohol. Hand and sliding microtome sections of the stems were stained with toluidin blue and phloroglucinol. Samples of fixed material and retted fibres were also embedded in wax for microtome sections. Sections were viewed under a Leitz microscope fitted with a digital camera for taking pictures. The bark was also stripped from the stems, the bark and core dried and weighed separately to determine the bark/core ratio.

RESULTS AND DISCUSSION

Fibres are produced by the vascular cambium as part of the secondary phloem. Fibres are arranged in rings of separate bundles isolated radially by thin-walled phloem ray parenchyma and tangentially by thin-walled sieve elements. The result being that closer to the tip of the stem there can be one or two rings of fibre bundles, whole towards the base of the stem there can be up to ten fibre bundle rings. Due to radial divisions of the ray cells, triangular fibre bundle groups are formed with one or two fibre bundles in the outer part of the triangle and five or more in the inner ring. Fibres have thick, lignified cell walls. There is a linear relationship between stem diameter and the amount of bark produced. On a dry weight basis, the bark containing the un-retted fibres makes up 35-40% of the stem.

CONCLUSION

Kenaf fibres are the product of the vascular cambium and the production is directly related to the activity of the cambium. Fibres are produced in bundles separated by parenchyma cells and sieve elements. Fibre cell walls are lignified and therefore fairly brittle resulting in great losses in the factory Except for the brittleness, dry retted fibres compare fairly well with wet retted fibres.

Keywords: toluidin blue, phloroglucinol, bark/core ration

EVALUATION OF DIFFERENT ATMOSPHERIC SHOCK TREATMENTS TO SYNCHRONISE THE RIPENING OF SMARTFRESH SM 'HASS' AVOCADO FRUIT

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INTRODUCTION

The ethylene inhibitor 1-methyl cyclopropene (1-MCP; SmartFresh^{SM}) is used by the South African avocado export industry to prevent soft landings, and to reduce the incidence of physiological disorders. However, SmartFresh^{SM} treated fruit may sometimes take too long to ripen or may soften unevenly. The aim of the present study was to establish what effect a number of low O_2 and/or high CO_2 shock treatments have on the ripening patterns of SmartFresh^{SM} treated 'Hass' avocados.

MATERIALS AND METHODS

SmartFresh^{SM} was applied to 400 'Hass' avocados at the registered rate, while an additional 400 fruit served as controls. After applying the SmartFresh^{SM}, the fruit were stored at 5°C for 25 days. At the end of the storage period, the following atmospheric combinations were applied for 24 hours at 10°C: 2% O_2; 20% CO_2; 2% O_2 + 20% CO_2 as well as a modified atmosphere which was allowed to build naturally during the 24 hour treatment period. The fruit were hereafter ripened and the mean number of days to reach the 'ready to eat' stage (DTR) recorded. The external and internal qualities of the avocados were also scored.

RESULTS AND DISCUSSION

he SmartFresh^{SM} applications effectively delayed fruit ripening by 3 to 6 days. However, in many cases the spread of ripening times was too wide and more than one peak was recorded over the ripening period. Of the various shock treatments, the 2% O_2 + 20% CO_2 combination was most effective in condensing the ripening with a single peak in the middle of the period. The incidence of physiological disorders was low in all treatments.

CONCLUSION

The application of 2% O_2 + 20% CO_2 for 24 hours at 10°C was found to effectively condense the post-storage ripening of 'Hass' avocados, to which SmartFresh^{SM} was applied before storage. It is recommended that this line of research be continued with early season fruit during the 2009 season. The present laboratory study needs to be expanded so as to include semi-commercial trials and, ultimately, commercial applications.

Keywords: SmartfreshSM, avocado, ripening, physiological disorders

EFFECTS OF PLANTING DATE AND LOCATION ON PHENOLOGY , YIELD AND YIELD COMPONETS AMONG SELECTED COWPEA VARITIES

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INTRODUCTION

Cowpea is a useful crop that serves as a source of protein, plays major role in animal nutrition and it is adaptable to harsh environment including extreme temperatures and water limiting environments.Yield in cowpea si the result of many interaction yield componets such as numebr od pod per plant, number of seeds per pod and mean seeds weight. Yield componets are affected by various factors inluding phenological development, planting date, genotypeic diffrences and the environment. The objectives of the present study were to 1) to determine the influence of different planting dates and locations on phenology, yield and yield component of selected cowpea varieties. 2) to determine the relationship of seed yield to environmental conditions such as rainfall, altitude, temperatures and soil characteristics.

MATERIALS AND METHODS

Ten genotypes, developed by the Agricultural Research Council, Potchefstroom,namely PAN311, IT18E-16, IT85F-2687, M217, M28, M101, Glenda, Benchuana White, M9 and CH14 were included in the study. These genotypes were planted in Potchefstroom, Taung in the Northwest and Syferkuil at three planting dates (8 Nov., 22 Nov and 6 Dec. 2004) in the Limpopo provinces of . The experiment was laid out in the randomized complete block design with three replications. Data collected included the number of days to 50% flowering, number of days to 50% physiological maturity, seed yield, number of branches per plant, number of pods per plant, number of seeds per pod and 100 seed weight. Data of seeds yield and yield components of each location were subjected to analysis of variance using Agrobase (2004). When found significant data of each location were pooled for combined analysis. The LSD procedure was used for comparison of means.

RESULTS AND DISCUSION

The results showed highly significantly differences among genotypes in each location and across locations in yield and yield components. Lines CH14, IT18E-16 and PAN311 were identified as the best genotypes for seeds yield and yield componets that can be cullivated across. Across locations, the first planting date was better in yield perfomance among genotypes. At Taung, extending the planting date resulted in an increase in yield except for line PAN311. These could indicate that temperature and r ailfall were favourable to yield that were relativley better towards these dates. Among the three locations, Potchefstroom was the best best achiever yield. This is due to high rainfall and low temperature conditions during the growing season. Although thre was a slight increase on seed yield at the last planting at Syferkuil, yield was generally low compared to the other environments. These could have been the results of low rainfall and high temperature.

CONCLUSION

The results indicated that planting date one (08 November) was better in yield over all locations. Potchefstroom was the best location for yield gain due to high rainfall and low temperatures. The lowest yield was at Syferkuil because of low rainfall and high temperatures. With relatively better performance across locations, IT18E-16, CH 14 and Pan 311 were the best genotypes.

Keywords: Cowpea, planting date, yield , yield component

EXPLORING MUCUNA MANAGEMENT OPTIONS AND N FERTILIZER RATES TO MAXIMIZE MAIZE PRODUCTIVITY ON A DEPLETED KAOLINITIC SANDY SOIL IN ZIMBABWE

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INTRODUCTION

Previous studies carried out on the use of cover crops showed that inclusion of mucuna (*Mucuna pruriens*) can increase the yield of a maize crop in the order of 700 to 900 kg ha^{-1}. The major objective of this research was to explore the optimum mucuna management options and N fertilizer rates which maximize maize productivity.

METHODOLOGY

The research was carried out at the Grasslands Research Station, in A split plot with four mucuna management options [1) fallow (F) , 2) mucuna ploughed-in at flowering (MF), 3) all mucuna above ground biomass removed at maturity (MAR) and 4) mucuna pods removed and the residues ploughed-in (MPR)] and four N treatments [N0 = 0 kg N ha^{-1}, N40 = 40 kg N ha^{-1}, N80 = 80 kg N ha^{-1} & N120 = 120 kg N ha^{-1}] applied to a subsequent maize crop. The following parameters were investigated biomass and leaf area index (LAI), while grain number per ear and total yield. Statistical analysis of the data was performed using the Statistica (Software, version 8.02).

RESULTS AND DISCUSSION

There were significant interactions ($P<0.05$) between N rates and time on biomass by the subsequent maize crop. At 8 WAE maize that received 80 and 120 kg N ha^{-1} had a significantly ($P<0.05$) higher biomass production than the 0 and 40 kg N ha^{-1} treatments. In terms of mucuna treatments, the MF treatment produced significantly more biomass than the other three management treatments. . There were significant interactions ($P<0.05$) between mucuna and N fertilizer treatments. In the N0 treatment, the MF management treatment produced about three times the yield (1.44 tons ha^{-1}) than the other three treatments (0.3 to 0.5 tons ha^{-1}).

CONCLUSIONS

Mucuna incorporated at flowering and supplemented with either 80 or 120 kg N ha^{-1} resulted in a maize crop with the highest biomass, LAI & yield.

ACKNOWLEDGEMENTS

Many thanks to NRF for wholly funding this two year research through its South African regional cooperation fund for scientific research and technological development [SACRF].

Keywords: fallow crop, options, management, options, suppliment, yields

THE EFFECT OF METHYL JASMONATE AND SALICYLIC ACID ON CHILLING INJURY OF 'EUREKA' LEMONS

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INTRODUCTION

Citrus fruit are known to be susceptible to chilling injury when exposed to temperatures below -0.6° C. South Africa produces and exports citrus fruit to many developed countries around the world. However, the industry is losing large amounts of fruit during postharvest storage due to chilling injury. Storing citrus at low temperatures cannot be avoided, since this is an obligatory quarantine treatment. The development of chilling injury during postharvest storage of citrus still remains an unsolved problem in the citrus industry.

MATERIALS AND METHODS

Eureka ' lemons were harvested at Ukulinga Research Station and transported to the laboratory. Fruit were washed with Sporekill® (Hygrotech Pty Ltd.), air-dried for 5 minutes, and randomly divided into treatments. For each postharvest treatment, fruit were dipped in 1, 10 or 50 µmol.L^{-1} of methyl jasmonate or salicylic acid for 30s. Control fruit were dipped in distilled water for 30s. Three replicates of 15 fruit each were used for each treatment. After dipping, fruit were waxed with Avoshine (Citrashine Pty. Ltd.) and stored at -0.5ºC for 0, 7, 14, 21, 28, 35,or 42 days, before being transferred to ambient temperature for 7 days. Measurements of fruit weight, ethylene and CO_2 production, electrolyte leakage of the rind and total antioxidant capacity/activity using the FRAP and the ABTS assay, respectively, were carried out.

RESULTS AND DISCUSSION

Fruit lost mass gradually, especially after storage for a week at room temperature. No visual symptoms of chilling injury were recorded on any fruit. However, the results indicated that fruit were stressed due to high electrolyte leakage from all treated fruit. Carbon dioxide production increased with the duration of storage. The level of ethylene was low, since lemons are non climacteric fruits. Treated fruit had significantly higher antioxidant activity than the control, indicating that although no chilling injury was observed, MeJas and SA dips prepare fruit for cold treatment through an increase in antioxidant levels.

ACKNOWLEDGMENTS

The study is funded by the Citrus Academy and Citrus Research International.

Keywords: Chilling injury, Methyl jasmonate, Salicylic acid, Electrolyte leakage, ABTS, FRAP

YIELD COMPARISON OF OPEN POLLINATED MAIZE VARIETIES WITH VARIETIES COMMONLY USED BY FARMERS IN THE LIMPOPO RIVER BASIN

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INTRODUCTION

The Limpopo River Basin in southern Africa is a semi-arid area dominated by rainfed subsistence agriculture. There has been an increase in research on water, soil and crop management techniques for drought-tolerant crops in recent years. Although initial adoption was poor, innovative approaches have been successful in enhancing adoption of integrated water, soil and crop management practices. Maize is the dominant staple food in southern Africa. A decrease in maize production in the rural areas of the Limpopo River Basin is as a result of increasing rainfall variability and production costs.

MATERIALS AND METHODS

An experiment was conducted to compare the yields of open pollinated maize varieties and commonly used farmer's varieties. The Sekhukhune, Mopani and Capricorn districts were selected. A randomized block design with one replication per site and two replications per district was planted with a 25m x 9m plot size. ZM521, ZM421, Obatambo and t he most common farmer's variety were selected for all the trials in the three districts.

RESULTS AND DISCUSSION

Sekhukhune district had the highest mean yield for all the varieties and Mopani district had the lowest yield. There was a good correlation between low seasonal rainfall at Mopani and low mean maize yield, while Sekhukhune received the highest rainfall and had the highest yield of the three districts. Obatambo had the highest yield in Capricorn district, ZM423 had the highest yield in Sekhukhune district and the local variety had the highest yield at Mopani district. A farmer's awareness day was held in each of the three districts to demonstrate the results.

CONCLUSION

A clear correlation between seasonal rainfall and maize yield was identified from the rainfall variability in the three districts. The three maize varieties illustrated the importance of identifying the relevant maize variety in a specific area. The highest yield in Mopani district from the local maize variety was not expected but the outcome from this study creates an opportunity to undertake more research on varieties commonly used by local farmers.

ACKNOWLEDGMENTS

I would like to thank all the extension officers from the three districts for their continuous support in this project.

Keywords: Maize varieties, Maize yield, Limpopo River Basin

EFFECTIVE REAL-TIME IRRIGATION SCHEDULING ADVICE. A SUGARCANE CASE STUDY.

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INTRODUCTION

Poor adoption of available irrigation scheduling technology has led to inefficient use of water and low profitability of crop production in South Africa. Adoption can be enhanced by utilizing modern technologies, involving clients in design and implementation, and ensuring that advice are simple and useful. The paper describes the pilot implementation and evaluation of a weather-based irrigation advice service on small-scale and commercial sugarcane farms.

METHODOLOGY

The *MyCanesim* system consists of a sugarcane crop model, an irrigation scheduling algorithm and an on-line weather data base (Singels & Smith, 2006). It uses basic field data, initially entered by a user via the Internet, to calculate the soil and crop status for each day of the growing season as the season progresses. It automatically generates and distributes reports to extension staff (by fax or e-mail), as well as simple irrigation advice to small-scale (by cellular text messages - SMS) and commercial farmers (via fax or e-mail).

The system was implemented on 46 small-scale irrigated farms in Pongola and Makhathini and on four commercial farms in Empangeni and Nkwaleni. Rianfall, irrigation and soil water status were recorded weekly, and canopy cover periodically, in selected fields over three seasons. Rainfall, irrigation and soil water status were also electronically monitored in four commercial fields. Fresh cane yield and seasonal water use data were used to assess trends and impacts.

RESULTS AND DISCUSSION

The model simulated canopy cover, soil water status and cane yield accurately when supplied with accurate input data. However, in many cases it proved difficult to obtain reliable rainfall and irrigation histories, either manually or electronically. Most Makhathini farmers were unable to benefit from the advice because the irrigation systems were entirely inadequate to supply the required amount of water. In Pongola, adherence to advice varied between seasons and farmers. Some farmers gained confidence in the advice and followed it more closely as time progressed. Others under-irrigated substantially, particularly in 2006/07, due to low water supply and electricity cuts. A survey in Pongola showed that most farmers found the irrigation advice useful and most changed irrigation practices because of it. Although external factors caused a general decline in irrigation water use and yield in Pongola, subscribers to the service experienced slower rates of decline and applied more water and achieved higher yields than non-subscribers. Results suggest that Empangeni and Nkwaleni farmers could increase yields substantially by changing their irrigation practices.

A feasibility study (Fourie & Grové, 2008) showed that full cost recovery of such a service would be possible if cane yields were increased by more than 4 t ha^{-1}, but that cost recovery would be impossible from irrigation water savings only.

The project highlighted important pre-requisites for successful adoption of weather-based irrigation scheduling decision support. These include (1) adequate irrigation systems, (2) adequate control over water supply at field level and (3) frequent interaction between field agents and farmers. Adoption in Pongola was rapid and wide because of perceived benefits and ease of use and a similar implementation model could be used fruitfully in other crops and locations.

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Keywords: irrigation, scheduling, decision support, MyCanesim, model, weather

IMPROVING DRYLAND MAIZE WATER PRODUCTIVITY IN THE LIMPOPO RIVER BASIN THROUGH BETTER NUTRIENT MANAGEMENT

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INTRODUCTION

The nitrogen and phosphorus demands of maize are relatively high (FAO & WFP, 2000). Nitrogen and water stress are reported as the most limiting factors in maize production in the world, and particularly in Africa (Otegui *et al.*, 1995; Russele *et al.*, 1987). In Mozambique, water productivity of dry land maize is also very low. However, it is believed that in many cases soil nutrient status, and not water supply, is the most important yield limiting factor. The aim of this experiment was to investigate whether water productivity could be improved by eliminating nutrient deficiencies.

MATERIALS AND METHODS

A dry land field experiment was conducted at Chókwè Agrarian Research Station, Mozambique. A two factorial design was used with three levels of nitrogen (0, 45 and 120 kg ha^{-1}) and three levels of phosphorus (0, 25 and 70 kg ha^{-1}). The experiment was planted in December 2007. Total above ground dry matter (TDM) yield, fractional interception of photosynthetic active radiation (FI_{PAR}), leaf area index (LAI), leaf area duration (LAD), grain yield and water use efficiency (WUE) was measured.

RESULTS AND DISCUSSION

Treatments did not differ in the number of leaves per plant. The N120P70 treatment gave highest TDM yield (1.3 kg m^{-2}), tallest plants (227 cm) and highest FI_{PAR} (0.92). The N0P0 treatment, on the other hand, produced lowest values for all these parameters. LAD values for the N120P70, N45P25, N45P0 and N0P25 treatments increased by 64, 34, 23 and 16 day m^2 m^{-2}, compared to N0P0. This can be explained by the drastic positive growth response to nitrogen and phosphorus applications. Consequently, the N120P70 treatment also gave highest grain yield (4.8 t ha^{-1}), while the N0P0 treatment had the lowest grain yield (0.9 t ha^{-1}). The positive effects of nitrogen and phosphorus fertilization on LAI, LAD and TDM, therefore, finally culminated in higher grain yields.

WUE varied with the rate of nitrogen and phosphorus applied. The N0P0 treatment produced the lowest WUE of 3 kg ha^{-1} mm^{-1}, while N120P70 gave the highest WUE of 13 kg ha^{-1} mm^{-1}. The differences in WUE were mainly due to differences in grain yield as a result of the nitrogen and phosphorus applied.

CONCLUSIONS

These results clearly illustrated that for this study nutrient supply was the most limiting factor and appropriate nitrogen and phosphorus fertilization could improve dry land maize water productivity dramatically. In dry land smallholder farming systems nutrient, weed, pest and disease management are often more limiting than water. In such cases water productivity can be improved by alleviating these other limiting factors.

AKNOWLEDGEMENTS

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Keywords: dry land maize, maize yield, nitrogen , nutrition, phosphorus, water productivity

Abstract # 892: A Paper on Soil fertility / Grondvrugbaarheid presented by Smith, Hendrik

EXPERIMENTATION AND SUSTAINABLE AGRICULTURE - WHAT ARE THE CRITICAL LINKS?

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INTRODUCTION

Sustainable agricultural systems which emphasize the use of practices such as Conservation Agriculture (CA), that integrate natural processes into food production and land rehabilitation, but simultaneously improve the livelihoods of farmers and contribute to the long-term sustainability of the resource base hold the key to successful agricultural development (Smith, 2006). However, many of the processes that operate in sustainable agricultural systems, both biophysical and socio-economic, as well as their interactions, are complex and poorly understood. The main research questions to be addressed are equally complex and require an innovative approach.

MATERIALS AND METHODS (APPROACH)

The ARC-ISCW has consequently adopted a systems approach that uses *experimentation* as a key methodology. The approach intends to improve the innovation capacity among various stakeholders, a critical ingredient for sustainable land management. The following three types of experiments are being used in various projects:

a) On-farm, collaborative trials: The objectivesof these trials are to create awareness among various stakeholders, build capacity and facilitate 'learning-by-doing' among researchers, farmers and extension.

b) On-farm, farmer-managed (FM) trials: The objectives of FM trials are to improve experiential learning, modification and dissemination of technologies to local farmers, increase awareness among farming communities and facilitate farmer-to-farmer extension and training.

c) On-station trials: The objectivesof these trials are to create awareness, develop technology and build research capacity and networks.

RESULTS AND DISCUSSION

Results show that the emphasis on improving the farmers' inherent capacity for experimentation is an important element in sustainable agricultural projects. Equiping farmers to select sustainable management options from a 'basket of technologies' and developing capacity to experiment with and adapt these technologies, were found to be the key to the success of community-based projects. It was furthermore found that the intensive and prolonged interaction of farmers with project staff (especially researchers) was clearly important for building experimentation skills. Building research capacity and networks are the primary outcomes of on-station trials.

CONCLUSIONS

Firstly, empowering participation (e.g. action research and farmer experimentation) rather than functional participation (e.g. PRA and farming systems surveys) can have a major positive impact in complex situations. By engaging farmers in a long enough period of experimentation, there is an emergence of innovation, self-learning and self organization, which are critical ingredients for adaptive management and sustainability. Furthermore, experimentation links up (integrates) various system elements and stakeholders and thereby serves as a platform for social learning and local institution building. Finally, the principles and process of experiential and adult learning play a fundamental role in changing farmers' interest, paradigms and behaviour, which are key indicators of emerging sustainability.

Literature Cited

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Keywords: Experimentation, Sustainable agriculture Action research

Abstract # 820: A Paper on Soil technology / Grondtegnologie presented by Smith, Kimberly

EVALUATING THE RESPONSE OF TRADITIONAL CROPS GROWN IN AN IN-FIELD RAINWATER HARVESTING SYSTEM

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INTRODUCTION

Historically, rural populations have used naturally-growing plants harvested from their fields and home-grown vegetables to balance their diets. Adapted to local growing conditions, traditional crops were cultivated for household subsistence without expensive inputs of water or chemical pest and weed control measures. Due to unsuccessful cultivation practices and unpredictable arid climates, food insecurity, malnutrition and disease have become highly prevalent under rural communities.

As a result of constant population growth, there is a necessity for an increased food supply, requiring the use of marginal land for food production. To combat this problem, water harvesting in home gardens is used to improve crop-available water and help to ensure that a variety of vegetables, including traditional crops, are grown. The in-field rainwater harvesting (IRWH) system has been implemented with great success in the Free State Province. Growing these nutritious traditional crops in an IRWH system can be advantageous in minimizing crop failures and aiding in a balanced diet. The aim of this study was to evaluate the response of selected traditional crops grown in an IRWH system.

MATERIALS AND METHODS

A statistically randomized block design trial was laid out on the Glen/Bonheim ecotope at Glen, commencing in 2007. The soil has a very high clay content of around 45% in the A horizon, decreasing to around 38% in the saprolitic C horizon. This high clay content makes the soil ideal for implementing the IRWH technique. Kale, bambara groundnuts, sweet potatoes and amaranthus were grown in an IRWH system, as well as in a conventional cropping system. Both the IRWH and the conventional systems comprised of exactly the same area, although number of plants differed as the IRWH system has a 2 m no-till runoff strip. Rainfall and temperature data were recorded during the season. Weekly soil water content measurements were made with a neutron water meter. The kale and Amaranthus were harvested by hand every two weeks. Sweet potatoes and bambara groundnuts were harvested after 6 months. The harvested biomass was weighed directly after harvesting to acquire the wet mass, whereafter the plant material was dried at 65°C for 14 days and the dry mass obtained. For the purpose of this paper only the kale and amaranthus data will be discussed.

RESULTS AND DISCUSSION

During the growing season the trial received a total of 284mm of rainfall. The data showed that the crops grown in the IRWH system produced much higher yields than the crops in the conventional system. In the IRWH system after a 3 month growing season, the combined wet mass yield amounted to 774.4 t/ha, where as the conventional treatment amounted to only 479 t/ha. The kale produced 224.1 t/ha on the IRWH system and only 148.5 t/ha on the conventional system. Nearly a 40% yield increase was seen in the IRWH system for both crops.

During the first season a large portion of the kale and amaranthus were destroyed due to drought in the conventional system, although the plants all survived in the IRWH system. This showed that the soil water storage was sufficient to sustain crop growth in the IRWH system but not sufficient enough in the conventional system.

CONCLUSION

The data showed that the IRWH cropping system is suitable for production of traditional crops. Follow-up seasons will give a more statistical reflection whereafter the IRWH cropping system can be recommended to farmers for the successful production of kale and amaranthus.

Keywords: conventional tillage, in-field rainwater harvesting, Glen/Bonheim ecotope, traditional crops

RAINWATER HARVESTING: MANAGEMENT STRATEGIES IN SEMI-ARID AREAS

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INTRODUCTION

Rainfall in semi-arid areas is usually erratic and insufficient to meet crop water requirements, resulting in yield fluctuations and food insecurity. Rainwater harvesting technologies, which involve the collection and concentration of runoff for productive purposes, could be implemented to mitigate the effects of seasonal droughts. Several micro catchment rainwater harvesting techniques are currently used worldwide (Hensley *et al*., 2000; Kunze, 2000; Haile & Merga, 2002; Senkondo *et al*., 2004).
The objectives were to quantify rainfall-runoff relationships for different rainwater harvesting scenarios, and improve the Soil Water Balance (SWB) model as tool for selecting best rainwater harvesting management strategies for a particular region.

MATERIALS AND METHODS

Field trials were conducted on a sandy clay loam (Hutton) soil at the Hatfield Experimental Farm during the 2007/08 season. Rainfall-runoff relationships were studied on runoff plots of different lengths (1, 2 and 3 m) and surface treatments (bare or plastic cover). Measurements included: infiltration rate, surface retention depth, rainfall, runoff, and collected sediment.
Eight rainwater harvesting treatments were compared, using maize as test crop: conventional tillage (CT); tied ridges (TR); in-field rainwater harvesting (IRWH) with run-on : runoff design ratio of 1:1 and plastic cover on runoff area (1mP); 1:2 ratio IRWH with plastic cover (2mP); 1:3 ratio IRWH with plastic (3mP); 1:1 ratio IRWH with bare soil runoff area (1mB); 1:2 ratio IRWH, bare soil (2mB); and 1:3 ratio IRWH, bare soil (3mB). Measurements included soil water content, plant height, leaf area index (LAI), and grain yield.
The Soil Water Balance (SWB) model was modified by incorporating runoff estimation to predict crop yield under different rainwater harvesting scenarios. After calibration, long-term model simulations were made for dry and wet seasons in Pretoria and Chokwe (Mozambique) to select ideal rainwater harvesting strategies for each locality.

RESULTS

All three runoff estimation models (linear model, curve number and Morin and Cluff model) gave good runoff estimations, with R^2 values of 0.88, 0.91 and 0.93. For bare soil, runoff and sediment amounts increased with increase in plot length, while runoff efficiencies decreased.
Highest LAI values in the reproductive stage were recorded by rainwater harvesting treatments. TR, 1mB and 1mP gave highest grain yields, and CT the lowest. SWB simulations for both localities revealed that 1mP is the best rainwater harvesting strategy in wetter seasons, while 2mP is best in drier seasons. SWB gave good yield estimates for CT and TR techniques, but IRWH simulations should be improved.

SUMMARY

Good runoff predictions were possible with all three runoff models. Rainwater harvesting significantly increased crop yields. For both localities, IRWH with smaller runoff areas (1m long) will give best maize yields in wet seasons, while larger runoff areas (>2m long) will be best in dry seasons.

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Keywords: maize yield, rainwater harvesting, semi-arid areas, SWB model

HOW MUCH WATER DO FRUIT TREES ACTUALLY USE?

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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. Existing models in South Africa cannot confidently simulate water use of fruit trees for different climate, soil, water and management conditions. This information is absolutely essential when drawing up on-farm water management plans for fruit production and for issuing licenses for water use. 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. The need to monitor nutrients in orchards has also been identified and as irrigation and nutrients cannot be separated in many orchards, a nutrient monitoring component has been included at monitoring sites.

MATERIALS AND METHODS

Water use monitoring is in progress in apples (Ceres), Valencia oranges (Groblersdal) and nectarines and peaches (Rustenburg) and will continue for a 2-year period. Sap flow is being monitored using a heat pulse velocity system. Ancillary measurements include climatic variables from an automatic weather station, soil water and electrical conductivity measurements using Decagon ECH_2O probes, total evaporation, during key window periods, via surface renewal and energy balance methods and irrigation events via wetting front detectors (fitted with logging electrodes), Watermark sensors and a pressure transducer switch. In addition, measurements of canopy dimensions, leaf area index and solar radiation interception are being performed at regular intervals.

RESULTS AND DISCUSSION

Diurnal trends of water use are clearly observable at present and the magnitude of sap flow each day is closely correlated with climatic factors which drive evaporative demand. Changes in water use were also discernible in response to changes in growth patterns (e.g. budbreak and fruit growth in deciduous fruit) and as a result of management practices (e.g. harvesting and pruning in oranges). There is also a correlation between irrigation events and sap flow in the orchards at Groblersdal and Rustenburg, especially under hot and dry conditions. The monitoring of wetting fronts and nutrient movement using logging wetting front detectors is currently allowing for adaptive management strategies in the Rustenburg orchard for both irrigation and fertilizer applications. However, in Groblersdal the disturbed soil around the wetting front detectors is creating a bias which does not seem to be representative of the orchard.

CONCLUSION

Preliminary results demonstrate good promise for providing an accurate data set on water use of some fruit tree species in South Africa which, can be used to model water use for extrapolation to other regions, soils and management practices. In addition, through the monitoring of soil water levels and the build up of EC in the soil profile decisions can be made on a daily or weekly time step regarding irrigation volumes and the application of fertilizer. With the current high prices of fertilizers this could prove to be a valuable tool for growers to reduce their input costs and to manage their water and nutrients within an orchard more efficiently.

Keywords: heat pulse velocity, sap flow, wetting front detectors , deciduous fruit, citrus

SEED BANK STUDIES OF THE ALIEN INVASIVE WEED, *Parthenium hysterophorus* L., IN THE EASTERN AREAS OF SOUTH AFRICA

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INTRODUCTION

Parthenium hysterophorus L. is a category 1 alien invasive plant which threatens biodiversity and agricultural productivity in South Africa. Competitive characteristics that contribute to its invasiveness include a very large and long-lived seed bank. Information on parthenium in South Africa is limited and baseline data for monitoring its control are inadequate. Consequently, long-term germination trials have been set up to determine the germination rates and seed bank dynamics of parthenium in the eastern region of South Africa

MATERIALS AND METHODS

Three sites in the Kruger National Park (3 years) and Pongola Game Reserve (2 years) were sampled by measuring density of adult parthenium plants and soil samples were collected for a germination study under greenhouse conditions. These were monitored for 5 months for seedling emergence where, after 4 months, soil was turned and monitored for a further month. Comparisons were made between locations and sites over the trial period and related to environmental conditions and density of parent plants.

RESULTS

Results showed a great variability in densities of viable seeds and in germination. Germination peaked soon after the start of the trial and levelled off for the remainder of the trial. A similar pattern was observed after the soil was turned although the numbers were lower. Trials showed that in each site, there was a point at which the mature parthenium plants had a significant limiting effect on the germination of the following generation. This varied between sites.

DISCUSSION

Sandy soil had a much higher germination rate than those in soils of high clay content. The size of the seed bank varied seasonally, with a positive relation to rainfall. Both trends were also observed in Australia (Navie *et al.*, 2004). The increase in germination after turning the soil indicated that disturbance enhances germination. This will have implications for control as optimal conditions with an added disturbance will greatly facilitate invasion and necessitate intervention.

CONCLUSION

This study has highlighted the extensiveness of the seed bank of *P. hysterophorus,* the role of environmental factors and plant density on seedling emergence. This plant is likely to cause a major loss in biodiversity as well as agricultural productivity if no form of control is initiated to prevent further invasion. These findings have therefore increased the incentive to introduce a biological control agent to reduce the reproductive capacity of the plant and hence deplete their seed banks. In doing so, the further spread of this plant can be controlled.

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Keywords: germination study, invasive weeds, Parthenium hysterophorus, biological control

PHENOLS IN 'HASS' AVOCADO LEAVES AND FRUIT

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INTRODUCTION

Plant phenolic compounds are a structurally diverse and ubiquitous group of compounds and have been suggested to play a variety of roles such as plant defence against pathogens through provision of structural barriers, modulation of pathogenicity, and activation of plant defence genes. Phenols in various avocado fruit tissues have been previously reported, however, little information is available on their presence from fruit set to harvest maturity and their distribution throughout fruit tissues.

MATERIALS AND METHODS

Monthly sampling of leaf and fruit material commenced at early fruit set (January) and continued, on a monthly basis, to June, when fruit had reached commercial maturity (62-67% moisture content; 18-22% oil in mesocarp dry matter) (Kotzé and Kuschke, 1978; McOnie and Wolstenholme, 1982). Each month the youngest fully mature leaf from ten trees (eight leaves/tree) and twenty fruit (two fruit/tree) at a tree-characteristic state of development were sampled. Fruit tissues (flesh, peel, and seed) as well as leaf tissue were freeze-dried, ground and subsequently stored at -20°C until further analysis. The concentration of polyphenols was determined spectrophotometrically using Folin-Ciocalteu reagent at 750 nm. Specific phenolics were quantified by HPLC.

RESULTS AND DISCUSSION

The concentrations of total phenolics was found to be higher in the exocarp (174.85±48.5 µg GAE g^{-1} DW), seed (227.32±111.8 µg GAE g^{-1} DW) and leaf (102.20±39.4 µg GAE g^{-1} DW) than in the mesocarp tissue (17.80±7.1 µg GAE g^{-1} DW), throughout the fruit growth period. The predominant phenols throughout fruit development were catechin and epi-catechin. It is postulated that the presence of phenolic compounds is aligned to the developmental process of fruit maturation and that phenolics in the exocarp act as antioxidants to reduce stress and as anti-feeding compounds in seeds as fruit maturity is approached.

Keywords: Antioxidants, catechin, Epi-catechin, phenols

GENOTYPIC VARIATION OF COLOUR AND OTHER QUALITY TRAITS IN APPLE BREEDING FAMILIES

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INTRODUCTION

Novelty of apple varieties is determined by the uniqueness of appearance and taste of the fruit. Breeders at ARC Infruitec–Nietvoorbij aim to develop unique apple cultivars and include variation in flesh colour as a breeding goal. The objective of this study was to evaluate and quantify colour variability in the flesh and peel of progenies derived from a red-fleshed apple selection 'KAZ 91' (*Malus niedzwetkyana.* Dieck.) and three Borkh. white-fleshed cultivars (KAZ 89, Meran and Treco Red Gala) in order to develop a novel pink or red-fleshed apple for the fresh consumer market.

MATERIALS AND METHODS

Fruit were collected from Drostersnes experimental farm in Vyeboom. Seedling trees where planted in 2003 at a spacing of 0.75 m x 4 m on M793 rootstock. Fruit from three breeding families, namely 'KAZ 91' x 'Meran' (family 1) 'KAZ 89' x 'Treco Red Gala' (family 2) and 'Meran' x 'Treco Red Gala' (family 3) were assessed for skin and flesh colour, incidence of flesh browning and maturity parameters. Fruit were harvested at optimum maturity. Five and three fruit per seedling were used in 2007 and 2008, respectively, for analysis. More than 145 and 173 seedlings per family were assessed in 2007 and 2008, respectively.

RESULTS AND DISCUSSION

Family 1 ('KAZ 91' x 'Meran') differed significantly from family 2 ('KAZ 89 x 'Treco Red Gala') and family 3 ('Meran' x 'Treco Red Gala') in peel colour, with fruit being on average more red and darker red due to higher anthocyanin concentrations and with greater blush coverage and propensity for flesh browning when cut. Only family 1 had red-fleshed fruits (25% of seedlings in 2007 and 33% in 2008). Varying intensities and patterns of red pigmentation, i.e., red cortex and core or white core and red cortex were observed. The intensity of red pigmentation in the flesh also varied between individual apples of the same seedling. Variation within families (between seedling variation) over the two seasons was high, indicating significant genetic variation for the various traits and predicting a favourable outcome when selecting on these traits. High broad sense heritability estimates were found for maturity indicators while medium estimates were found for over colour lightness and hue, background lightness, and percentage over colour.

CONCLUSION

Crossing white-fleshed cultivars with *M. niedwetzkyana* delivered ca. 25% to 33% red-fleshed seedlings over two seasons from bearing trees. Skin and flesh colour intensity as well as the pattern of anthocyanin accumulation in the flesh varied considerably within the progeny. Fruit from the same tree also varied with regard to the intensity of red flesh colour, implying that it may be difficult to set and comply with production and marketing standards for percentage coverage and intensity of red flesh colouring. Quantification of the variance in flesh colour between fruit of the same seedling is of considerable importance due to the above limitation and more research is needed to assess the effect of environmental conditions and canopy position on anthocyanin accumulation in red-fleshed apple. High heritabilities suggest that selection will be successful and genetic advancement is expected to be relatively rapid.

Keywords: Malus niedzwetkyana Dieck., *Malus domestica* Borkh., red-flesh

RELATIONSHIPS BETWEEN THE COMPONENTS OF YIELD AS INFLUENCED BY THE PLANTING DENSITY OF SPRING WHEAT PRODUCED IN CONSERVATION TILLAGE SYSTEMS IN THE WESTERN CAPE

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INTRODUCTION

Field trials to determine the effect of different spatial arrangements (due to changes in row widths and planting densities) on the components of yield and grain yield itself were conducted at five localities in the Western Cape Province of South Africa.

MATERIALS AND METHODS

Replicated, farmer-managed, factorial experiments with spilt-split plot arrangements were established in commercial wheat fields during the 2005 and 2006 seasons. Treatments included three cultivars, split into row widths (250-350 mm) which were split into different planting densities. Data from these experiments were combined and relationships of three important components of yield (number of plants m^{-2}, the number of heads m^{-2} and the number of heads $plant^{-1}$) between each other and on grain yield itself (ton ha^{-1}), will be discussed. A comparison between current yield component data (2006) and historic data (1985-1987) was made to establish the effect modern conservation tillage practices and cultivar advances have had on the components of yield.

RESULTS AND DISCUSSION

In the comparison with historical data, wheat production in modern conservation tillage systems compared well with high yields achieved under experimental conditions 21 year ago and very favourably with yields achieved by farmers at the time. The response in grain yield due to increasing planting densities was very variable and was strongly influenced by seasonal and environmental differences. Strong relationships between the number of heads $plant^{-1}$ and plants m^{-2} emerged, which is a mechanism of compensation to reduced planting densities applied. RESULTS showed that there was an increasing trend in grain yield as the head population increased, but that variation in grain yield also increased at higher head populations. This resulted in a poor fit (R^2 = 31.7%) if a linear regression was fitted to the data. A concept of Yield $_{(max)}$, which indicates the maximum yield which can be expected for different head populations were developed from this data.

CONCLUSION

The historical comparison indicated that in general, it seems that grain yields achievable with the current no-till planting method are at least on par with optimum yields achieved under experimental conditions 21 years ago. According to the Yield $_{(max)}$ concept, maximum yields ranged from 2.45 to 6.14 ton ha^{-1} as head populations are increased from 150-300 heads m^{-2}. RESULTS also confirm that the current minimum recommended planting density target of 175 established plants m^{-2} is sufficient for most localities and in most seasons in the Western Cape when the no-till planting method is used.

ACKNOWLEDGEMENTS

The authors would like to thank the Winter Cereal Trust and the ARC for funding support and Mr PS Mokoena for technical assistance.

Keywords: conservation tillage, spring wheat, planting density, yield components

COOPERATIVE SCREENING IN FORTY EIGHT WHEAT LINES INFESTED WITH *Diuraphis noxia* BIOTYPES FROM HUNGARY AND CHILE

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INTRODUCTION

Russian wheat aphid (*Diuraphis noxia*) is the most important pest of wheat in South Africa annually causing severe damage to crops in the summer-rainfall production region. South Africa is a world leader in the development of cultivars with resistance to this pest with the first resistant cultivars ever released in the world coming from ARC-Small Grain Institute (ARC-SGI) in 1992. Biotypes from different regions of the world vary in their virulence and reaction to different resistant genes. Screening RWA resistant germplasm with different biotypes is essential to be able to identify and characterise the correct germplasm to deploy in breeding resistant cultivars for release to producers. The aim of this study was to assess the resistance of these wheat lines to *D. noxia* biotypes from Hungary and Chile.

MATERIAL AND METHODS

Forty eight wheat lines, know to be resistant or susceptible to South African *Diuraphis noxia* were evaluated in a quarantine greenhouse in Montferrier sur Lez in France. The experiment was arranged as three randomized complete blocks, each within a cage. One cage contained the uninfested control while the other two were infested with Russian wheat aphid biotypes from Chile and Hungary. Supplementary artificial light was supplied for 10 h during the day and the mean temperature was maintained at 20°C:16°C day:night. A data logger in each cage recorded the temperature and relative humidity throughout. Plants were scored 22 (Hungary) and 23 (Chile) days after infestation using a 1-10 damage rating scale. Dry plant mass was determined and the dry mass loss was calculated using the formula DML = [(MC-MI)/MCx100] where DML was the dry mass loss, MC was the dry mass of non infested plants and MI the dry mass of infested plants.

RESULTS

Significant differences were observed for the damage ratings between entries within a biotype as well as between the two biotypes. Significant differences also occurred between entries and biotypes with respect to dry weight loss.

DISCUSSION

This study reports significative differences in resistance to RWA biotypes from Chile and from Hungary in most of the wheat lines tested. When combined with data on the damage ratings of the two South Africa RWA biotypes, namely RWASA1 and RWASA2, for the same set of lines, valuable information on the usefulness of specific resistance lines is available. This information will enable breeders to focus their efforts to develop lines with resistance to multiple biotypes.

ACKNOWLEDGEMENTS

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Keywords: Russian wheat aphid, biotypes, seedling evaluation

DIAGNOSTIC SSR MARKERS FOR THE WHEAT STEM RUST RESISTANCE GENE SR6 AND THEIR VALIDATION FOR MOLECULAR BREEDING

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INTRODUCTION

Stem rust resistance in several American and Australian wheat cultivars is conferred by a combination of *Sr* genes including *Sr6*, a race-specific resistance gene that confers resistance against a wide range of races of *Puccinia graminis* f. sp. *tritici* (Knott, 1989; McIntosh et al., 1995). However, pyramiding *Sr6* with other *Sr* genes through traditional rust-screening methods is difficult and imprecise, especially when more than one gene is effective against many races. Here, we report the identification of diagnostic molecular markers for *Sr6* and describe their usefulness for the detection of this gene in breeding programs.

MATERIALS AND METHODS

To identify diagnostic markers for *Sr6*, a set of 25 international wheat accessions and breeding lines developed and/or collected in Australia, Canada, China, Egypt, Ethiopia, Kenya, Mexico, South Africa, and USA were used to screen the *Sr6*-linked simple sequence repeats (SSR) markers, *Xwmc453, Xcfd43, Xcfd77,* and *Xgwm484*. The information of *Sr6* in these accessions and breeding lines was obtained from the GrainGenes website, Knott (1989), and McIntosh et al. (1995). Seedling tests were conducted to verify the *Sr6* allelic status of all accessions and lines using the two *Sr6*-avirulent races QFCS and TPMK following the methods of Tsilo et al. (2008).

To determine the usefulness of markers in wheat breeding programs, an additional set of 21 non-*Sr6* cultivars and breeding lines of different wheat classes, obtained from different U.S. wheat breeding programs, as part of the U.S. Wheat Coordinated Agricultural Project (Wheat CAP), was included in this study.

RESULTS AND DISCUSSION

The *Sr6*-linked marker alleles at the *Xwmc453* and *Xcfd43* loci amplified fragment sizes of 131-bp and 215-bp, respectively, and were associated with the presence of *Sr6* in all accessions and breeding lines that were known to carry *Sr6*. The *Sr6*-carrying accessions and breeding lines showed immunity or hypersensitive fleck against all the races used. All of the known non-*Sr*6-carrying accessions and breeding lines lack these specific alleles and were susceptible to at least one of the races used.

The set of 21 non-*Sr6* wheat cultivars and breeding lines representing different breeding programs across the U.S. showed that the marker alleles at the *Xwmc453* and *Xcfd43* loci are highly specific to *Sr6* and are not present in germplasm that lacks *Sr6*. The *Sr6*-specific marker alleles identified in this study are diagnostic for *Sr6* and will be useful for marker-assisted selection and for pyramiding *Sr6* with other stem rust resistance genes.

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Keywords: Stem rust resistance, Wheat, Simple sequence repeat

LABORATORY DETERMINED SOIL HEALTH INDICATORS FOR THE SOUTH AFRICAN SUGARCANE INDUSTRY

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INTRODUCTION

Farmers in the SA sugar industry are aware of the importance of a healthy soil to maximise the possibility for a healthy crop and good yields in order to be sustainable in the long term. The objective of this paper is to come-up with a list of parameters that can be easily measured in the laboratory from which the condition of a soil can be gauged.

MATERIALS AND METHODS

Soil samples to a depth of 100 mm were collected from 28 cane fields from the rainfed areas of the sugar industry. Samples were collected from paired sites, which consisted of areas used for growing sugarcane compared with natural vegetation (NV). The fields used to produce sugarcane were further divided into those burnt (B, less than 3 tons of organic residue returned to the soil after harvest) and not burnt (NB) at harvest. An important criterion used in the selection of sites to be sampled was that the same land uses had to be in place for at least five years. Soil samples were taken on cane rows in triplicate per field and not closer than 10 m from each other. All soil samples were analysed for their chemical (pH, total N, P, K, Ca, Mg), physical (texture, dispersion, dry bulk density and aggregate stability) and biological properties (microbial biomass and basal respiration). METHODS of analysis are all routinely used in SASRI laboratories.

RESULTS AND DISCUSSIONS

For 23 paired sites clay contents differed by not more than 1% between pairs. The clay content of six paired sites differed between 5 and 15%. They too were kept for analysis as trends were strongly linked to land-use. The NV sites contained 0.52% more carbon (C) than the B sites but 0.15% less C than the NB sites. This is meaningful as the NB sites receive between 7 and 13 tons of organic residues after harvest (mostly in the form of leaves). Even paired site 20 with 14.9% less clay in the NB site compared to the B site, contained 1% more C in the top 100 mm soil layer. Total soil N followed the same trend as C.

The NV sites had higher pH values compared to both B and NB sites. The mean difference in pH was 0.32 units between B and NV and 0.48 units between NB and NV. The same trend was found for P. Soil bulk density (SBD), soil aggregate stability (SAS, the 2-5mm and 0.5-5mm fractions), K, Ca, Mg and microbial biomass (MB) had similar trends regarding mean differences between cane (B and NB) and NV sites, with NV sites containing much larger quantities than B sites and just larger amounts than NB sites. The mean basal respiration (BR) differences were however, similar between the two groups (NV vs B and NV vs NB) with the higher BR measured on the NV. Soil dispersion index (SDI) along with the 0.5-1mm and 1-2mm SAS fractions did not show clear trends and will not be considered as indicators of soil health.

CONCLUSION

Data from this work suggest that the impact that organic carbon had on soil properties over shadowed the effect of clay content on soil properties. Most of the parameters considered were able to reflect differences between land uses, which could largely be explained by soil carbon content differences. These parameters are therefore considered suitable for further consideration in the development of a soil health index for the SA sugarcane industry.

Keywords: sugarcane, soil health, paired sites

ESTIMATING OPTIMUM FERTILISER APPLICATION RATES USING THE RESPONSE SURFACE DESIGN IN POT EXPERIMENTS

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INTRODUCTION

Response surface experimental designs offer the important advantage over conventional complete factorial designs in that they require far fewer pots or plots. This paper assesses the validity and reliability of the response surface design for use in nutrient response studies.

MATERIALS AND METHODS

The validity and reliability of the response surface design was assessed using the African leafy vegetables *Brassica rapa L. subsp. chinensis* and *Solanum retroflexum* Dun. for which the nutrient response has been characterised using conventional experimental designs (Van Averbeke *et al*., 2007). The response surface design employed an arrangement of 49 entries, which consisted of 41 different N, P and K treatments and c ontained three parts. The entries comprising the first part consisted of 8 replicates of the expected 'centre point' for the purpose of estimating error. The entries in part two contained a full 3 x 3 x 3 design with levels 'equally' distributed around the centre level of each of N, P and K in order to get a solid estimate of the optimal combination of N, P and K levels and of the response around that level. The entries in the third part aimed to strengthen the response model along the edges. All experiments were duplicated. Experimental materials and methods were identical to those reported by Van Averbeke *et al*. (2007). The validity and reliability of the response surface design was assessed using the R values of the models that were derived from the data and the statistical significance of the interactions (internal validity); the closeness of fit between two models obtained by conducting duplicate experiments under exactly the same conditions (reliability) and between the models and the actual data (internal validity); the closeness of fit between the model and data obtained in earlier experiments (external validity); and t he performance of the models when exposed to extreme values of the independent variables (N, P and K application rates) (external validity).

RESULTS AND DISCUSSION

The response surface design was unsuitable for the study of interactions among nutrients. The very high R^2 values and close fit between models and data points, particularly in the case of nightshade, indicated that the design provided a high degree of internal validity. Close fit between the two models from duplicate experiments indicated ay high degree of reliability and close fit between the model and the data previously reported indicated a high degree of external validity. Performance of the models under extreme circumstances, such as variability in two of the nutrients whilst keeping the application rate of one nutrient at the zero level, was rather poor, particularly when P was kept at the zero level.

CONCLUSIONS

Overall, the response surface design appeared to be adequate for the purpose of studying the nutrient response of crops in pots.

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Keywords: optimising, nitrogen, phosphorus, potassium, response surface design

DO AFRICAN LEAFY VEGETABLES HAVE LOWER NUTRIENT REQUIREMENTS THAN SWISS CHARD?

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INTRODUCTION

African leafy vegetables are described as being adapted to harsh environments and generally requiring simpler technologies and inputs to grow than conventional vegetables. This paper investigates whether this general description of the adaptability of African leafy vegetables has application on plant nutrition as a growth factor.

MATERIALS AND METHODS

Pot experiments that used the response surface design, with a wide range of nitrogen, phosphorus and potassium application rates and a low-fertility soil, were conducted in a greenhouse with temperature control using the African leafy vegetable species non-heading Chinese cabbage (*Brassica rapa* L. subsp. *chinensis*); nightshade (*Solanum retroflexum* Dun.); tsamma melon (*Citrillus lanatus* (Thunberg) Matsum. subsp. *lanatus*) and pumpkin (*Cucurbita maxima* L.) and the exotic leafy vegetable Swiss chard (*Beta vulgaris* L.) as test crops. Each experiment was duplicated. Details on the experimental procedures are provided by Van Averbeke *et al*. (2007). Total above-ground biomass and mass of leaves considered suitable for consumption (both oven-dry) were used as the indicators of plant growth. The analysis of the data focused on the low fertiliser application range where the plant response to nutrient additions is typically positive and linear and involved linear regression of the data points in this range. For each experiment, the biomass data were transformed into relative biomass data by dividing the biomass of each data point by the biomass of the data point that represented maximum production in that experiment. This enabled comparisons among crops. The analysis of plant response to nutrient additions considered three parameters for each of the crops and nutrients concerned. The first parameter was the intersect of the regression line and the horizontal line that represented 100% relative biomass production, which provided an indication of the optimum or critical application rate of the nutrient for the crop concerned. The second parameter was the slope of the regression line, which provided an indication of the magnitude of the biomass response of the crop concerned to additions of the nutrient under investigation. The third parameter was the position of the intersect of the regression line and the biomass axis, which provided an indication of the relative capacity of the crop concerned to produce biomass at very low availability levels of the nutrient under investigation.

RESULTS AND DISCUSSION

Estimated optimum application rates of N and P differed slightly among the five vegetable species, ranging between 73.8 kg N ha^{-1} for tsamma melon and 101 kg N ha^{-1} for nightshade and between 38.8 kg P ha^{-1} for nightshade and 48.2 kg P ha^{-1} for tsamma melon. However, the optimum rate of K identified for Swiss chard (100.8 kg K ha^{-1}) was almost three times higher than that for tsamma melon (34.9 kg K ha^{-1}). All five vegetables responded most substantially to additions of P. For every increase of 1 kg P ha^{-1} in the rate of P applied, relative biomass production consistently increased by about 2 to 2.2%. For all five vegetables the low P content of the soil represented the most severe limitation with Chinese cabbage least and pumpkin most affected by the low P status of the soil.

CONCLUSIONS

None of the five vegetables that were tested performed markedly different from each other at very low fertility levels, suggesting that replacing exotic leafy vegetables, such as Swiss chard, with any of the four African leafy vegetables for improved biomass production under conditions of low chemical soil fertility is not really warranted.

References

VAN AVERBEKE, W., JUMA, K.A. & TSHIKALANGE, T.E. 2007. Yield response of African leafy vegetables to nitrogen, phosphorus and potassium: the case of *Brassica rapa* L. subsp. c*hinensis* and *Solanum retroflexum* Dun. *Water SA*, 33(3): 355-362.

ACKNOWLEDGEMENTS

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Keywords: African leafy vegetables, plant nutrition

A THRESHOLD VALUE FOR ZINC IN THE MAIN MAIZE PRODUCING SANDY SOILS OF SOUTH AFRICA

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INTRODUCTION

In the early 1960s widespread zinc deficiencies became a serious problem in maize production. It coincided with the intensification of production and the introduction of high yielding maize hybrids. Research on zinc during the 1960s has led to the inclusion of zinc in the fertilization programme for maize as standard practice. In recent years there has been renewed concern about the zinc nutrition of maize, a major staple food and one of the most sensitive crops to zinc deficiencies, due to two matters, viz. (i) the much higher zinc requirements of the new higher yielding maize cultivars and (ii) increased awareness of the importance of zinc in human nutrition, especially in strengthening of the immune system. Research was therefore undertaken to establish an appropriate soil Zn threshold value for maize.

MATERIALS AND METHODS

Dryland field experiments with maize were conducted between 1997 and 2001 on sandy soils at seven localities in the main maize producing area. At each locality there were nine treatments, replicated in three blocks. A reference treatment received macro- and micronutrients in sufficient quantities while one element was omitted in each of the other eight treatments. This study looked at yield comparisons between the reference treatment (including Zn) and the –Zn treatment at each site. These soils have a clay content between 3.2 and 14.4%, consisting mainly of quartz and kaolinite. The topsoils (0-200 mm) were sampled and analysed for extractable Zn by using a 0.1 M hydrochloric acid extraction solution.

RESULTS AND DISCUSSION

To determine the threshold values for Zn, the relationship between relative yield (the yield of the –Zn treatment expressed as percentage of the yield of the reference treatment) and the extractable soil-Zn was evaluated by fitting various mathematical models. The threshold value for Zn was determined with the linear-linear regression indicating a split at 3.7 mg Zn kg^{-1} with R^2 = 0.92. The value where the split occurs is considered to be the threshold value. When using the quadratic regression, the curve reaches a turning point at 3.9 mg Zn kg^{-1} (R^2 = 0.94). After considering both models it was decided to propose a threshold value as 3.8 mg Zn kg^{-1}. This threshold value is higher than the threshold value of 1.5 - 2.0 mg Zn kg^{-1} which is currently used (FSSA, 2003), but not excessive when considering that values up to as high as 5 mg Zn kg^{-1} are used elsewhere for this method (Alloway, 2004).

Plant sap samples (1387 samples) were taken across the study area. From the plant sap sample results it is clear that there is need for additional application of Zn. The highest percentage of possible Zn deficiencies is in the North West (45%) followed by the Western Free State (44%). More than a third (34%) for Mpumalanga and nearly a quarter (24%) of the samples for the Eastern Free State show possible Zn deficiencies. The relatively high occurrence of Zn deficiencies according to the plant sap analysis, could be the result of using a threshold value of 1.5 - 2.0 mg Zn kg^{-1} instead of 3.8 mg Zn kg^{-1}.

CONCLUSIONS

A threshold value of 3.8 mg Zn kg^{-1} is proposed. This implies that there is an additional need for Zn application in especially the North West, Western Free State followed by Mpumalanga. The use of plant sap analysis confirms the need for additional Zn applications.

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Keywords: Maize, Zinc, soil, threshold value

SCIENCE RIGOUR AND INDUSTRY RELEVANCE. CAN BOTH REALLY BE ACHIEVED IN PARTICIPATORY ACTION RESEARCH?

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INTRODUCTION

Across the globe, the lack of adoption of agricultural research findings has been identified as a major stumbling block for agricultural development; and fingers are often pointed at a lack of industry relevance of agricultural research.

In 2001, Peter Carberry (CSIRO) published a paper in which Participatory Action Research (PAR) is proposed as an alternative methodology that potentially delivers the benefits of new science knowledge and improved farming practices – as well as providing the opportunity to continually improve our research process. This paper reviews his findings on the basis of an analysis of subsequent literature, as well as experiences at the South African Sugarcane Research Institute (SASRI).

METHOD

International literature was screened for evidence in favour or against the title question. In addition, three participatory research projects managed by SASRI were inspected in more detail, in terms of the title question, as well as regarding management aspects of these projects. The projects looked into strongly differ in scope and the target groups of beneficiaries: (i) a project focusing on improved irrigation scheduling by small-scale growers; (ii) a project with a broad focus at the farming systems level, with large-scale growers, with; and (iii) broad, farming systems level focus, with small-scale growers.

RESULTS AND DISCUSSION

The (still preliminary) results suggest that an affirmative answer to the title question is possible, but depends to a large extent on the mindset of researchers and research agencies; mainly because participatory research requires much more flexibility in the methodological approach as well as of the agencies sponsoring the research than is usually the case in conventional agricultural research, with e.g. pot- and field-trials under semi-controlled conditions.

Whereas several examples were found of PAR projects that were highly successful in terms of both industry relevant outcomes and scientific publications, the focus of the publications was mostly on application and adoption of research findings, rather than the discovery of new findings. This would suggest that, rather than as 'an alternative methodology', PAR should be considered as complementary to disciplinary research to generate relevant research questions and ensure relevant outcomes.

The answer to the title question also depends on the perception of what science rigour actually entails. Taking this to the extreme: one could argue that scientific rigour cannot exist in agricultural science if the characteristics of the most important 'driving variable', i.e. the farmer, are ignored or taken for granted. One could equally well argue that true industry relevance cannot be achieved without science rigour. Hence, in agricultural science, rather than as antagonistic, science rigour and relevance should be seen as synergetic, or, as mutual imperatives: one cannot exist without the other.

Reference

Carberry, P.S., 2001. Can science rigor and industry relevance both be achieved in participatory action research? *Agricultural Science* 14(3), 25-31.

Keywords: technology adoption, agricultural research

MOBILITY OF Cr, Ni AND V IN LONG-TERM SLAG APPLIED SOILS OF MPUMALANGA

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INTRODUCTION

Slags are used in agriculture as liming materials due to their high acid neutralising capacities. Their use poses some challenges due to the presence of a variety of heavy metals (Cr, Ni, V, Al, Fe, Mn, Zn, and Pb) as impurities in the slags. In 2005 a detailed study was launched into the agronomic and environmental risks posed by heavy metals contained in the slags. Investigations relating to long-term slag use are difficult as it is not possible to accurately mimic long-term use conditions in trials of limited duration (2 years). The aim of this study was therefore to assess the metal risk posed by the long-term use of two slag sources through a dedicated field sampling exercise.

MATERIALS AND METHODS

Long-term slag application sites (fields on active farms where one slag source has been used continuously for at least 15 years) for two different slags as well as two farms where no slags had been applied during the past 15 years were identified. Each of these fields were sampled along a soil colour gradient that corresponds with a toposequence. At each sampling point soil samples were collected at 20 to 30 cm depth intervals up to a maximum depth of 120 cm and the position (GPS) and depth recorded. In total 240 soil samples were collected for analysis from 62 field points.

Exchangeable metals were extracted with ammonium acetate according to the method prescribed by the Non-Affiliated Soil Analysis Work Committee (1990). Ca, Mg, K, Na, Cr, Ni, V, Zn, Cd, Pb, Co, Cu, Fe and Mn determined in the extracts on an ICP-OES. The “so called total fraction” was determined through a microwave acid digestion (EPA 3051A) and Cr, Ni, V, Zn, Cd, Pb, Co, Cu, Fe and Mn determined in the extracts on an ICP-OES.

A “mobility factor” was calculated by expressing the ammonium acetate values as a percentage of the EPA 3051A values. This parameter effectively indicates mobility of the specific metal under the specific circumstances.

RESULTS AND DISCUSSION

Cr and Ni levels in long term slag treated soils were relatively low and did not differ significantly from soils that had not received Cr and Ni containing slags. At all the sampling points extractable Cr levels tended to be highest in the topsoil and in the deep subsoil. At most sampling points extractable Ni levels tended to be highest in the topsoil. "Mobility factor" data for Cr indicate that this metal is largely immobile in the soils, while Ni is relatively mobile. At all sampling points extractable V levels tended to be highest in the topsoil. The data also indicate that V, where applied through slags, is more mobile that Cr and Ni and that pH plays an important role in its mobility. The mobility of V increases with increased pH. The implication of these elevated levels are not yet clear as there is not enough information on the environmental risk of V in soils.

CONCLUSIONS AND RECOMMENDATIONS

In the absence of guideline levels and extensive literature on V in soils and the environment it is suggested that a dedicated study be conducted to determine the risk posed by this metal in soils. One factor that should be avoided during the use of V containing slags is overliming.

Keywords: Heavy Metals, Slag, Long-term, Soil, Extraction

YIELD INCREASES IN RAIN-FED MAIZE IN LIGHT OF INCREASING INPUT COSTS

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INTRODUCTION

Despite the impressive advances that have been made over the years in improving yields of food crops, there is little reason to become complacent about food supply (Heidhues, 2001), especially in light of the current world population growth and the food insecurity in developing countries (Penning de Vries, 2001). To increase yields on limited land requires manipulation of agricultural crops by means of innovative techniques, including the use of wetting agents in order to increase the uptake and performance of commercially available bio-stimulatory products under dry land conditions. The potential to manipulate crops captured the imagination of plant biochemists and agronomists alike, and has lead to an unparalleled surge of information on new products to fit this purpose (Ramirez et al. 2000). This study was prompted by the fact that many of these new generation products for which manipulation potential is claimed by the manufacturers, is rather inconsistent at times under field conditions. Hence, the effect of combined applications of one of these products together with wetting agents and a new prototype uptake enhancer was investigated.

MATERIALS AND METHODS

ComCat®, a new commercially available natural product, was sprayed on dry land maize at the 5-10 leaf stage over several season. Stress conditions hindered the uptake and efficacy of all products under rain fed conditions. Subsequently, some commercially available wetting agents as well as a new prototype uptake enhancer, named Anngro™, was combined with ComCat® and applied as a foliar spray on dry land maize in five trials at different locations during 2008. Only yield was monitored with the aim to evaluate the effectivity of the wetting agents to improve on previously reported data. The latter approach was based upon available data obtained with lettuce and strawberries in terms of the uptake enhancement of fertilizer.

RESULTS AND DISCUSSION

ComCat® applied on dry land maize showed an increase in yield compared to a normal fertiizer control. However, results were rather inconsistent where ComCat® was applied on its own in the absence of a wetter. In combination with wetting agents, and especially the new prototype uptake enhancer, yield increases were highly significant. This clearly indicated that Anngro™ has the potential to increase the uptake and efficacy of other products, such as ComCat®, in maize under dryland conditions. This is consistent with the enhancement of fertilizer uptake by the product as observed in lettuce and strawberries.

CONCLUSIONS

From this study it became evident that the new prototype uptake enhancer Anngro™ has the potential to increase the efficacy of other products, e.g. plant growth regulators such as ComCat® as well as fertilzer applied as foliar treatments.

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Keywords: Maize, Yield, uptake enhancer

SEED AND SEEDLING DYNAMICS OF ANNUAL LEGUMES IN PASTURE/WINTER GRAIN CROPPING SYSTEMS IN THE SWARTLAND AND RûENS

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INTRODUCTION

Annual legume pastures are produced in rotation with winter grains and other crops in the Swartland and Rûens. Legume pastures fix substantial amounts of nitrogen, while grass weeds can be most effectively controlled in them and the legumes have a positive influence on animal production. Medics (annual *Medicago* spp, mainly *M polymorpha* and *M truncatula*) are the main pasture legumes used, while subterranean (*Trifolium subterraneum*) and balansa clover (*T michelianum*) play a subservient role. A general decline in the productivity and sustainability of these pastures was, however, observed due to a decrease in the number of legume seedlings reestablishing after the cropping phase. A study was therefore conducted to quantify the extent of the problem and to identify possible contributing factors and solutions.

MATERIALS AND METHODS

Soil samples were collected during late summer from 1998 to 2008 on 271 paddocks on 61 commercial farms distributed throughout the Swartland and Rûens. The samples (0 to 50 mm depth) were used to determine the potential number of legume and weed seedlings which would establish and the number of available legume seeds. From 2001 to 2008 sampling was, however, done on only two farms (Malmesbury and Porterville) in the Swartland. From 1998 to 2004 the samples were wetted to determine the potential number of legume, grass and broad leaved weed seedlings which would germinate before determining the hard seed content, but from 2005 to 2008 only the available legume seeds were determined. The aim was also to determine possible influences of season, sampling date and depth and cropping system and phase on the number of legume seedlings and seed reserves.

RESULTS AND DISCUSSION

The legume seed reserves and the number of seedlings which regenerated varied substantially between farms and paddocks. Medics, and specifically *M polymorpha*, formed the main component of the legume seeds and seedlings. The grass and broad leaved weed seedlings also varied between farms and paddocks, but the number of broadleaved weed seedlings tended to be higher than the grass seedlings. This seems to indicate that broadleaved weeds are more of a problem in the pasture phase of these systems than grasses. A significantly ($P \leq 0.05$) negative relationship was derived between the total number of legume seedlings and the weed seedling numbers.

The number of legume seedlings and seed varied between seasons on a particular site. This variation was found to be correlated with the rainfall during the period April/May to September/October during the previous pasture phase. Sampling date determined the number of seedlings and the percentage of the seed reserve which regenerated and legume seedling numbers increased with later sampling. Sampling depth influenced the number of seeds which were retrieved. The majority or 75% of the seeds were found at a depth of 0 to 50 mm, but as a further 25% of the total seed reserves were derived from 50 and 100 mm, deeper sampling would perhaps be necessary in future. The length of the pasture and cropping phases influenced the seed reserves. Longer pasture phases (> two seasons) resulted in higher legume seed reserves, while cropping phases (one or more seasons) resulted in lower legume seed reserves.

CONCLUSIONS

The number of legume seed and seedlings varied between farms, paddocks and seasons. This can be attributed to variations in rainfall during the pasture phase, length of the cropping and pasture phases and weed infestation. Care should be taken with sampling date and depth as both influenced the the number of seedlings which regenerated.

Keywords: seedlings, crop rotation, weeds, sampling depth

EFFECTS OF SOIL ADDITIVES,MULCHING AND PLANTING PRACTICE ON THE PERFORMANCE OF VEGETABLES, PEACH TREES AND GRAPE VINES

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INTRODUCTION

Many urban residents have access to small areas of land on which food may be produced. The success of this production will nevertheless depend on the methods employed. This trial aims to compare soil additives, mulching and planting systems (sequences) to determine their effects on yields, and on soil properties.

MATERIALS AND METHODS

A matrix of 40 trenches, each 1.5 m wide x 13 m long x 0.5m deep was excavated on a Glenrosa soil in Stellenbosch. Refilling was carried out to create five treatments: soil only (S1), soil plus post-plant nitrogen (N) and potassium (K) (S3), soil mixed 50:50 (v/v) with organic compost (S4) and S4 plus a microbial supplement at planting (S5). Each treatment received phosphorus, gypsum and calcitic lime during refilling, and was replicated at random in mulched (10 cm layer of wood chips) and unmulched form, in each of four blocks. Each bed was divided into 4 sub plots, each 1.5m wide x 2m long, to accommodate four planting systems (sequences): permanent legumes, permanent non-legumes, rotation between legumes and non-legumes, mixed (legumes, non-legumes and perennials). A peach tree (Summer Sun peach / Kakamas seedling) and a grape vine (Sauvignon blanc / Richter 99) were planted in each guard space. Micro-drip irrigation was provided. Two crop cycles have been completed to date: cycle one (September 2007 to January 2008), and cycle 2 (March to July 2008). Yields were determined, performance was assessed and various measurements taken.

RESULTS AND DISCUSSION

During cycle 1, incorporation into the soil of semi-composted wood chips (S2) suppressed leaf nitrogen concentrations in green bean plants, and suppressed yields of green beans and tomatoes relative to treatments which received compost, or which received N and K planting. Prior to cycle 2, S2 received a topdressing of compost to offset a possible N deficiency. This topdressing increased yields of broccoli, Swiss chard and spring onions to the same level as S3. S2 suppressed residue mass, relative to S3 in cycle 1 but not in cycle 2. Yields from S5 were lower than those from S4. After one year, stem circumferences in the peach trees and pruning mass in the vines was significantly greater in S3, S4 and S5 than in S1 and S2. Urease activity and C% were lower in S1 and S3 relative to the remaining treatments. The effects of mulching and of planting system were inconsistent. Soil temperatures in summer were lower in the mulched than in the unmulched treatments.

ACKNOWLEDGEMENTS

Funding for this project was provided by the ARC.

Keywords: compost, urease, wood chips

EFFECT OF BIOLOGICAL SOIL AMENDMENTS ON TREE PERFORMANCE AND SOIL MICROBIOLOGY IN APPLE REPLANT DISEASE MANAGEMENT

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INTRODUCTION

Apple replant disease (ARD) is typified by the poor growth of apple trees planted on previous apple sites. Although the etiology is not clear, it seems to be of biological origin and that apple monoculture causes a change in the composition of the soil microbial community towards pathogens dominating the microbial profile (Mazzola, 1998). The integration of biological amendments into production systems could possibly shift the balance of the microbial communities towards a population structure more conducive to increased plant health and productivity. In a previous study, applications of compost and compost extracts were identified as promising, practical tools for managing ARD, under South African conditions (Van Schoor, *et al.,* 2008). We postulated that the application of organic matter and soil microbial inoculants could positively affect tree performance in ARD sites, through improving soil microbial properties.

MATERIALS AND METHODS

Experiments were conducted in newly established commercial orchards, with known ARD problems, in the Elgin/Vyeboom area. Treatments at planting consisted of a control, methyl bromide fumigation, compost, a *Bacillus* inoculant (Biostart®) with a low dosage humate, and compost extracts. Compost applications were repeated every spring at 20L per tree and soil inoculants were applied monthly throughout the growing season. Tree performance was measured as yield and fruit quality for long term trials and as trunk diameter and shoot growth, for recently established trials. The effect of treatments on soil microbial parameters was examined through soil enzyme activity assays, conventional microbial plate counts and substrate utilisation profiles (Biolog™ plates).

RESULTS AND DISCUSSION

Methyl bromide fumigation had the most positive effect on yield. However, yield efficiency was also significantly improved by both Biostart® and Compost extract application. The largest fruit size during 2007 and 2008 was measured in compost extract-treated plots. In other trials, within the first growing season, biological treatments generally increased growth significantly compared with control plots, and in two of the trials, produced similar growth to fumigated plots.

Compost extract application consistently increased *Bacillus* counts and phosphatase activity with long term application, which was also related to higher leaf P, K and Ca levels. *Bacillus* spp. is well documented plant growth promoting rhizobacteria and mechanisms through which growth is improved include P-solubilisation, phytohormone production as well as biological control of soil pathogens (Dobbelaere *et al*., 2003).

Soil microbial functional diversity was altered by the biological treatments. Where compost, compost extract and Biostart® were combined, the highest soil microbial activity was measured and growth improved significantly. However, tree performance could not always be related to increased microbial activity.

CONCLUSION

Long term application of the biological amendments Biostart® and Compost extract in combination with compost, improved yield efficiency significantly as well as tree growth in the establishment phase. However, fumigation was still the most consistent treatment in managing ARD and therefore a combination of biological treatments with other management practices such as the use of ARD-tolerant rootstocks should be investigated.

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Keywords: Bacillus bacteria , compost , compost extract

HYDROLOGY OF SOIL TYPES OF SOUTH AFRICA- PRELIMANARY RESULTS

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INTRODUCTION

Soil was an important factor in food security during the previous century. Soil was seen as a crop growth medium, and its properties related to hydrology and ecology were relatively neglected. Global pressure on the role of ecology in saving the earth, and local pressure on water scarcity shifted interest towards the soil to ecology and soil to hydrology relationships. The latter relationships are encompassed by the subject of hydropedology. Because of the dominant influence of water on soil formation it leaves a signature on the morphology of soils which facilitates interpretation of the hydrological properties of each soil profile.

MATERIALS AND METHODS

RESULTS from the following research projects were analysed with the aim of exposing relationships between soil profile morphological features and hydrological properties: the Weatherley soil morphology project (long-term soil water contents, soil profile descriptions), the Ecotope project (drainage curves), Weatherley soil organic matter project (OC, N and botanic survey), Weatherley hydrological research projects (rainfall, tensiometer and hydrograph data), the Bedford, Cathedral Peak and Craigie Burn hydropedological surveys and the Soilscape survey project.

RESULTS AND DISCUSSION

Preliminary results from these studies indicate that in summer rainfall areas with rain season aridity index above about 0.8 three clearly different hydrological soil types exists in South Africa namely recharge, interflow and saturation excess responsive soils. These soil types differ in:

- Soil morphology. Recharge soils generally have red or yellow brown colourd subsoils, with fairly homogeneous texture and structure. Interflow soils have second horizons that are grey (gs) and mottled (sp). Saturation excess responsive soils have grey gh, on and uw) subsoils.
- The mean annual duration of degree of saturation (S>0.7) is typically <3 days in the B horizons of recharge soils, >3 weeks in gs and sp horizons of interflow soils and 6 - 12 moths in the subsoils of saturation excess responsive soils.
- Phases of soil water regime: A prolonged draining phase is absent in the recharge soils, present in all interflow soils and dominates in saturation excess responsive soils. A drying phase is dominant in recharge soils after the rain season, short in interflow soils and absent in saturation excess responsive soils.
- The botanical composition varies between recharge, interflow and saturation excess responsive soils.
- ET, vegetation mass and SOM contents is the lowest in interflow soils and highest in recharge and saturation excess responsive soils.
- Recharge soils contribute mainly to baseflow, interflow soils mainly to the ‘shoulder’ of the hydrograph and saturation excess responsive soils to mainly peak flow.
- Recharge soils recharge hillslope water, whereas interflow soils act as a conduit for lateral draining water, and saturation excess responsive soils located close to the stream release water to the stream.
- Transient water tables occur in interflow soils and perennial water tables in saturation excess responsive soils.
- The drainage/water release characteristics of recharge soils are the quickest and that of saturation excess responsive soils the slowest.

CONCLUSION

Soil forms are natural entities that have different hydrological properties. The soil forms of South Africa can be grouped according to their hydrological behaviour. Application of this information has proved to be useful in hydrology. It should also aid in the understanding of hydrological aspects related to dryland and irrigation agriculture, and ecology.

Keywords: recharge soil, interflow soil, Saturation escess responsive soil, hydropedology, soil morphology

SOIL INDICATORS OF HILLSLOPE HYDROLOGICAL RESPONSE IN THE WEATHERLEY CATCHMENT, EASTERN CAPE

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INTRODUCTION

Soils integrate the influences of parent material, topography, vegetation/land use, and climate and can therefore act as a first order control on hydrological processes which include the partitioning of hydrological flow paths, residence time distributions and water storage. Water plays a major role in soil formation, resulting in specific soil properties with signatures of the processes which formed them. Identifying and interpreting these soil properties may reveal information on the key hydrological processes. Development of conceptual hydrological models improves theory development. A clear understanding of key hydrological processes is needed for effective water resource management. The processes are captured in hydrological models. These processes are however dynamic in nature, with strong temporal variation making measurements expensive and time consuming. The need for predictions of these processes, and especially predictions in ungauged catchments, are therefore essential. The aim of this study was to use soil information to predict hydrological processes.

METHODOLOGY

The study was conducted in the Weatherley research catchment close to Mclear in the Eastern Cape. A study, which included 7 profile pits, 8 auger observations, 3 neutron water meter observation points and 5 tensiometer nests, was conducted in a selected hillslope in the upper catchment. Stream hydrograph data are also available for this catchment. A conceptual hillslope hydrological response model was developed using soil survey information and tested using measured hydrological data.

RESULTS AND DISCUSSION

The soils of this hillslope are hydrologically recharge, interflow and responsive soils. On the upper slopes Hutton soils cover a recharge area. Infiltration and vertical drainage of water through and out of the solum to supply water to interflow (Tukulu, Longlands and Kroonstad) and responsive (Katspruit) soils is dominant. The Katspruit soils of the lower slopes are saturated throughout the year as indicated by the presence of water tables within the profiles even during the driest periods. A constant feed of water from the recharge soils, through the bedrock, towards this area exists. Two bedding plains play a prominent role in the partitioning of pathways in the hillslope. They facilitate flow at the soil bedrock interface in the interflow soils and govern recharge of the responsive soils.

Tensiometer and neutron water meter data confirm (1) that the recharge soils do not saturate, (2) there is flow at the soil/bedrock interface in the interflow soils and (3) that the subsoil of responsive soils is saturated for long periods. Evapotranspiration data agree that there must be a feed of water to the responsive soils throughout the year. Hydrograph analysis proves that responsive soils are responsible for peak flow in the stream.

CONLUSIONS

Soil properties serve as signature of hydrological response. Identifying and interpreting these properties correctly can facilitate predictions of hydrological behaviour in catchments and especially ungauged ones.

Keywords: soil properties, hillslope hydrology, predictions in ingauged catchments

COMPARATIVE EFFICACY OF BT MAIZE EVENTS MON810 AND BT11 AGAINST *Sesamia calamistis* (LEPIDOPTERA: NOCTUIDAE)

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INTRODUCTION

Maize, expressing *Cry1Ab* insecticidal proteins produced by the bacterium *Bacillus thuringiensis* (Bt), was introduced for control of *Busseola fusca* (Fuller)(Lepidoptera: Noctuidae), and *Chilo partellus* (Swinhoe)(Lepidoptera: Crambidae) in South Africa in 1998. In the light of the reportedly lower toxicity of Bt maize to certain Noctuidae borers, the effect of Bt maize was evaluated on *Sesamia calamistis* (Hampson) (Lepidoptera: Noctuidae) in South Africa. The characteristic larval behaviour of *S. calamistis* may result in reduced exposure to Bt toxin and subsequent high levels of survival since larvae do not feed in plant whorls like other borer species, but penetrate stems directly from behind leaf sheaths

MATERIAL AND METHODS

Growth and survival of *S. calamistis* larvae were determined in a greenhouse bioassay with two Bt maize hybrids (DKC 7815B, Monsanto event MON810 and NK Mayor B, Syngenta event Bt11) and their non-Bt, isoline hybrids (CRN 3505 and Brasco). Potted plants were artificially infested with ten first instar larvae with a camel-hair brush. Nine randomly selected plants of each maize hybrid were dissected at regular intervals after inoculation. The percentage larval survival and mean larval mass were recorded over time.

RESULTS

Larval survival decreased rapidly over the first nine days after inoculation. Larval survival differed significantly over time between the Bt and non-Bt hybrids. The percentage surviving larvae on DKC 78-15B (MON810) was 3.3% six days after inoculation, and 1. 1% on NK Mayor B (Bt11). The percentage surviving larvae on the non-Bt plants was 23.3% on CRN 3505, the iso-hybrid of DKC 78-15B and 14.4% on Brasco, iso-hybrid of NK Mayor B, 42 days after infestation. No surviving larvae were recorded from nine days after inoculation onwards on both Bt maize hybrids. Bt maize of both events was shown to be highly toxic to *S. calamistis*. There was a significant difference between the mean larval mass of larvae feeding on both Bt maize hybrids compared to the non-Bt iso-hybrids. Larval mass on Bt plants did not increase between three and nine days after commencement of the experiment but increased rapidly on non-Bt plants from day 12 onwards.

DISCUSSION

Results from this study indicate that *S. calamistis* was just as highly susceptible to event Bt11 than event MON810. The behavioural characteristic of larvae to feed behind leaf sheaths and to enter stems directly did therefore not result in escape of exposure to the toxin. Larval feeding on leaf sheaths therefore resulted in the ingestion of enough toxin to kill larvae before they entered maize stems.

It was expected that *S. calamistis* larvae may survive on the Bt11 event to some extent, because the Cry toxin expression in Bt11 leaves is reportedly lower compared to event MON810. From results of this study it appears that larval survival was not affected by differences in expression levels.

CONCLUSION

Sesamia calamistis is stenophagous and occurs in mixed populations with other borer species, with which it shares several parasitoid species in Africa. The ecological impact of local extinction of *S. calamistis* caused by this highly effective transgenic event is therefore not expected to be great.

Because of differences in toxicity between different varieties depending on which event present, this aspect will need careful consideration in risk assessments and decisions on deployment of Bt maize varieties.

Keywords: Bt 11, Bt maize, Lepidoptera, MON810, *Sesamia calamistis*

THE RESPONSE OF *Malus domestica* 'GOLDEN DELICIOUS' APPLE TREES TO DRIP IRRIGATION IN STONY SOIL

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INTRODUCTION

Information on crop water use, production and fruit quality of apple trees under drip irrigation with varying frequencies in stony soils in the Western Cape is urgently needed to assist producers in irrigation scheduling. Such information could lead to more efficient use of limited water resources and reduce pollution of soil and ground water.

METHODOLOGY

Five different drip irrigation frequencies were applied during four growing seasons (2003/04 to 2006/07) to 'Pink Lady'/M793 apple trees planted on ridges at Oak Valley, Elgin. Vegetative, reproductive growth and sap flow was monitored throughout the season. Production records were taken and fruit quality evaluated at harvest and after cold storage. Root profile studies were performed during June 2007 after treatments were terminated.

RESULTS AND DISCUSSION

After induction of different drip irrigation frequency treatments for four seasons, there was no significant effect on leaf area development. Transpiration in the treatment with the lowest irrigation frequency decreased significantly during the warmest months. The irrigation treatments did not have a statistically significant effect during 2007 on most of the variables monitored to quantify growth, production and fruit quality. The average yield for 2007 was almost double that for 2005 and 2006, and a crop load of 17.7 fruit per cm stem circumference resulted in a less favourable average fruit mass of about 135 g per fruit. In 2007 irrigation frequency also did not significantly affect any of the fruit quality variables, except for sunburn incidence and firmness of fruit. Sunburn incidence was significantly lower for the treatment that received hourly irrigation compared to the treatment that received irrigation every two hours. Firmness of fruit was significantly reduced at the treatment that received hourly irrigation compared to that of all the other lower irrigation frequency treatments. Preliminary results of root profile studies indicated no significant differences in root density or root distribution in the different irrigation frequency treatments, which could explain the lack of differences in tree response to treatment after an induction period of four years.

CONCLUSION

After induction of different drip irrigation frequency treatments for four seasons, there were limited significant effects of treatments on most of the variables monitored to quantify growth, production and fruit quality. Lack of significant differences in root density or root distribution in the different irrigation frequency treatments could explain the lack of differences in tree response to treatment after an induction period of four years.

ACKNOWLEDGEMENTS

Technical staff and Research assistants of Soil and Water Science, ARC Infruitec-Nietvoorbij
Oak Valley Estates for experimental block and other assistance in field work.

Keywords: Malus domestica, apple, water use, production, fruit quality

SPATIAL MODELLING OF SOIL ASSOCIATIONS FOR CATCHMENTS B51, T35 AND V32

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There is a need to investigate ways of speeding up the semi-detailed mapping of soil associations for South Africa. This is driven by the need for curbing soil degradation and the demarcation of high potential soil areas.
There are limitations in the available national soil coverage (the National Land Type Survey). These are primarily the reconnaissance level of the data and the fact that the soil components are defined, but not individually mapped. Conventional semi-detailed and detailed soil surveys, as a means of supplying baseline and planning information, are time consuming and expensive.
The National Department of Agriculture (DoA) funded a project with the ARC-Institute for Soil, Climate and Water (ARC-ISCW) to investigate and implement spatial modelling procedures for the mapping of soil associations. Three priority tertiary catchments targeted by the national Soil Protection Strategy, namely T35 in the Eastern Cape, V32 in KwaZulu-Natal and B51 in Limpopo, were studied.
The soil modelling process relies on a combination of relationships derived from statistical analysis of soil observation sites and various spatial data layers (e.g. geology, terrain units, elevation, slope, topsoil colour and soil wetness) as well as expert knowledge of soil and landscape relationships.
Field data consisted of field observations as well as soil samples that were analyzed for physical and chemical properties. About 3000 field observations per catchment were digitized from the 1:50 000 field sheets of various soil surveys. In addition to existing information in the ARC-ISCW Soil Profile Information System, about 250 top- and subsoil samples were collected and analyzed for each catchment.
Terrain units were derived from the SRTM (Shuttle Radar Topographic Mission) dataset. Subjective scaling during a 3-dimensional visualization process of the landscape created the terrain units. Adjustments were made after field verification by an experienced pedologist for the final calibration.
Landsat images from different years (about five years) were collected with the objective being to map as many ploughed areas as possible. Topsoil colour was classified from these Landsat images into dark, red and grey soils for each image. Grey topsoil colours included both yellow and brown colours. A mosaic was created from the different images. Finally the gaps that were left were interpolated from the surrounding areas.
Geological data, which is crucial for any soil modelling process, was aggregated into 15 classes according to soil forming factors.
Five products were completed for each of the three catchments using both subjective and objective methods. These products included soil association maps, soil depth maps, topsoil colour maps, soil clay content maps and terrain unit maps.
By comparing the visual and statistical results of the spatial modelling against field data and other spatial data it was possible to conclude that meaningful spatial information on soils could be derived at a more detailed scale than the National Land Type Survey. The products are intended to derive spatial information on soils at a regional level that would otherwise be far more costly and time consuming, but should not replace detailed soil surveys.

Keywords: soil associations, GIS, modelling

MAIZE KERNEL HARDNESS:CAN WE SEE IT?

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INTRODUCTION

A novel analytical technique recently been evaluated for food and agricultural applications is NIR hyperspectral imaging which is a powerful spectroscopic imaging technique that is capable of capturing images at many wavelengths in the NIR region (Burger & Geladi, 2006). It acquires both spatial (x and y axes) and spectral (z axis) information that provides a three dimensional data cube permitting characterisation of samples. A NIR hyperspectral imaging system collects image data by arranging it into a three-way data matrix, known as a hypercube.

Maize is different from wheat, with respect to kernel hardness, in that both the glassy and the floury endosperm are found within in a single kernel in a particular ratio (Watson, 1987). It is this ratio that determines whether the kernel is hard, soft or intermediate. Hard kernels have predominantly glassy endosperm; soft kernels consist principally of floury endosperm while intermediate kernels possess approximately equal quantities of both. In this study the potential of NIR hyperspectral imaging to predict maize hardness has been evaluated.

MATERIALS AND METHODS

Maize kernels of varying degrees of hardness*, i.e*. hard, intermediate and soft (Pioneer Hi-Bred Research Delmas, South Africa) were selected randomly from yellow inbred lines used during breeding trials. Eight kernels randomly selected from each hardness category (n=24) were imaged on a 70 mm x 70 mm silicon carbide (SiC) sandpaper according to a Latin Square design using a Spectral Dimensions MatrixNIR camera (Malvern Instruments Ltd, Malvern, Worcestershire, UK) from 960-1662 nm. Transformation to absorbance was done using Spectralon reflectance standards and ISys (v. 4.0) software. Evince (v. 2.0.20) multivariate image analysis software was used for image cleaning on principal component analysis (PCA) score plots and score images. Cleaned images were further subjected to PCA and partial least squares-discriminant analysis (PLS-DA).

RESULTS AND DISCUSSION

PCA illustrated a distinct difference between floury and glassy endosperm along principal component (PC) three with two distinguishable clusters. PCA scatter plots were then projected onto the score images to make classification images. Regions of hard and soft endosperm (differences in starch and protein linkages) had different sizes in the classification image for maize kernels of different hardness. Interpreting the PC loading plots, important absorbance peaks responsible for the variation were 1215, 1395 and 1450 nm. After 10 PLS-factors, 84.9% of the variation in Y was predicted by the model. was predicted by the model.

CONCLUSIONS

PC3 is responsible for the separation of glassy and floury endosperm. it was possible to predict hardness in the set of kernels using PLS-DA; thus, it is possible to distinguish between hard and soft maize using NIR hyperspectral imaging. However more samples have to be evaluated

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Keywords: NIR hyperspectral imaging, maize hardness

TOWARDS THE SUSTAINABLE MANAGEMENT OF A CONFLICT OF INTEREST SPECIES: ESTABLISHING THE COSTS & BENEFITS OF PROSOPIS IN THE NORTHERN CAPE

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INTRODUCTION

A group of weed species collectively known as "Prosopis" (or mesquite) are"conflict of interest" species with both positive and negative impacts on nature and society (Zimmerman and Pasiecznik, 2005). The picture is complicated by the fact that only the 'invasive' Prosopis species (*P. velutina* & *P. glandulosa*, and their hybrids) and not the 'benign' species (*P. chilensis*) have both positive and negative impacts. The density of infestation creates conflicts because impacts become increasingly negative as density increases. Additionally, the social-ecological context within which Prosopis exists also creates conflicts of interest because Prosopis behaviour and its impacts on ecosystem services varies between vegetation types and communities.

Existing approaches to controlling infestations comprise a mix of manual, chemical and biological (limited to seed-feeding beetles) control combined with managed utilisation. Prosopis infestations are increasing their ranges and densities and it is uncertain what the net impacts of these are on society (Roberts, 2006). Consequently, it is unclear whether additional control should be introduced. Such a decision needs to be informed by an assessment of the current and expected future status and economics of the infestation (De Wit et al., 2001).

OBJECTIVES

The objectives of this study are: 1) to develop a robust but flexible cost-benefit-analysis framework to evaluate the implications of context-specific, conflict-of-interest invasive alien plants; and 2) evaluate the magnitude and distribution of the existing and future economic impacts of Prosopis across a range of social-ecological contexts.

PRELIMINARY RESULTS AND DISCUSSION

Initial findings thus far are that: 1) the extent and density of infestations have continually increased over time, even since bio-control agents were released, and now exceed 1 million ha; 2) the impacts on biodiversity are poorly known but infestations negatively affect the supply of ecosystem services (grazing and water); 3) the Working for Water programme currently invests R22.4 million annually in the N. Cape but this only covers 20% of the infestation; 4) the main benefits of Prosopis are from the pods. The economic value of the pods for fodder, based on replacement cost, is a maximum of R2.50 per kg (R75 per ha), but this is only realised during drought years. The net return to pods used to produce "Manna" tablets is R30 per kg of pods; but the market is unlikely to exceed 100 tonnes/yr which is met with less than 2 500 ha and only generates temporary employment for 20 people per year; 5) some private incomes are generated from the sale of Prosopis wood for firewood (R10 per kg) but this is small-scale and limited to areas close to towns. Prosopis wood is the primary source of energy for most communities, but its economic value is unknown; and 6) since control efforts have not been effective, many are forced to exploit the trees in any way possible (e.g., honey, charcoal) but no economic estimates are available for these.

CONCLUSIONS

Early findings indicate that it may not be possible to complete a comprehensive CBA due to the costs and time required to collect the necessary information. This is because the data are dispersed across organisations, are seldom updated, and are often in formats not suitable for economic analysis; many of the values are non-use or non-market; and to determine the distributional effects requires interviewing many stakeholders. Nonetheless, this framework will be applied in a context for which data exist. The framework will also provide a robust means for evaluating such species to guide future decision making.

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Keywords: Cost benefit analysis, Prosopis (mesquite), South Africa, invasive alien species, control

DIFFERENCES IN VINE PERFORMANCE AND WINE CHARACTERISTICS IN MERLOT ON SOILS DERIVED MAINLY FROM GRANITE AND SHALE

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INTRODUCTION

Vineyard soils on the coastal foreland and adjacent mountain slopes of the Western Cape locally contain high concentrations of material derived from shale and granite. The terroir concept holds that wines reflect aspects of the production environment, including that of the vineyard. If so, wines produced on shale and granite soils should differ. The aim of this trial was to identify any differences in vine performance and wine characteristics that might be attributed to soil parent material.

MATERIALS AND METHODS

The trial was performed in a drainage lysimeter at ARC Infruitec in Stellenbosch. Each 3m x 1.5 m tank was filled with soil excavated from sites on a deflating ridgetop underlain by Malmesbury sediments and Stellenbosch granite. Calcitic lime and superphosphate were added. Each soil treatment included two Merlot vines, one on R110, the other on 101-14 Mgt. Nitrogen and sprays were applied in accordance with normal vineyard practice. Soil moisture tensions were kept above -0.07 MPa. Leaf element concentrations, pruning masses and stem diameters were measured. In season three the first (thinned) crop was harvested, and wines were made. Analysis of the soils, leaf tissues and wine were carried out using standard procedures.

RESULTS AND DISCUSSION

Trends observed by the end of season three suggest that, relative to shale, granite soils promoted increased pruning mass and stem circumferences, and higher November leaf potassium (K) concentrations. Mallic, lactic and citric acid concentrations tended to be higher from granite than from shale whereas volatile acid and tartaric acid concentrations tended to be higher from shale than from granite. Berry character in wine from R110 was more pronounced from granite than from shale. By the end of season three, Bray II K in the granite soil decreased from 64 to 59 mg/kg^{-1} (6.9 to 2.7% of S-value). Corresponding vValues for the shale soil were 67 and 39 m g/kg^{-1}, and 4. 6% to 4.0%. Although both soils contained similar amounts of Bray II K initially, the K content of the shale soils decreased more than that of the granite soils over three seasons. The consequence of this was the poorer vegetative growth and lower November leaf K concentrations in the vines on the shale soil. Conceivably, the weathering minerals in the granite soil were able to sustain the supply of plant-available K better than those in the shale soil.

ACKNOWLEDGEMENTS

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Keywords: geology, potassium, terroir, mineralogy

THE INFLUENCE OF SOIL FUNGI ON CITRUS PRODUCTION

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INTRODUCTION

Soil micro-organisms are an important part of the soil. Soil microbial biomass is considered to act both as the agent of biochemical changes in soil and as a repository of plant nutrients such as nitrogen (N) and phosphorus (P) in agricultural ecosystems (Jenkinson and Ladd, 1981). Studies revealed that microbial biomass was an important source of mineralizable soil organic N (Jenkinson and Ladd, 1981; Marumoto, 1984). Hiltner (2001) stated that in general, the nutrition of plants certainly depends upon the composition of the soil flora in the rhizosphere. This indicates that the health of the rhizosphere is very important for good root development and consequently higher yield. FUNGIMAX™ is a product developed to increase the soil micro-organism population. The objectives of the study were to evaluate the product for its merit to increase fungal populations in the soil, to measure the impact on citrus yield and fruit quality and the effect thereof on orchard profitability.

MATERIALS AND METHODS

FUNGIMAX™ was applied to soils of orchards located in the Hectorspruit and Groblersdal districts for three consecutive seasons (2005/2006 – 2007/2008). It was applied at a rate of 5 L ha^{-1} per month (October to January). The trials were laid out in a statistical strip design with 20 control strips paired with 20 treated strips. Observations were made of yield, fruit diameter and brix. Microbial populations were determined at intervals of between 6 and 37 weeks after the first application.

RESULTS AND DISCUSSION

During the first season, fungal populations increased on average by 38% ($P<0.01$) 16 weeks after application. In the second season, fungal populations were determined at 6, 15 and 24 weeks after the first application. No statistical differences were observed in the fungal populations. In the last season, fungal populations were determined at 9, 20 and 37 weeks after the first application. At 9 and 20 weeks, the treated soils had lower fungal counts than the control soils. However, the fungal population in the treated soils increased from 9 through to 20 and 37 weeks. The opposite trend was observed in the control soils. At 37 weeks, treatment applications significantly increased the fungal population by 23.8% compared with the control. Yield was not affected by the treatment in the first season. In the second season, yield increased significantly by an average of 6.0t ha^{-1} which was equivalent to an increase of 10%. In the last season the yield significantly increased by 5.6 t ha^{-1} (equivalent to 13%). Fruit size increases were significant across all three seasons and ranged from an increase of 1.0 - 1.5 mm. No significant differences were found between the control and treated strips in the fruit brix levels.

CONCLUSION

Applications of FUNGIMAX™ increased the fungal population of the soil in two out of the three seasons. Crop responses were also measured with significant increases in yield two out of three seasons and increases in fruit size across all seasons. The increases in yield and fruit size were of significant economic value to the farmer.

Keywords: FUNGIMAX™, Fungi, Citrus, Yield, Fruit size