Abstracts:

Poster Presentations

EVALUATION OF WHEAT GERMPLASM FOR RUSSIAN WHEAT APHID *(Diuraphis noxia)* RESISTANCE IN SOUTH AFRICA

JAN Asiwe[1], VL Tolmay[1] and A Jankielsohn[1]

[1]*ARC-Small Grain Institute (ARC-SGI), Private Bag X29, Bethlehem 9700, South Africa*

E-mail: AsiweJ@arc.agric.za

INTRODUCTION

Wheat (*Triticum* spp.) is an important crop grown nearly in all continents of the world. It is the third most important cereal crop after maize and rice. ARC-SGI has over 15,000 wheat accessions in its genebank. One of the major activities in our pre-breeding programme is to characterize the existing collections against wheat diseases and insect pests, particularly the Russian wheat aphid and update the ARC-SGI germplasm collection database. This paper discusses a set of wheat germplasm accessions (1,421) from small grain germplasm collections at ARC-SGI that were evaluated against Russian wheat aphid (RWASA2) in the glasshouse (Bethlehem) for seedling resistance (SR) and in the field (at Kransfontein) for adult plant resistance (APR).

MATERIALS AND METHODS

One thousand, four hundred and twenty one germplasm accessions obtained from the ARC-SGI small grain genebank were evaluated in the glasshouse and field. The evaluation in the glasshouse was conducted using an augmented design. Three control checks were included namely "Hugenoot" (universal susceptible), "Gariep" (resistant check for Russian wheat aphid biotype 1 (RWASA1), susceptible check for Russian wheat aphid biotype 2 (RWASA2) and "CItr2401" as resistant check for RWASA2. Five seeds of each entry were sown per tube filled with Kwagga seedling mix. Plants were infested when 2-3 cm tall with five RWASA2 each. Scoring took place three weeks after infestation using a ten-point damage rating scale, where scores of 1- 3 = highly resistant; 7- 9 and 10 = susceptible. For field evaluation, it was conducted at Kransfontein where aphid biotype was predominantly RWASA2. Accessions were planted in hillplots using an augmented design. Three resistant and susceptible cultivars were included for comparison with test accessions. Insect damage was rated using a five-point scale where; 1 = no visible damage; 5 = plant died. In addition, a three-point scoring scale was used to quantify the aphid density on the plants where; 1 = to 10 aphids; 2 = 11 to 100 aphids and 3 = 101 to 1000 aphids.

RESULTS AND DISCUSSION

Results showed that there were significant variations in the response of the accessions to RWASA2. Of the 1,421 accessions evaluated in the glasshouse, 140 were identified with seedling resistance (SR) while 160 exhibited adult plant resistance (APR) among the accessions evaluated in the field. When data from glasshouse and field evaluations were combined and compared, 36 accessions exhibited combined SR and APR resistance.

CONCLUSIONS

The 36 accessions exhibited combined resistance for SR and APR and are being used in pre-breeding programme for the development of RWASA2 resistant germplasm. In addition, the accessions were distributed as public goods to wheat industry and breeding companies.

Keywords: APR, Russian wheat aphid, RWASA1, RWASA2, seedling resistance, wheat

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

JJ Botha[1], LF Joseph[1], PP van Staden[1], JJ Anderson[1] and K Smith[1]

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

E-mail: BothaC@arc.agric.za

INTRODUCTION

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

MATERIALS AND METHODS

Cropland field experiments were carried out over four seasons (2008/09 - 2011/12) in three provinces on the Glen/Swartland, Glen/Oakleaf, Fort Cox/Oakleaf, Towoomba/Hutton and Towoomba/Arcadia ecotopes to compare RWH&C techniques. Five treatments, *viz.* conventional tillage (*CON* – control), in-field rainwater harvesting (*IRWH* – 2 m & 2.4 m runoff areas), Daling plough (*DAL*), mechanized basins (*MB*) and minimum/no-till (*MIN/NT*), replicated four times, were laid out in a randomized block design. Maize was used as the test crop and the indicators used were practicality, grain yield, dry matter production and rainwater productivity (RWP).

RESULTS AND DISCUSSION

Field preparation, implementation, planting, maintenance and harvesting went well with the implements only posing minor practical problems. Variations in yields and RWP were observed between seasons, as well as between localities. The preliminary general trend clearly demonstrated that the RWH techniques (*IRWH* and *DAL),* produced on average 3%, 7% and 7% higher biomass yield, grain yield and RWP values, respectively, as compared to *CON*.

CONCLUSIONS

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

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Keywords: Conservation tillage; maize; rainwater harvesting

EFFICACY OF SELECTED RHIZOBACTERIA AS BIOFERTILIZERS FOR MAIZE IN SOUTH AFRICA

G Breedt[1], NL Labuschagne[2] and ML Mokoena[1]

[1]Limpopo Department of Agriculture, Towoomba ADC, Private bag X1615, Bela-Bela, 0480;
[2]University of Pretoria, Department of Microbiology and Plant Pathology, Private Bag X20 Hatfield 0028

E-mail: Gerhardbreedt@gmail.com

INTRODUCTION

Various experiments show that Plant Growth Promoting Rhizobacteria (PGPR) can affect plant physiology. A substitute for improving the availability of water and nutrients via fertilizers and chemicals maybe constituted by the inoculation of these crops with advantageous PGPR. The main aim of the study was to evaluate rhizobacteria as biofertilizers and determine the mode of action thereof.

MATERIALS AND METHODS

The Biofertilizer maize trial was planted at the Towoomba Research Station on the Southern part of the Springbok flats. The rhizobacterial isolates S7, T19, A26, B-rus®, A40 and T29 from the University of Pretoria's culture collection were evaluated for their growth promoting capabilities under dryland conditions in Arcadia and Hutton soil ecotopes and under irrigation in a Shortland soil ecotope during the 2011/2012 growing season. The nitrogen and phosphate content of the soil were adjusted to recommended levels (100 kg N ha^{-1} & 75 kg P ha^{-1}) at planting using superphosphate and an ammonium nitrate mixture. Untreated seed was inoculated and treated with the fungicide Thiram®. Each treatment consisted of a Rhizobacterial inoculant at a concentration of 200 g inoculant powder mixed with 50 kg maize seed. The trial layout was an RCBD replicated 3 times. Each treatment consisted of 4X80 m rows of maize planted at a plant population of 22 000 plants $ha^{-1}$with an intra-row and inter-row spacing of 0.5 m and 0.9 m respectively. Plant height (bimonthly), fresh and dry biomass and grain yield at 12% moisture was measured and data were statistically analysed using the Dunnett's test in SAS 9.2.

RESULTS AND DISCUSSION

In the Shortland soil, the best performing inoculant, T-19 resulted in an increase of 2.88 t ha^{-1} over that of the control at 8.54 t ha^{-1}, while T-29, B-rus, S7 and A-40 resulted in yield increases of 2.50, 1.42, 0.72 and 0.21 t ha^{-1} respectively. In the Hutton soil, the best performing inoculants in descending order were the commercial product B-rus, A-26, A-40, T19 and T-29 with mean yield increase of 0.60, 0.58, 0.42, 0.40, and 0.22 t ha^{-1} respectively as compared to the control with a yield of 3.02 t ha^{-1}. However, the maize yield with the inoculant S7 was 0.05 t ha^{-1} lower than that of the control. The Arcadian data shows that all the inoculants had a negative influence on yield when compared with the control yield of 5.05 tons/ha. The inoculant S7 had the least amount of negative effect with a yield reduction of 0.15 tons/ha followed by T-19 with a 0.3tons/ha reduction when compared to the control.

CONCLUSIONS

The data suggests that, there is a link between soil fertility and Rhizobacterial effectiveness with the lower fertility soils (Shorthand's) having a greater positive effect on the mean yield of maize over the mean control yield. While on the other hand a negative yield over the control mean is observed in the high fertile Arcadian soil.

Keywords: biofertilizer, inoculants, maize production, soil type

SOYBEAN, THE MOST PREFERRED HOST FOR *A. simplixella* PS1 (LEPIDOPTERA: GELECHIIDAE) OCCURING IN SOUTH AFRICA

NM Buthelezi[1], DE Conlong[2] and GE Zharare[3]

[1]Mangosuthu University of Technology, P O Box 12363, Jacobs 4026; [2]SASRI, P O Box 700, Mount Edgecombe 4300; [3]University of Zululand, Private Bag X1001, KwaDlangezwa 3886

E-mail: buthelezim@mut.ac.za

INTRODUCTION

A leaf miner pest often referred to as *Aproaerema modicella* (Deventer) has recently become known in Africa as a serious pest of groundnut *(Arachis hypogaea* L.*)*. A recent mtDNA CO1 study of specimens collected from South Africa has identified the pest as *Aproaerema simplixella* PS1, a strain native to Australia and known in that country as the soybean moth. The present study examines the preference of *A. simplixella* among five known host crops of *A. modicella*.

MATERIALS AND METHODS

Groundnut, soybean, lucerne, pigeon pea and lablab bean (the common known host crops of *A. modicella*) were grown in two plantings during the 2011/2012 growing season at Vaalharts, Brits, Nelspruit, Bhekabantu and Manguzi. The first planting was done mid November 2011 and the second planting during the second week of January 2012. The five crops were planted in a RCB design replicated three times. An additional experiment was performed at Vaalharts and Nelspruit on 13 and 25 January 2012 respectively in two blocks; each block having three plots of groundnut and soybean planted in which pesticide Cypermetrin was applied to one block three times at 30, 50 and 70DAP and compared with where it was not applied. In both experiments, scouting on the crops was done at 30, 50 and 70DAP. During scouting, 10 plants per plot were randomly selected and inspected for infestation. For each plant the number of infested leaves per plant were determined and expressed as the percentage of the total leaves.

RESULTS

Among the host crops tested, soybean was the most preferred by *A. simplixella* followed by groundnut at all sites. This pest was also observed on pigeon pea at all sites, but the infestation was very low occurring on one to five plants per site and the infestation per plant ranged from one to three larvae. Lucerne was scarcely attacked with only two larvae found on one lucerne plant per site at Brits and Manguzi. No infestation was observed on lablab at all sites. In the unsprayed plots, high infestation levels were observed and grain yield was reduced to uneconomical levels.

CONCLUSION

Soybean is the most preferred host for *A. simplixella* PS1 occurring in South Africa. Cypermetrin application in groundnut and soybean reduced infestation in both crops to very low levels.

Keywords: Aproaerema simplixella PS1, *A. Modicella*, alternative hosts, cypermetrin

SEED PERFORMANCE OF AMARANTH (*Amaranthus* spp.) AND WILD MUSTARD (*Brassica* spp.) COMPARED WITH SELECTED EXOTIC VEGETABLES

TP Chibarabada[1] and AT Modi[1]

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

E-mail: tendaipolite@gmail.com

INTRODUCTION

African leafy vegetables (ALVs) are those that were originally domesticated or cultivated in Africa. Until recently, ALVs have remained underutilised owing to scant information on their husbandry. Promotion of ALVs as healthy alternatives will rely, in part, on availability of information describing aspects of their seed quality. This study compared seed quality and early establishment performance under water stress conditions of selected ALVs [amaranth (*Amaranthus spp*.), wild mustard (*Brassica spp*.)], and exotic vegetables [lettuce (*Lactuca sativa*), swiss chard (*Beta vulgaris*) and mustard (*Brassica juncea*)].

MATERIALS AND METHODS

Seeds of wild mustard landraces (Isaha, Mahlalisane and Kwayimba) were collected from subsistence farmers in Greytown, KwaZulu–Natal. Seeds of amaranth were obtained from a trial conducted at the University of KwaZulu-Natal. Seeds of lettuce var. Great Lakes, swiss chard var. Foodhock Giant and mustard var. Florida were purchased from a local seed dealer. Seed viability and vigour were evaluated using the standard germination test with 20 seeds (x3 replicates) in petri dishes. Seedling establishment was evaluated over 50 days in seedling trays under controlled environment (27/21°C day/night; 65% RH) using three water regimes (30, 50 & 75% of field capacity) arranged in a completely randomised design. Thereafter, seedlings of best performing varieties (lettuce, swiss chard, Isaha and Mahlalisane) were transplanted to beds for growth and yield evaluation for 45 days. Plant height and leaf number were used to determine growth; yield was defined as fresh mass.

RESULTS AND DISCUSSION

The standard germination test showed highly significant differences ($P<0.001$) between varieties. Isaha (98%) and amaranth (64%) had the highest and lowest final germination percentage. Mean germination time and germination velocity index showed that exotic vegetables germinated faster and more uniformly than ALVs. During seedling establishment, Kwayimba was dormant across all water regimes. Amaranth had less than 40% emergence at 75% FC and 0% emergence at 25% FC. Exotic vegetables performed better under 75% FC while Isaha and Mahlalisane performed better under 25% and 50% FC. There were significant differences ($P<0.05$) between varieties for growth parameters observed during the growth and yield trial. Isaha and Mahlalisane had a higher relative growth rate compared with lettuce and swiss chard. Biomass showed highly significant differences ($P<0.001$) between varieties with Isaha yielding 100% more fresh mass than other varieties.

CONCLUSIONS

ALVs and exotic vegetables may have similar germination potential. Exotic vegetables germinate faster and more uniformly compared to ALVs. Wild mustard performs better under moderate and severe water stress. Under water stress, ALVs may yield higher than exotic vegetables.

Keywords: seed quality, water stress, wild mustard, yield

GRAIN QUALITY CHARACTERISTICS OF OPEN POLLINATED MAIZE VARIETIES COMPARED TO HYBRID VARIETIES

C Chiremba[1] and K Mashingaidze[1]

[1]*Agricultural Research Council-Grain Crops Institute, P Bag X1251, Potchefstroom 2520*

E-mail: chirembac@arc.agric.za

INTRODUCTION

Maize open-pollinated varieties (OPVs) are often recommended for resource poor farmers as an alternative to hybrids. Generally OPVs have flint and semi-flint grain whereas hybrids have dent grain. Quality protein maize (QPM)-OPVs provide a better alternative to normal maize OPVs in having about double the amount of essential amino-acids, lysine and tryptophan. However, QPM has not been widely grown because of lower yields and soft endosperm, associated with susceptibility to ear rots and low milling quality. Maize breeders have now developed hard endosperm QPM varieties with near-normal grain (Vivek *et al*., 2008). It is not known whether OPVs and QPM-OPVs would produce grain of acceptable milling quality. The objective of the study was to evaluate quality properties of OPVs and QPM-OPVs against standard commercial hybrids to determine their milling potential.

MATERIALS AND METHODS

Five OPVs, five QPM-OPVs and six white maize hybrids grown in Potchefstroom, South Africa during the 2010/11 growing season were used for the study. Samples were field dried and harvested at 14% moisture. Grain quality was evaluated in terms of kernel size, Tangential Abrasive Dehulling Device (TADD) hardness, near infrared transmittance (NIT) Milling index, thousand kernel weight (TKW) and test weight (TW). The tests were performed according to Chiremba *et al.* (2011) on sound grain. Three replicates were used for each variety. Data were analyzed by analysis of variance and means compared by Fisher's Least Significant Differences. Calculations were performed using Statgraphics Centurion XV.

RESULTS AND DISCUSSION

Hybrids had the highest TKW (395 g) and QPM-OPVs had the lowest (292 g). OPVs and QPM-OPVs had smaller KS than hybrid varieties. OPVs were the hardest in terms of the NIT Milling Index. OPVs had a Milling Index of 101 compared to 89.9 and 89 for QPM-OPVs and hybrids, respectively. There were no significant differences ($p > 0.05$) in TW of OPVs, QPM-OPVs and hybrid. TADD hardness (% kernel removed) was 26.6 -29.5%. There were no significant differences ($p > 0.05$) in the TADD hardness of all the maize types.

CONCLUSIONS

The study shows that OPVs and QPM-OPVs produce grain of the same hardness quality as hybrids although their kernel size and kernel weight is lower than that of hybrids. Thus, OPVs and QPM-OPVs have potential for milling as with hybrid varieties.

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Keywords: hardness, open pollinated varieties, quality

PHYSICAL CHARACTERISTICS OF COWPEA GRAIN AS AFFECTED BY VARIABLE PHOSPHORUS AND ZINC FERTILISER APPLICATION RATES

C Chiremba[1], RA Nkoana[2], PS Mthombeni[2] and FR Kutu[2]

[1]Agricultural Research Council-Grain Crops Institute, P/Bag X1251, Potchefstroom 2520;
[2]University of Limpopo, School of Agriculture and Environmental Science, P/Bag X1106, Sovenga 0727

E-mail: chirembac@arc.agric.za

INTRODUCTION

Phosphorus (P) is a key element limiting cowpea production while excessive P application may trigger major nutritional problems particularly zinc (Zn) uptake. However, the effect of P and Zn fertilisation and their interaction on physical grain characteristics is unknown. This study aimed at providing quantitative information on the effects of P and zinc fertilizer application on the physical quality attributes of cowpea grains. The knowledge of grain quality characteristics is important for determining post-harvest processing.

MATERIALS AND METHODS

Cowpea grains obtained from a field study carried out under dryland conditions at University of Limpopo's Experimental farm, Syferkuil during the 2011/12 season were evaluated for selected physical characteristics. Pre-planting soil test on the field revealed Bray P1 content of 8.48 mg kg^{-1}. The trial consisted of two cowpea varieties namely IT00K-1217 (white) and Oloyin (brown); five P fertiliser levels (0, 15, 30, 45 and 60 kg P ha^{-1}) applied as double superphosphate (10.5% P) and three Zn levels (0, 10 and 20 kg Zn ha^{-1}) applied as zinc sulphate (36.4% Zn). All treatments were replicated three times. Grain characteristics evaluated included kernel size, thousand kernels weight (TKW) and colour using the HunterLab colorimeter. Data generated were subjected to analysis of variance.

RESULTS AND DISCUSSION

Mean TKW of 189.8g and 169.9g was obtained for Oloyin and IT00K-1217 variety, respectively. Significant ($p<0.05$) differences in TKW and kernel size between the two cowpea varieties were observed. As expected the IT00K-1217 variety had higher lightness (*L*) values than Oloyin. Comparison of the two cowpea varieties revealed a significant P and ZnxP interaction effects on TKW and grain lightness while Zn rates had inconsequential effects on the grain physical attributes studied. However, P and Zn fertilizer application showed no significant effect on the studied physical characteristics of the individual cowpea variety. Furthermore, more than 90% of the kernels were distributed between 6.35mm and 7.00 mm; with the kernel size of Oloyin being generally larger than that of IT00K-1217.

CONCLUSIONS

Fertiliser P and Zn application had no effect on the physical grain characteristics of the individual cowpea varieties evaluated.

Keywords: Cowpea, thousand kernel weight, kernel size, grain lightness

EFFECT OF AUTUMN WATER STRESS AND ETHEPHON ON LITCHI FLOWERING AND YIELD IN SOUTH AFRICA

RB Cronje[1], IJ Froneman[1] and PG Mostert[2]

[1]ARC-Institute for Tropical and Subtropical Crops, P/Bag X11208, Nelspruit 1200; [2]Mostert Consulting Service

E-mail: regina@arc.agric.za

INTRODUCTION

Poor litchi flowering is a worldwide problem, especially in areas where temperatures during the flower induction period are not cool enough. Various studies in the literature indicate that flower induction and initiation in litchi is solely triggered by temperature differences. However, reducing soil moisture by withholding water in autumn and early winter to levels below the water requirements of the trees can assist the trees to enter a rest period and indirectly influence flower induction positively.

MATERIALS AND METHODS

The effect of water stress in combination with the plant growth regulator Ethapon® (a.i. 480 g/L ethephon) on litchi production was tested between 2009 and 2011 on 'Mauritius' litchi trees in the Malelane and Hazyview areas, in a complete randomized block design. The treatments applied were: No water stress (100% of optimum water requirement) + ethephon application, no water stress without ethephon application, early water stress between mid-March and mid/end-April (25 and 50% of optimum water requirement for March and April) + ethephon, and late water stress between April and mid/end-May (70 and 20% of optimum water requirement for April and May) + ethephon application. At harvest, total yield per tree was determined. Temperature, humidity, soil moisture and tree phenology were monitored on a continuous basis. Starch samples were taken monthly from the main branches. Starch analysis was done according to a modified AOAC (Association of Analytical Chemists) method.

RESULTS AND DISCUSIONS

In the Malelane region trees were more vigorous and flushed more often during the year than at Hazyview, which has a more moderate climate. The application of water stress improved flower formation by up to 20% at both sites. Optimum irrigation (wet treatment) without the application of ethephon encouraged the trees to flush vegetatively and produce less flowers, compared to either optimum irrigation or water stress treatments with ethephon application. The water stress + ethephon treatments, however, successfully reduced/ prevented vegetative flushing during the flowering period. In Malelane, yield was improved by late water stress + ethephon and in Hazyview by early water stress + ethephon, which is in accordance with the later induction period in warm/hot climates and earlier induction period in moderate/cool climates, respectively. Starch content varied little between treatments. Starch content in main branches was influenced by growth phases such as vegetative flushing during February and April, flower panicle development and fruit growth.

CONCLUSIONS

The results indicate that water stress can improve litchi flowering when applied at the correct time (March - May), i.e. before and during the flower induction period, which is about one month before flower panicle appearance. The application of ethephon still remains a necessary management tool as temperatures and rainfall in April/May are unpredictable.

Keywords: Litchi chinensis Sonn., flower intensity, autumn water stress, climate, temperature, soil, plant growth regulator

EVALUATION OF INDIGENOUS FRUIT ICE CREAM

K de Jager[1], CP Welgemoed[1], O Maphanga[1] and RJ du Preez[1]

[1]*ARC-Institute for Tropical and Subtropical Crops, P/Bag X11208, Nelspruit 1200*

E-mail: karendj@arc.agric.za

INTRODUCTION

The harvesting, utilization and marketing of indigenous fruit and nuts have been central to the livelihoods of the majority of rural communities throughout Africa and can make a difference during periods of famine and food scarcity. The potential of developing indigenous fruit species as commercial crops lies in the value-adding component. Any value-adding could lead to the development of agri-businesses if products can be developed successfully and can supply a niche market. This can facilitate economic empowerment in some of the poorest areas in South Africa.

MATERIAL & METHODS

Ice cream, sorbet, low fat ice cream and frozen yoghurts were made from indigenous fruits. *Garcinia livingstonei*, *Engelerophytum magalismontaum*, *Dovyalis caffra* and S*clerocarya birrea* fruits were used in producing ice creams following traditional recipes. The taste, colour, texture and overall impression were evaluated by a sensory panel.

RESULTS & DISCUSSION

The panellists liked the taste of the stem fruit yoghurt and all the marula ice cream products. They preferred the colour of the kei apple ice creams. More than 80% indicated that they would buy the stem fruit yogurt and the *Garcinia* low fat ice cream

CONCLUSION

Indigenous fruits have potential to be developed into various ice cream products. Further trials should be conducted to refine the products.

Keywords: Indigenous fruits, *Garcinia livingstonei*, *Engelerophytum magalsimontanum*, *Dovyalis caffra, Sclerocarya birrea*, processing

SMOTHER CROPS SUPPRESS WEEDS IN SMALL GRAIN CROPPING SYSTEMS OF THE WESTERN CAPE

MI Ferreira[1] and Z Sedeman[1]

[1]*Department of Agriculture Western Cape, Institute for Plant Production, Private Bag X1, Elsenburg 7607, South Africa*

E-mail: mikefe@elsenburg.com

INTRODUCTION

A combination of pressures, namely herbicide-resistant weeds, environmental concerns and cost containment, has prompted interest in new weed control measures. Addressing these issues, points to conservation agriculture, which includes the use of smother crops. By broadening the array of weed management options available, producers may manage these pressures more effectively. Therefore, the aim of this research was to study the effects of two smother crops on weed populations.

MATERIALS AND METHODS

The smother crops, white mustard and black oats, were each planted annually for three years at two localities, namely Langgewens and Riversdale. No agricultural chemicals and fertilisation were applied during cultivation of smother crops. Plots were laid out in a randomised block design with three replicates. The control was an untreated plot of similar dimensions to allow natural weed seed germination and establishment.

RESULTS AND DISCUSSION

Both smother crops effectively suppressed weeds at 86 % for black oats and 81 % for white mustard at Riverdale, when compared to the control. At Langgewens, weed suppression was lower at 83% for black oats and 74 % for white mustard, respectively. The moderate weed control achieved by white mustard at Langgewens was most probably due to a very high ryegrass seed bank and a limiting soil depth which prevented normal development of its tap root system. Nevertheless, all other treatments at both localities provided fast-growing, high-biomass smother cropping which skipped herbicide use for that particular year, thus preserving its efficacy for longer.

CONCLUSIONS

The adoption of smother cropping as a standard practice in conservation agriculture may benefit sustainability and form part of an integrated weed management system in crop rotation.

Keywords: conservation agriculture, smother crops, weed suppression.

PRELIMINARY STUDIES ON THE USE OF POLYPLOIDY FOR THE IMPROVEMENT OF LITCHI

K Hannweg[1], M Penter[1] and A Sippel[1]

[1]*Agricultural Research Council - Institute for Tropical and Subtropical Crops*

E-mail: karin@arc.agric.za

INTRODUCTION

Polyploidy is a condition in which individuals have two or more chromosome sets or genomes in their somatic cells and which may arise naturally. Polyploid plants can arise from duplication of chromosomes of a single species (autoploidy) or the combination of two or more chromosome sets of different species (alloploidy). Induced autopolyploids have one or more of the following characteristics which would result in the improvement, or development of new economically important plants: larger tuber, rhizome or root size; increased fruit size; enhanced flower size and/or colour intensity, improved drought tolerance, increased bio-mass; improved photosynthetic capacity; larger and/or thicker leaves; dwarfism; increased secondary metabolite production e.g. medicinal compounds. In litchi, larger fruit size and greater flesh to seed ratio is required. The methods used and results obtained in efforts to develop polyploid selections will be highlighted.

METHODS AND MATERIALS

Selected shoots, both green and mature, of trees growing in the field were tipped and the leaves removed such that up to fifteen axillary buds were exposed. Branches of cv. Mauritius and selection R1G22 were prepared, and three colchicine concentrations, namely 0.1 g/kg, 1.0 g/kg and 10.0 g/kg applied to each axillary bud. Colchicine was prepared by mixing the colchicine with warmed aqueous lanolin. The Lanolin was applied at three different times (0 weeks, 1 week and 2 weeks) after branch preparation, with fifteen replicates per combination of treatment time, cultivar and colchicine concentration. Ploidy analysis was carried out using flow cytometry to determine if ploidy transformation had occurred. The effect of colchicine concentration and treatment time on bud break, bud swell and extension was also recorded.

RESULTS AND DISCUSSION

Compared with control shoots, colchicine-treated shoots showed inhibited shoot extension with all treatments. A method for flow cytometry analysis for polyploid induction was developed. A low percentage of transformation was recorded, with only chimeric shoots produced. No trend in terms of colchicine concentration or treatment date was observed. Since no pure polyploids were obtained, further investigations are underway to identify whether individual buds on chimeric shoots are pure polyploids. Alternative methods using growth regulators are also being investigated to encourage bud break and shoot elongation.

CONCLUSIONS

Polyploidy could potentially positively affect litchi scions in terms of yield, fruit size and colour as well as reduced seed size (development of triploids); there is also the potential for development of dwarf, drought-tolerant rootstocks. More research needs to be carried out in this regard.

Keywords: Improvement, polyploidy, breeding and selection

SOIL WATER BALANCE COMPONENTS UNDER IN-FIELD RAINWATER HARVESTING AND CONVENTIONAL TILLAGE ON FORT HARE/OAKLEAF ECOTOPE

LF Joseph[1], JJ Botha[1] and JJ Anderson[1]

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

E-mail: josephf@arc.agric.za

INTRODUCTION

In recent years, research has been done on rainwater harvesting and conservation (RWH&C) techniques. The case studies of Joseph (2007) indicate that more emphasis is put on grain yield when evaluating RWH&C techniques and soil water balance components (SWBC) should be evaluated in order to make sound recommendations. The aim of this study was to evaluate in-field rainwater harvesting (*IRWH*) treatments in terms of SWBC, compared to conventional tillage (*CT*).

MATERIALS AND METHODS

A field experiment with three treatments and three replications, *viz. IRWH*: with mulch ($IRWH_{+M}$), IRWH: without mulch ($IRWH_{-M}$) and *CT* was conducted over four seasons (2004/05 – 2007/08) on Fort Hare/Oakleaf ecotope. SWBC measurements were taken regularly during each growing season. Anderson (2007) equation was used to predict R_{EX} on *CT* from each rainfall event. Deep drainage was estimated by interpreting soil water extraction diagrams in relation to the drainage curve. The procedure of Tanner & Sinclair (1983) was used to separate evapotranspiration into transpiration (Ev) and evaporation from the soil surface (Es). A neutron water meter was used to measure soil water content and an automatic weather station to record rainfall.

RESULTS AND DISCUSSION

The $IRWH_{+M}$ and $IRWH_{-M}$ treatments had on average 39 and 14% higher soil water content respectively, compared to *CT.* Deep drainage never occurred during the experimental period. Mean values for Ev over the four growing seasons indicate that $IRWH_{+M}$ and $IRWH_{-M}$ were 12 and 24% higher respectively, as compared to *CT*. R_{EX} amounted to 9% of total rainfall for *CT*. The Es values for all treatments varied between 196 and 258 mm.

CONCLUSIONS

It can be concluded that implementation of $IRWH_{+M}$ or $IRWH_{-M}$ on similar ecotopes can increase crop yields due to stoppage of R_{EX} and inducement of transpiration.

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Keywords: Conventional tillage, in-field rainwater harvesting, soil water balance components

INVESTIGATION OF THE EFFECT OF PARAFFIN ON GERMINATION AND GROWTH OF SEEDS OF CANOLA (*Brassica napus* L.) AND WHEAT (*Triticum aestivum* L.)

JS Kadende[1] and PJ Pieterse[1]

[1]*Stellenbosch University, Private Bag X1, Matieland 7602*

E-mail: kadende@sun.ac.za

INTRODUCTION

Paraffin is used in agriculture for different purposes such as dispersants and insecticides. In order to investigate the feasibility of treating crop seeds with paraffin as deterrent, the effect of paraffin on seed germination and early seedling growth has to be determined. Sharanova and Breus (2012) found that the effect of paraffin on plant growth was not too detrimental. It is of use to know whether paraffin would not damage the embryo nor disturb any step of the germination of treated seeds or the growth of subsequent seedlings before it is considered as animal deterrent.

MATERIALS AND METHODS

Two experiments were conducted to investigate the effect of paraffin on germination and seedling vigour of canola (*Canola napus* L.) and wheat (*Triticum aestivum*, L.). Wheat and canola seed were subjected to a 5X4 factorial design treatment with factors Paraffin concentration (0, 25, 50, 75 and 100% of commercial paraffin diluted with distilled water) and Time of immersion (1, 5, 10, and 30 minutes). Treatments were repeated four times. After immersion seeds were dried with water absorbent paper and immediately used for the different experiments. Germination tests included 20 seeds per replicate and were incubated at a constant temperature of 20 °C under dark conditions. Seed germination was monitored daily and seed viability and vigour were calculated. In the seedling vigour test, seeds were sown in 8 cm x 8 cm plastic pots (10 seeds per pot) and the establishment of the seedlings was monitored daily. The final percentage and rate of establishment were calculated. After germination stopped only the strongest seedling per pot were retained and harvested six weeks after establishment. Plant height and dry mass were determined.

RESULTS AND DISCUSSION

The germination percentage on wheat drops with paraffin imbibitions compared to control which is 80%. The most affected is at 30 minutes of imbibitions in 100% paraffin concentration with the germination of 25%. Paraffin damages the germination capacity of wheat grain whereas on canola, variations between the control and paraffin washed seeds at different concentrations and period of imbibitions are not apparent. This may be caused by the constitution of its seed coat (Costanza et al, 1994). The computation of dry masses of seedlings, either on canola or wheat, washed by paraffin or not, show no critical difference, which proves that the vigour of the seeds germinated is not affected. Paraffin exerts no any influence on the growth of wheat and canola, since values of dry masses obtained after six weeks of establishment oscillate between 3.7gr and 3.9gr and the heights of plants show no distinctive difference.

CONCLUSIONS

Results show that paraffin treatment reduced wheat germination significantly but it had no detrimental effects on canola germination. After seedling establishment, paraffin treatment, however, had no significant detrimental effect on the vigour of either wheat or canola seedlings.

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Keywords: paraffin, germination

SITE-SPECIFIC SOIL pH MANAGEMENT ACROSS SPATIALLY VARIABLE SOILS

PM Kgopa[1], ME Moshia[2] and P Shaker[1]

[1]University of Limpopo, School of Agriculture and Environmental Sciences, P/Bag X1106, Sovenga 0727; [2]Tshwane University of Technology, Department of Crop Science, Pretoria Campus, 0001

E-mail: pholosho.kgopa@ul.ac.za

INTRODUCTION

Soil pH influences chemical solubility, pesticide performance, organic matter decomposition, and determines how efficiently many of the necessary farming inputs can be utilized by crops (McCauley *et al*., 2003). However, knowledge and management of soil pH, particularly soil acidity across spatially variable soils is greatly ignored by farmers, although it is of great importance.

METHODOLOGY

The study was conducted in the semi-arid regions of the Limpopo Province over 3 site years (23°50' S; 29 °40' E), Syferkuil experimental farm and (23°59'S; 28°52E), Mapela irrigation Scheme. Soil samples were taken in four replicates within a 1 m radius from geo-referenced locations to a sampling depth of 0-20 cm on a systematic unaligned sampling within a grid of 30 m. Soils were analyzed for pH (H_2O), and SMP buffer pH for lime recommendations. Lime requirement to achieve a soil pH of 6.0 to 6.5 for a 20 cm plough layer per hectare was calculated using Calcium Carbonate equivalent, efficiency factor (fineness factor), and neutralizing index of the liming materials. The spatial maps and interpolation of data using inverse distance weighing (IDW) were produced using Surfer Golden software version 8.0.

RESULTS AND DISCUSSION

Soil pH varied significantly (P<0.05) with minimum and maximum values from 4.22, 3.93, and 4.74, to 6.11, 7.00, and 6.82 in site I, II, and II respectively. In all fields, areas of the field that had soil pH values of less than 6.0 were 99.43, 82.61, and 62.89% of the field. When lime was recommended for application using a conventional method of uniform lime application based on an average value derived from samples collected in the whole field, the results of the study showed a waste of lime in excess of lime recommended for individual grids. An excess amount of lime as high as 10, 30, and 7 tons/ha recommended on sites I, II and III respectively under uniform application. These recommendations were in excess on field areas that needed little or no lime applications. Again, the fields showed under applications of lime as much as 30, 35, and 13 tons/ha in site I, II, and III respectively for uniform liming applications.

CONCLUSIONS

These under- and over recommendations of lime based on average soil pH values suggests that uniform soil acidity management strategy is not an appropriate strategy to be adopted in these fields. Again, there was a spatial dependency in the fields, such that they could be divided into lime application zones. When a field is divided into lime application zones, management of soil acidity becomes easier because instead of applying variable rates of lime for every grid, lime rates are applied per zone.

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Keywords: Soil pH

EVALUATION OF THE COMBINED EFFECT OF VERMICOMPOST TEA AND *Trichoderma harzianum* ON ROOT DISEASE-INDUCED STRESS IN CABBAGE SEEDLINGS

BP Kubheka[1] and NL Skenjana[1]

[1]*Dohne Agricultural Development Institute, P/bag X15, Stutterheim, RSA*

E-mail: bongani.kubheka@agr.ecprov.gov.za

INTRODUCTION

Vermicompost tea is known to have positive effect on vegetable seedling health as it controls root diseases such as damping-off, and other root diseases (Joshi, *et al*. 2009). *Trichoderma harzianum* is also known to control damping-off and other root diseases in seedlings (Mbarga *et al*. 2012). The aim of this study was to investigate whether the combination of *Trichoderma harzianum* and vermicompost tea would have a synergistic effect on reduction of disease induced stress on cabbage seedlings more than when the two products are applied separately.

MATERIALS AND METHODS

Vermicompost tea was prepared from mature vermicompost by suspending 1 kg vermicompost in 5 L of water and stirring continuously for 24 hours. After 24 hours, the roots of cabbage seedlings were dipped into that supernatant before the seedlings were transplanted into 5 L pots filled with garden topsoil. The second treatment consisted of cabbage seedlings treated with 2 x 10^9 spores of *Trichoderma harzianum* applied on the roots. All seedlings were inoculated with *Rhizoctonia solani*, except the positive control. The control treatments were dipped in water. To get an indication of seedling stress levels resulting from infection, chlorophyll content index of the seedlings was measured using a CCM200 chlorophyll meter.

RESULTS AND DISCUSSION

Trichoderma harzianum and vermicompost tea individually significantly reduced the disease stress levels but the combination of the two did not at $p = 0.05$. The results obtained from this study suggest that when applied in a single treatment at transplanting of the seedlings, the two products that were tested perform better on their own than when applied simultaneously.

CONCLUSIONS

Trichoderma harzianum and vermicompost tea in combination do not reduce root disease induced stress on cabbage seedlings more than when applied separately.

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Keywords: Vermicompost tea, *Trichoderma harzianum, Rhizoctonia solani*

THE EFFECTS OF SOIL TILLAGE AND CROPPING SEQUENCE ON MICROBIAL DIVERSITY IN SHALE-DERIVED SOILS OF THE WESTERN CAPE

J Labuschagne[1], J Habig[2], H van Zyl[1] and W Langenhoven[1]

[1]Western Cape Department of Agriculture, Institute for Plant Production, Private Bag X1, Elsenburg 7607 ; [2]ARC, Plant Protection Research Institute, Private Bag X134, Queenswood, Pretoria 0121

E-mail: johanl@elsenburg.com

INTRODUCTION

Knowledge about the influence of management practices on microbes is important to ensure sustainable crop production. It is expected that tillage and crop rotation will influence the microbial community in the root zone of crops. The aim of this study was to develop a better understanding of the effects of tillage practice and cropping sequence on microbial diversity.

MATERIALS AND METHODS

This long-term tillage/crop rotation trial was started in 2007 on Langgewens near Moorreesburg and Tygerhoek near Riviersonderend. Three cropping systems namely, wheat monoculture (WWWW), wheat-canola-wheat-lupin (WCWL) and wheat-medic-wheat-medic (WMcWMc) systems were included. Tillage treatments included were; zero tillage (ZT), *soil left undisturbed and planted*, no- (NT), *soil left undisturbed and then planted with a no-till planter*, minimum- (MT), *soil scarified to a depth of 100mm to 150mm in March/April and then planted with no-till planter* and conventional- (CT), *soil scarified in March/April, then ploughed before planting, and planted with the no-till planter.* Five subsamples to a depth of 150mm per treatment combination were aseptically collected at the end of August 2011, pooled, and stored at ±5 ºC until analysis. Carbon source utilization profiles were determined by inoculating the soil suspension into Biolog EcoPlates^{TM}. Soil microbial diversity was determined using the amount and equitability of 31 carbon sources metabolised as indicators of richness and evenness, respectively.

RESULTS AND DISCUSSION

At Langgewens, cluster analysis illustrated two main clusters: a clear combined cluster of WMcWMc and WWWW, and a separate cluster of WCWL. No trend as a result of tillage treatments within cropping systems was observed at Langgewens. Statistical differences (p<0.05) in carbon source utilization profiles (CSUP) were recorded between different cropping sequences within a specific tillage treatment only under minimum- and conventional tillage at Langgewens.

Clustering analysis of the Tygerhoek study also illustrated the combined cluster of WMcWMc and WWWW and a separate WCWL cluster. In most cases tillage treatments seemed not to result in significant differences in microbial diversity at both Langgewens and Tygerhoek. Statistical differences in CSUP were recorded between different cropping sequences within a specific tillage treatment only under zero and minimum tillage at Langgewens.

CONCLUSIONS

Preliminary results showed that the composition of soil microbial populations in the WWWW and McWMcW cropping sequences tend to be similar, but differed from those in the WCWL sequences. Soil microbial diversity showed higher sensitivity to cropping sequences, than to tillage treatments, possibly due to the differences in root exudate composition between crops.

Keywords: Crop rotation, carbon source utilization profiles, soil tillage, soil quality, microbial diversity

THE EFFECTS OF SOIL TILLAGE AND CROPPING SEQUENCE ON ENZYME ACTIVITY IN SHALE-DERIVED SOILS OF THE WESTERN CAPE

J Labuschagne[1], J Habig[2], H van Zyl[1] and W Langenhoven[1]

[1]Western Cape Department of Agriculture, Institute for Plant Production, Private Bag X1, Elsenburg 7607; [2]ARC Plant Protection Research Institute, Private Bag X134, Queenswood, Pretoria 0121

E-mail: johanl@elsenburg.com

INTRODUCTION

Soil enzymes play an important role in organic matter decomposition and nutrient mineralisation in soils. The aim of this study was to develop a better understanding of the effects of tillage practice and cropping sequence on the potential of the soil microbial population to decompose or convert substrates.

MATERIALS AND METHODS

This trial is conducted as a component study within a long-term tillage/crop rotation trial started in 2007 on Langgewens near Moorreesburg and Tygerhoek near Riviersonderend. Three cropping systems namely, wheat monoculture (WWWW), wheat-canola-wheat-lupin (WCWL) and wheat-medic-wheat-medic (WMcWMc) systems were included. Tillage treatments were; zero tillage (ZT), *soil left undisturbed and planted with a star-wheel planter*, no- (NT), *soil left undisturbed until planting and then planted with a tined planter*, minimum– (MT), *soil scarified to a depth of 100mm to 150mm in March/April and then planted with the no-till planter* and conventional- (CT), *soil scarified to a depth of 100mm to 150mm in March/ April, then ploughed before planting, and planted with the no-till planter.* Five subsamples to a depth of 150mm per treatment combination were aseptically collected at the end of August 2011, pooled, air-dried at 40 ºC, sieved (2mm), stored at ±5 ºC and soil microbial enzyme activity determined. ß-glucosidase, acid-and alkaline phosphatase and urease activity were calculated with reference to the applicable calibration curves.

RESULTS AND DISCUSSION

At Langgewens, the highest and lowest microbial activities tend to be under the NT and CT treatments respectively. The lowest microbial activity occurred under the WWWW system, the highest ß-glucosidase activity under the McWMcW sequence, the highest alkaline phosphatase under the WMcWMc sequence and the highest urease activity under the WMcWMc cropping system.

Contrary to Langgewens, Tygerhoek demonstrated the highest and lowest microbial activity under the CT and ZT treatments respectively. The lowest ß-glucosidase and alkaline phosphatase activity was recorded in the wheat-medic system, possibly the result of substandard medic productivity during the medic phase. The lowest urease activity was observed under the WWWW system. The highest ß-glucosidase activity was recorded under the LWCW sequence and the highest urease and alkaline phosphatase under the CWLW system.

CONCLUSIONS

Although no conclusions can be drawn at this stage as these are preliminary results from the first year of a three year study, soil enzyme activity showed high sensitivity to tillage and crop rotation.

Keywords: Crop rotation, soil tillage, soil quality, microbial activity, soil enzyme activities

GRAIN YIELD AND PROTEIN CONTENT OF WHEAT (*Triticum aestivum* L.) AS INFLUENCED BY NITROGEN AND CROPPING SYSTEM UNDER NO-TILL IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

J Labuschagne[1] and P Karsen[1]

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

E-mail: johanl@elsenburg.com

INTRODUCTION

Grain yield and quality is a function of, amongst others, nitrogen supply. Adopting conservation agriculture (CA) leads to changes in soil organic matter content and a resultant increase in soil nitrogen mineralisation potential. As a result of this increase, a decrease in nitrogen fertiliser requirement of the wheat crop is expected. The aim of this study was to evaluate the effect of mineral nitrogen as influenced by the previous crop on wheat yield and grain protein content in no-till systems.

MATERIALS AND METHODS

A trial was laid out at the Langgewens Research Farm near Moorreesburg to evaluate the effect of previous crop and nitrogen (N) application rate on wheat production and grain protein content grown under no-till conditions during the 2008-2010 seasons. The trial was laid out as a factorial arranged in a split plot design with previous crops (wheat in WWWW-, canola in WWCW- or medic in McWMcW system) allocated to main plots and N treatments to sub-plots. Nitrogen fertiliser rate treatments were either 0 or 30 kg N ha^{-1} at planting followed by various combinations of 0, 30 or 60 kg N ha^{-1}, 30 and/or 60 days after emergence. Fertiliser application rate was calculated as the sum of nitrogen applied during the growing season. Data were pooled as 0, 30, 60, 90 and 120 kg N ha^{-1}.

RESULTS AND DISCUSSION

A gradual increase in mean grain production in the McWMcW system was recorded as N fertiliser application rate was increased from 0 kg N ha^{-1} to 90 kg N ha^{-1} followed by a decrease in grain yield as N rate was increased to 120 kg N ha^{-1}. Grain protein content followed a linear increased response (R^2=0.9824) as N application rate was increased from 0 – 120 kg N ha^{-1}. An increase in N fertiliser application rate resulted in a gradual increase in grain yield in the WWCW system. Although increased N fertiliser application rate resulted in a linear increased response (R^2=0.8405) in grain protein content, a definite decline in grain protein content was observed at 30 kg N ha^{-1}, a definite indication of N shortages during grain filling. The response to fertiliser N in the WWWW was similar to the WWCW, however at lower grain yield and grain protein levels.

CONCLUSIONS

Wheat that followed medic in a cropping system produced higher grain yields of higher grain protein content compared to the WWWCW and WWWW systems.

Keywords: Grain quality, nitrogen, wheat

THE EFFECT OF SOIL TILLAGE AND CROP ROTATION ON CROP RESIDUE COVER IN THE SWARTLAND AND RÛENS SUB-REGIONS OF THE WESTERN CAPE

J Labuschagne[1], W Langenhoven[1] and H van Zyl[1]

[1]Western Cape Department of Agriculture, Institute for Plant Production, Private Bag X1, Elsenburg 7607

E-mail: johanl@elsenburg.com

INTRODUCTION

One of the cornerstones of conservation agriculture is stubble retention. Residue cover of at least 30% directly after seeding is prescribed to qualify as conservation agricultural practice and thereby contributes to ensure sustainable crop production. The aim of this study was to quantify residue cover of the soil surface as influenced by tillage practice and crop rotation.

MATERIALS AND METHODS

The current study is a component study within a long-term tillage/cropping system trial. Three crop rotations, continuous wheat (WWWW), wheat/medic/wheat/medic (WMcWMc) and wheat/canola/wheat/lupin (WCWL) were allocated to main plots replicated four times at the Langgewens (Moorreesburg) and Tygerhoek (Riviersonderend) Research Farms. Each main plot was subdivided into four sub-plots allocated to four tillage treatments, namely: zero-till – soil left undisturbed and planted with starwheel planter, no-till – soil left undisturbed until planting and then planted with a tined, no-till planter, minimum till – soil scarified March/April and then planted with a no-till planter and conventional tillage – soil scarified late March/early April, then ploughed and planted with a no-till planter. During 2012 data were recorded before any tillage treatments were applied and also immediately after seeding, using the line-transect method to estimate residue cover.

RESULTS AND DISCUSSION

Mean residue cover during 2012 was at similar levels for both sites with Langgewens and Tygerhoek recording mean residue cover values of 53 and 59 percent respectively. At Langgewens the zero-, no-, minimum- and conventional-till treatments resulted in 98, 63, 29 and 5 percent residue cover, respectively. The percentage residue cover recorded at Tygerhoek for the zero-, no-, minimum- and conventional-till treatments were 86, 56, 42 and 30 percent respectively. At both sites, wheat as previous crop resulted in higher (P=0.05) residue cover compared to the other systems tested. Lupin as previous crop resulted in the lowest residue cover, although not always significantly. As no tillage treatments were done in the medic after wheat (McWMcW) systems, relatively high levels of crop residue cover were measured in these systems at both localities. Using the Ausplow (no-till planter) resulted in a reduction in mean residue cover of 23 and 24 % at Langgewens and Tygerhoek respectively.

CONCLUSIONS

The study showed that, on both sites, cultivation of the soil will reduce residue cover. The use of conventional tillage practices is questionable as the residue cover was reduced at both sites. In terms of residue cover wheat as previous crop was superior to medic, lupin and canola.

Keywords: Crop rotation, soil tillage, wheat

THE INFLUENCE OF SOIL TILLAGE AND CROP ROTATION ON THE DEPTH DISTRIBUTION OF SELECTED ELEMENTS AND VARIATION IN pH OF THE TOPSOIL ON A SHALE DERIVED SOIL OF THE SWARTLAND SUBREGION OF THE WESTERN CAPE

J Labuschagne[1] and H van Zyl[1]

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

E-mail: johanl@elsenburg.com

INTRODUCTION

It is expected that changing to conservation driven agricultural practices will influence the nutrient distribution in the different layers of the topsoil. Stratification of nutrients in the topsoil will, amongst others, place pressure on accuracy of soil sampling.

MATERIALS AND METHODS

Two crop rotations, wheat/medic/wheat/medic (WMcWMc) and wheat/canola/wheat/lupin (WCWL) were allocated to main plots replicated four times at Langgewens(S 33.27635^{o}; E 018,70623^{o}; altitude 191m). Each main plot was subdivided into four sub-plots allocated to four tillage treatments, namely: zero-till (soil left undisturbed), no-till (soil left undisturbed until planting and then planted with a tined, no-till planter), minimum-till (soil scarified March/April and then planted with a no-till planter) and conventional-till (soil scarified late March/early April, then ploughed and planted with a no-till planter.

One composite soil sample comprising of six sub-samples per treatment combination, was collected at 0-5, 5-10, 10-15 and 15-20 cm depth, respectively before the medic- and lupin phases during February 2012. The soil was dried at 60 ºC for 72 hours and sieved through a 2mm sieve before being analysed for resistance, $pH_{(KCl)}$, Ca, Mg, Na, K, P, Cu, Zn, Mn, B, S and C. This data were used to calculate the mean nutrient content of the 0-5, 0-10, 0-15 and 0-20 soil layers. Only organic C, pH, phosphorus, sulphur and zinc are discussed.

RESULTS AND DISCUSSION

Organic carbon content in the no-till in the WMcWMc system decreased from 2.14 % in the 0-5cm soil layer to 0.54 % in the 15-20cm layer. The mixing effect of the tine-and plough treatments in the conventional tillage treatment is clear as soil organic carbon content in the conventional-till treatment decreased from 1.38 % (0-5cm) to 0.67 % (15-20 cm). Similar trends were observed for pH, P and S. Similar responses as observed for the WMcWMc were reported for the WCWL system. However, due to annual tillage treatments in the WCWL system, the differences in data values between the 0-5 and 15-20 cm sampling depths were less, an indication of “better” mixing of the topsoil in the WCWL system.

CONCLUSIONS

The distribution of nutrients within the root zone differs and is influenced by degree of soil disturbance. Errors with sampling depth, especially under reduced tillage practices, can result in inaccurate fertilisation programmes. Care must therefore be taken to ensure accurate soil sampling to the prescribed depth.

Keywords: Phosphorous, sampling depth, soil organic carbon, stratification of elements, sulphur

EFFECT OF FARM RETAINED AND CERTIFIED CANOLA SEED ON GERMINATION AND YIELD

PJA Lombard[1] and JA Strauss[1]

[1]*Department of Agriculture, Western Cape, Private Bag X1, Elsenburg 7607*

E-mail: pietl@elsenburg.com

INTRODUCTION

Many farmers are looking to cut seed costs to reduce input costs. Consequently, some producer's plant farm retained seed from the previous season. The cost of certified seed is high and therefore a farmer can save on input cost by using farm retained seed, but the question is how the retained seed compare to certified seed in terms of germination percentage and yield. If the yield penalty is marginal (balancing loss in yield with lower input cost) then retaining seed could be a viable option.

MATERIAL AND METHODS

A conventional and Triazine tolerant (TT) cultivar was collected from trial samples after harvest. Certified seed for the same two varieties was used for the comparison. One germination and two seed yield trials with 3 replications each were undertaken with both seed sources. Seed was divided according to seed size, namely <1.7 mm (small), 1.7-2 mm (medium) and >2 mm (large). There was little difference in seed size between farm retained and certified seed. Seed size is a cultivar characteristic (Clayton et al. 2009). The TT cultivar had the highest percentage of medium (72.8%) to large seed (9%), for both farm retained and certified seed.

The germination trial was conducted in a glasshouse at a constant temperature of 20°C. Seeds were planted in both sterilized sand and normal soil at a depth of 10 mm and seedlings was counted daily during germination. The two seed yield trials were conducted at Langgewens in the Swartland and Tygerhoek in the Southern Cape. Trials were planted with a Wintersteiger-plot seeder and harvest with a plot harvester.

RESULTS AND DISCUSSION

The percentage germination in the soil (79.1%) and sand (77%) did not differ significantly. The germination of the farm retained (83.3%) seed was significantly better than the certified seed (72.3%). The conventional cultivar showed the highest percentage of small seed 51.9%), however its germination was significantly better. The germination of the medium (>1.7mm) seed (85.7%) was significantly better than the small seed (70.4%). The seed yield of the conventional cultivars was more than those of the TT cultivars, at both localities. No distinctive yield pattern was observed between farm retained, certified conventional seed and seed of different sizes. No significant yield response occurred within the TT cultivar.

CONCLUTIONS

The germination percentage of farm retained seed was better in this trial for this specific seed lots. Good germination is important but environmental, genetic and management factors play a more important role in production. These trials showed that there was little difference in yield between certified seed and farm-retained seed. However, canola out-crosses and retained seed can result in "genetic drift". Open pollinated canola seed can be retained only if extra caution is taken to ensure quality seed (>1.7mm).

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Keywords: Canola, certified seed, farm seed, yield

GROWTH AND YIELD ASSESSMENT OF WHEAT CULTIVARS IN THE SUB-TROPICAL REGION OF LIMPOPO PROVINCE

MP Mabapa[1], SK Petja[1] and E Morojele[2]

[1]University of Limpopo, Private Bag X1106, Sovenga 0727; [2]Agricultural Research Council, Small Grains Institute, Private Bag X29, Bethlehem 9700

E-mail: Paulina.mabapa@ul.ac.za

INTRODUCTION

Wheat (*Triticum aestivum*) is mainly grown as an annual winter crop planted between mid-April and mid-June in the winter rainfall areas and between mid-May and end of July in summer rainfall areas. Wheat is produced throughout South Africa with the Western Cape, Northern Cape and Free State Province being the largest producers. However, South Africa is a net importer of wheat, importing about 300 000 tons per annum (DAFF, 2010). The major producing areas in Limpopo province are Thabazimbi and Marble Hall; these areas are situated in regions where mostly sub-tropical crops are being produced. The study was aimed at identifying wheat cultivar(s), able to tolerate the environmental conditions of the sub-tropical regions.

MATERIALS AND METHODS

The experiment was conducted in July 2011 at the University of Limpopo experimental farm. Wheat cultivars: Duzi, Olifant, Steenbras, Baviaans, SST 876, SST 822, SST 806, Pan 3471, Pan 3434 and Pan 3478, were arranged in a RCBD with four replicates. The cultivars were planted at a density of 222 000 plants ha^{-1} under irrigation. Fertilizer was not applied due to the relatively high soil fertility at the site. The following data was collected; number of days to emergence, emergence percentage, 50% heading, biomass and grain yield. Data of above-ground biomass (at physiological maturity) and grain yield were determined from an area of 1 m^2.

RESULTS AND DISCUSSION

The cultivars showed significant differences (P=0.05) amongst most of the measured parameters. The cultivars had a good emergence percentage of over 80% and occurred within 9 days. Temperature was favourable for germination since it was above 10°C.The cultivars took between 87 and 97 days after planting to reach 50% heading. Baviaans had highest total biomass of 5700 kg ha^{-1} while Pan 3471 had the lowest total biomass of 2280 kg ha^{-1}. Duzi, Pan 3434, Pan 3478 and SST 876 had higher grain yield of above 5 t ha^{-1} while Olifant had the lowest grain yield of 4360 kg ha^{-1}.

CONCLUSION

These preliminary findings indicate that cultivars Duzi, Pan 3434, Pan 3478 and SST 876 had the best potential for production in the arid ecological zone with supplemental irrigation.

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Keywords: Adaptability, cultivars, grain yield and wheat

EFFECT OF BIOCHAR TYPE, PYROLYSIS TEMPERATURE AND WATER-FILLED PORE SPACE ON N_2O EMISSIONS FROM A COARSE-TEXTURED SOIL

OF Madiba[1], ZM Solaiman[2], L Barton[2] and DV Murphy[2]

[1]School of Agriculture and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, P/Bag X1106, Sovenga 0727, South Africa; [2]School of Earth and Environment, The University of Western Australia, 6009, Australia

E-mail: Freddy.madiba@ul.ac.za

INTRODUCTION

Nitrous oxide (N_2O) contributes to global warming. The incorporation of biochar is proposed to be a soil amendment which might decrease N_2O emissions from soils. However, studies of soil-biochars interactions and role of biochar pyrolysis temperature in decreasing N_2O are few. We hypothesized that a) incorporating chicken manure biochar in the soil will decrease N_2O emissions compared to wheat chaff b) increasing soil water content will increase N_2O emissions and c) biochar pyrolysed at higher temperature will reduce N_2O emissions.

MATERIALS AND METHODS

A laboratory study was conducted to evaluate effect of incorporating biochar with soil on water-filled pore space (WFPS) and also effects of dissolved organic carbon (DOC), pH, NH_4^+, and NO_3^- in soil were evaluated as well as on N_2O emissions. Treatments consisted of organic matter (OM) loaded and tilled soil (control). Two types of biochar (chicken manure [CM] and wheat chaff [WC]) that were manufactured at two temperatures (450 ^oC & 550 ^oC) were used in this study. N_2O emissions were measured at 40%, 70% and 100% WFPS.

RESULTS AND DISCUSSION

Results indicated that biochar type (CM450) compared to WC550 and soil treatment (OM loaded) significantly ($p = 0.001$) increased DOC compared to tilled control soil. Incorporating biochar also increased pH significantly ($p = 0.001$) compared to the control. Subsequently, results showed that there was a significant increase in pH of CM450 (pH 6.71), CM550 (pH 7.02), WC450 (pH 6.82) and WC550 (pH 6.99) compared to the pH of control biochar treatment (pH 6.53). Biochar significantly increased soil NH_4^+ in the CM450 (2.34 mg/kg). However, NH_4^+ decreased in the WC550 (1.13 mg/kg) compared to the biochar control treatment (0.97 mg/kg). Organic matter loaded soil increased NO_3^- significantly (35.1 mg/kg) compared to the tilled control soil (17.9 mg/kg) ($p = 0.001$). Generally, CM450 (8.2 N kg/hr) increased emissions compared to WC450 (3.1 mg N kg/hr) and WC550 (2.5 mg N kg/hr). WFPS decreased DOC, NH_4^+ and NO_3^- from 40%, 70% to 100% ($p = 0.001$). N_2O emissions in the soil without biochar were greater than those from the biochar treatments ($p=0.007$). Also emissions increased with an in increase in WFPS ($p = 0.001$).

CONCLUSION

The study provided evidence that chicken manure biochar increased N_2O emissions compared to wheat chaff biochar. Consequently, N_2O emissions increased with water content (WFPS). Both CM450 and CM550 increased emissions compared to WC biochar at both temperatures. However, further investigation is needed using isotopes to trace the role of biochars on nitrification and denitrification to determine the biological source of N_2O emissions.

Keywords: Chicken manure biochar, N_2O emissions, temperature, water-filled pore space, wheat chaff biochar

INFLUENCE OF LABLAB *(Lablab purpureus)* AND DRYBEAN *(Phaseolus vulgaris)* INTERCROPS WITH MAIZE (*Zea mays* L.) ON MAIZE GRAIN YIELD AND SOIL FERTILITY STATUS

MW Makgoga[1], IK Mariga[1] and MP Mabapa[1]

[1]*University of Limpopo, School of Agriculture and Environmental Sciences, P/Bag X1106, Sovenga 0727*

E-mail: mahubane@gmail.com

INTRODUCTION

Due to the high cost of chemical nitrogen fertilizers, intercropping with legumes has become one of the methods of getting "cheap" nitrogen for maize production. Therefore maize/legume intercropping system has become one of the solutions for food security amongst small scale maize producers and is commonly practiced throughout the Limpopo province. The objective of this study was to determine the effect of maize/dry bean and maize/lablab intercropping on maize (*Z. mays* L.) grain yield and soil fertility status.

MATERIALS AND METHODS

A dry land field experiment was conducted during 2010/2011 and 2011/2012 growing seasons at the University of Limpopo Experimental Farm. Treatments were sole maize (ZM 521, an improved open pollinated variety, ex-CIMMYT), sole lablab (Rongai, indeterminate cultivar), sole dry bean (DBS 360, indeterminate cultivar), maize/dry bean and maize/lablab intercrops arranged in a randomized complete block design with five replications. Grain yield and intercrop productivity were evaluated. Soil samples were taken at beginning and end of experiment for evaluation of macro and secondary nutrients.

RESULTS AND DISCUSSION

The 2010/2011 trial was destroyed by wild pigs. The 2011/2012 season results showed that maize/lablab intercropping lowered maize grain (1259.3 $kgha^{-1}$) than sole maize and maize/dry bean intercropping which yielded 2093.7 $kgha^{-1}$ and 2156.3 $kgha^{-1}$, respectively. Sole dry bean yielded significantly ($P<0.05$) more grain (1778.5$kgha^{-1}$) than intercropped dry bean (691.8$kgha^{-1}$). Maize/dry bean intercropping was advantageous to sole cropping as it obtained Land Equivalent Ratio (LER) of 1.42. The maize partial Land Equivalent Ratio (PLER) of maize/lablab intercropping was 0.60. Dry bean was out competed by maize as calculated aggressivity value was positive at +0.64. The soil sampling results after harvesting showed a reduction in total N, P, K, Ca, Mg and Na both sole and intercropping in all treatments.

CONCLUSIONS

Results show that maize/dry bean intercropping could be the best system to be recommended to the farmers. Intercropping with lablab is likely to significantly lower maize yield under dry land conditions.

Keywords: Dry bean, grain yield, intercropping, lablab, maize, smallholder, soil fertility

HETEROTIC GROUPING OF ARC MAIZE (*Zea mays* L.) INBRED LINES USING MOLECULAR MARKERS

TJ Malala[1], H Shimelis[2] and LA Madubanya[1]

[1]Agricultural Research Council-Grain Crops Institute P/Bag X1251, Potchefstroom, 2520;
[2]African Center for Crop Improvement, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa ;

E-mail: MalalaT@arc.agric.za

INTRODUCTION

Genetic diversity analysis and assigning inbred lines into heterotic patterns are important in crop improvement programs. Heterotic grouping helps maize breeders to predict the most heterozygotic hybrid combinations and develop efficient breeding strategies. Furthermore, it reduces the development and evaluation of unnecessary hybrids. This study was conducted to assign selected ARC maize inbred lines into heterotic groupings for effective hybrid breeding to exploit hybrid vigour.

MATERIALS AND METHODS

Genomic DNA was extracted using the CTAB method from 25 maize inbred lines obtained from the ARC germplasm bank. Lines were selected based on field evaluations of agronomic traits. PCR products were generated using 68 fluorescently labelled SSR primers pairs and separated using the ABI 3130x1 genetic analyser. Electrophoresis results were analysed using Genemapper 4.0 software (Applied Biosystems). Statistical analyses were carried out using Powermarker v3.25 using the Rogers (1972) parameter to determine genetic distances. Cluster analysis using NTSYS version 2.2 was performed to create a dendogram using the unweighted pair group method with arithmetic mean (UPGMA).

RESULTS AND DISCUSSION

Cluster analyses grouped the inbred lines into five distinctive groups i.e. $G_1$to G_5. Grouping based on SSR markers was consistent with the pedigree data of the inbred lines. G_1 contained M37w which is wildly used in SA. G_2 contained K64-22-17 that originated from K64 known for moderate drought tolerance. G_4 contained local inbred line I137TN known for its combining ability while G_5 contained B73 a well-known US inbred line.

CONCLUSIONS

The SSR markers can clustered inbred lines into distinguishable heterotic groups and can be used to eliminate redundant information created by incomplete or unknown pedigree records. This information can be used by maize breeders to establish an effective hybrid breeding program with further complimentary combining ability tests.

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ACKNOWLEDGEMENTS

The Maize Trust is thanked for their financial assistance of this study.

Keywords: Cluster analysis, genetic diversity, heterotic groups, inbred lines, SSR markers

WEED INTERFERENCE ON GROWTH AND YIELD OF KALE AND TOMATO

MG Manamela[1], TP Mahlobogoane[1] and VI Ayodele[1]

[1]*University of Limpopo, School of Agricultural and Environmental Sciences, P/Bag X1106, Sovenga 0727, South Africa*

E-mail: victoria.ayodele@ul.ac.za

INTRODUCTION

Weeds compete with crops for light, nutrients, moisture and space, which results in yield reductions. Weeds harbour insects and plant pathogens, hence making it difficult to control crop pests (Qasem and Foy, 2001). The aim of the study was to investigate the effects of weed interference on growth and yield of kale and tomato.

MATERIALS AND METHODS

Two Field studies were conducted during the 2010 growing season at the University of Limpopo experimental farm, Syferkuil. Each experiment comprised of the following treatments; W_1 = Weed free, W_2 = No weeding (Control), W_3 = One week weeding interval, W_4 = Two weeks weeding interval, W_5 = Three weeks weeding interval and W_6 = Four weeks weeding interval. Treatments were laid out in a randomized complete block design (RCBD) with four replications. The experimental unit was 2 m × 2 m. Kale seedlings were transplanted at 50 cm x 30 cm while tomato seedlings were transplanted at 50 cm x 60 cm spacing. Weeds were controlled manually using hand hoe.

RESULTS AND DISCUSSION

Weeding frequency had significant ($P< 0.05$) effect on growth and yield of Kale and tomato. Significantly ($P< 0.05$) tallest kale plant (76.90 cm) at 12 WAT was observed on no weeding plot compared to the lowest value (56.60 cm) observed on weed free plot. This might be due to shading effects by weeds which led to crop plant etiolation. With regards to tomato, significantly highest mean fruit diameter (7.80 cm) was observed on weed free plots compare to the least value of 5.40 cm observed on no weeding plot. The significantly highest ($P< 0.05$) yield per crop was observed on weed free plots. The lowest yield for tomato was observed on no weeding plot, while the lowest yield for kale was observed on one week weeding interval. Thus the two crops differ in their sensitivity to competition from weeds.

CONCLUSION

The growth and yield of kale and tomato were affected by weeding frequencies. The two crops also responded differently to competition from weeds. Both also differ in the critical period for weed removal from plots.

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Keywords: Kale, tomato, weed interference

SPATIAL VARIABILITY OF SELECTED SOIL PROPERTIES IN A DEGRADED SMALL SCALE AGRICULTURAL CATCHMENT OF SPITZKOP VILLAGE, SOUTH AFRICA

MP Maredi[1] and NN Buthelezi[1]

[1]*University of Limpopo, School of Agriculture and Environmental Sciences, Private Bag X1106, Sovenga 0727*

E-mail: maredimp@webmail.co.za

INTRODUCTION

In eroded landscapes the spatial variability of soils is largely affected by soil erosion. Understanding such variations is critical in designing sustainable soil management practices. However, the extent of the variability is poorly documented, especially in rural communities. This study investigated and mapped the spatial variability of phosphorus (P) and soil organic carbon across the degraded catchment of Spitzkop.

MATERIAL AND METHODS

The study was conducted in a 31 ha agricultural field at Spitzkop, South Africa. Thirty one soil samples were taken at 0 – 10cm from predetermined coordinates at 100m×100m grid. Soil water content (SWC), soil organic carbon (SOC), bulk density (BD), soil pH (KCl), extractable P and soil texture were determined. Descriptive statistics was used to characterise the variables while geostatistics was used to map spatial variability of SOC using Ordinary Kriging (mean error = 0.02; mean absolute error = 0.13) and P using Inverse distance weighing (mean error = 0.23 and mean absolute error = 0.52).

RESULTS AND DISCUSSION

Most soils had a low pH (4.28 - 5.54) and consequently, the very low available P (0.12 –2.97 mg/kg). The acidic conditions favoured P fixation. BD decreased in soils at the lower slope compared to those upperslope. This could be attributed to the increase in organic matter content which was supported by relatively high SOC (up to 2.27kg/m^3) from these positions. The observed spatial variability (details given on the maps) is a function of erosion deposition processes evident in the catchment. Hence the SWC was also high in areas towards catchment outlet. These differences should be considered when managing soils in landscape affected by erosion to avoid economic and environmental problems that may be caused by uniform application of inputs.

CONCLUSION

The highest variation was observed for extractable P while the lowest is for SOC. Erosion deposition processes contribute significantly to the variation of measured soil properties.

Keywords: Spatial variability, soil properties, geostatistics

TREATING KENAF (*Hibiscus cannabinus* L.) WITH N, P AND K INFLUENCED GROWTH AND YIELD

JH Marneweck[1] and D Marais[1]

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

E-mail: jacques.marneweck@up.ac.za

INTRODUCTION

Information on how nutrition impacts the growth and development of kenaf under local conditions is not readily available. Currently kenaf producers use maize and cotton fertilizer recommendations as guidelines for kenaf fertilization. Future kenaf production would benefit from crop specific fertilizer application guidelines. The aim of the pot trial study was to investigate how various N, P and K application rates influence kenaf plant height, stem diameter and dry mass. Information gathered from the pot trial can be utilized in planning field trials which in future could assist in making fertilizer recommendations to kenaf producers.

MATERIALS AND METHODS

A glasshouse pot trial was conducted (2007/2008 & 2008/2009) on the Hatfield Experimental Farm of the University of Pretoria. Kenaf "Tainung 2" seeds were sown into pots containing a sandy soil treated with various rates of N, P, and K granular fertilizer. Nitrogen treatments were split; half applied together with the P and K treatments at planting and the remainder as a top dressing four weeks after emergence. The plants were irrigated twice a week using reverse osmosis water, bringing the soil water content back to field capacity, no additional nutrients were applied. The treatments applied consisted of 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}) rates. Plant height and stem diameter were measured weekly for a period of six weeks after emergence. The plants were harvested once the final measurements where collected to determine fresh and dry mass. The data was statistically analysed using SAS.

RESULTS AND DISCUSSION

The shortest plants (±40 cm) were recorded where high levels of N but zero P and K were applied. The tallest plants (±85 cm) were recorded where high levels of N, P and K were applied. This was evident for both seasons. Stem diameter as determined at soil level were significantly affected by the N, P, K interaction effect. In the absence of P (0 P ha^{-1}), the stems tended to be thinner (decreased from ±6 to ±4 mm) as N increased regardless of the level of K. However, when 50 or 100 kg P ha^{-1} were applied, this tendency was no longer evident. The total dry mass was only significantly affected by P applications at the various levels of N and K.

CONCLUSIONS

Most of the plant growth parameters were positively affected by higher N applications rates in combination with the application of P. Treatments where no P was applied an increase in N application rate often resulted in a reduction in the specific plant growth parameter. Phosphorus applications had a more significant effect on growth and yield as compared to K. Increasing only the application of N without addressing the application of K, and more specifically P, an increase in growth and yield cannot be expected. Therefore the principals gleaned from the pot trial in regards to the N and P interactions can play an important role when planning field trials.

Keywords: Dry mass, fresh mass, plant height, stem diameter

MAIZE GRAIN YIELD COMPARISON UNDER CONVENTIONAL AND SITE-SPECIFIC NITROGEN MANAGEMENT IN A DRYLAND FARMING SYSTEM

S Mashego[1,2], BM Petja[1], ME Moshia[3], N Mailula[1], P Shaker[2], RG Lekalakala[1], SB Dikgwatlhe[1] and WG Mushadu[1]

[1]Limpopo Dept. of Agric., Directorate of Research Services, P/Bag X9487, Polokwane 0700; [2]Department of Plant Production, Soil Sc. & Agricultural Engineering, University of Limpopo, Turfloop Campus, Private Bag X1106, Sovenga 0727; [3]Department of Crop Science, Tshwane Univ. of Technology, Pretoria Campus, Pretoria 0001

E-mail: suzan.mashego6@gmail.com

INTRODUCTION

Large amount of pre-plant nitrogen (N) fertilization results in low nutrient-use-efficiency (NUE) due to poor synchrony between soil N supply and maize demand, especially during N sensitive growth stages (Cassman *et al*., 2002). Optimum maize production is dependent on adequate N availability to the crop during the critical stages (Robertson and Vitousek, 2009). High nitrogen fertilizer prices and maize yield decline are the main challenges faced by Limpopo Province farmers. The objective of this study was to compare yields of maize production under conventional and site-specific nitrogen management in a dryland farming system.

MATERIALS AND METHODS

The study was conducted in Leeukraal (24°92'S and 29°79'E) and Towoomba Agricultural Research Station, (TARS) (24°25'S and 28°34'E) in Limpopo Province. Experimental plots were laid out in a Randomized Complete Block Design, with four replications. Treatments consisted of 3 N management strategies as follows: (i) No N application (N0), (ii) Site-specific N at a rate of 21.9 kg N/ha N1) and (iii) Conventional N application at 58 kg N/ha (N2). Treatment N2 was applied at a uniform rate at planting. Sufficiency index as an indication for N deficiency was determined using CCM-200 (N sensor) for treatment N1. The sufficiency index was determined during leaf stage V6, V10 and V14, and thereafter N was applied only when needed (Thabang *et al*., 2012).

RESULTS AND DISCUSSION

At Leeukraal, maize grain yield (Kg/ha) of N1, (5171) was significantly higher than N0 (3246) and N2, (4002) (P<0.05), with no significant difference between N0 and N2. The soil moisture was sufficient to dissolve the top-dressed N fertilizer to be utilized by maize during N sensitive stages on N1 experimental units. There was no difference in maize yield (kg/ha) at TARS for N1, (4604); N2, (4736) and N0, (3947) (P>0.05). The trial at TARS experienced disturbance, as the fourth block was damaged by warthog, which may have influenced the maize development. The conventional approach required significantly higher N rates of 58 N/ha than site-specific rate of 21.9 N/ha for both sites based on soil analysis results. Site-specific approach monitors maize N status in the field and only recommends N fertilization when necessary; hence N1 required lesser N than N2 and produced significantly higher grain yields at Leeukraal.

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Keywords: Conventional farming, maize yield, site-specific N management

RESPONSE OF DRY BEAN TO MOISTURE STRESS

R Mathobo[1] and D Marais[2]

[1]Limpopo Department of Agriculture, Private Bag X9487, Polokwane 0700; [2]University of Pretoria, Private Bag X20, Hatfield 0028

E-mail: rudzanimathobo@gmail.com

INTRODUCTION

South Africa is known to be an arid country. Water efficient agriculture plays a major in producing sufficient food with less water without compromising other industries. Dry bean (*Phaseolus vulgaris* L.) is an important protein seed crop in South Africa grown mostly for human consumption. Production of beans in the rest of Africa is very less than consumption; a lot of beans are imported from other countries (DPO).Beans constitute a vital, palatable and nourishing part of the diet of many people in the country due to their high protein content. The objective of the study is to determine the response of dry beans to water stress.

MATERIALS AND METHODS

The experiment was conducted on the Hatfield Experimental Farm of the University of Pretoria under a rain shelter. Dry bean cultivar DBS 360 were subjected to four levels of moisture stress arranged in a randomized complete block design with three replications. Moisture was monitored on a weekly basis in the top 1.2 m of soil using a neutron probe. For the first 40 days the seedlings were not stressed and received enough water once a week to bring back the soil to field capacity (FC). The stress levels were as follows S1= 90% of FC from 41 DAP (Days after planting to the end of the season), S2= 40% of FC from 41 DAP to the end of the season, S3= 40% of FC from 60 DAP to the end of the season and S4= 40% of FC during flowering only. The following data was collected hundred seed mass, number of seed per plant, number of pods per plant, moisture content of the seed and seed yield during harvest. Data was analyzed using General linear models of SAS.

RESULTS AND DISCUSSION

The highest number of pods per plant resulted from treatment S1 with 22.60 pods per plant and the lowest number of pods per plant resulted from treatment S2 (13.37). The number of seeds was significantly affected by moisture stress with treatment S1 resulting in 85.93 seeds per plant while plants from treatment S3 had the fewest number of seeds per plant of 46.67. The reduction might have been caused by abscission of flowers and small pods due to water shortage. There was a significant difference ($P<0.05$) in seed yield due to water stress with treatmentS1 resulting in 3.30t/ha and treatment S3 resulting in 1.55t/ha. Shelling % and hundred seed weight were not significantly affected by the moisture stress.

CONCLUSIONS

The results suggest that dry bean is very sensitive to moisture stress when 40% of FC is introduced at 60 days after planting until the end of the season but less sensitive when stress is introduced during flowering only.

Keywords: Moisture stress, *Phaseolus vulgaris*, seed yield

INFLUENCE OF FERTILISER TYPES AND RATES ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF TWO AMARANTH SPECIES

LE Matshona[1], VI Ayodele[1] and FR Kutu[1]

[1]*University of Limpopo, School of Agricultural and Environmental Sciences, Private Bag X1106, Sovenga 0727*

E-mail: matshonale@gmail.com

INTRODUCTION

The Amaranthaceae family is generally divided into grain and leafy vegetable amaranth. Amaranths are considered as under exploited plants, therefore research efforts are focused on their biology and utilisation (Quinton, 2006; Sedibe *et al.*, 2005). The objective of this study was to determine how fertiliser application will affect the growth, yield and nutritional component of two *Amaranthus* species grown under dryland conditions in the Limpopo Province.

MATERIALS AND METHODS

Two field experiments were conducted at the University of Limpopo Experimental Farm, Syferkuil, during 2006/2007 growing season. *Amaranthus hybridus* and *A. hypochondriacus* were planted in 2 X 6 split plot factorial experiments. Two fertiliser types viz., inorganic (LAN) and organic (poultry manure) were used. Six different levels were used and they were 0, 50, 75, 100, 125 and 150 kg N $ha^{-1}$for both organic and inorganic fertilisers. Two separate experiments were conducted concurrently based on fertiliser type.

RESULTS AND DISCUSSION

Application of fertilisers (LAN and poultry manure) increased growth and yield of both Amaranth species. The interactions between amaranth and fertiliser rates were observed to be significant (P = 0.05) for plant height, leaf number and leaf area. Similar significant interactions were obtained for fresh and dry biomass of both amaranth species. The highest significant fresh mass of 91.60 g $plant^{-1}$at 12 WAP was obtained in *A. hybridus* at 150 kg N ha^{-1} (LAN) compared to 82.30 g $plant^{-1}$ obtained at the same rate for *A. hypochondriacus. A* similar trend was also observed for plants grown in soil treated with poultry manure. A varied trend was observed in the nutritional quality of amaranth in relation to rate of fertiliser application, even though the protein content was higher in plants grown on soil treated with LAN compared to those grown on soil treated with poultry manure.

CONCLUSION

Fertiliser application enhanced growth, yield and nutritional quality of both amaranth species. For poor-resourced farmers, poultry manure can be used for improved amaranth production.

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Keywords: Amaranth, inorganic and organic fertilisers

YIELD RESPONSE OF BOLTED SPIDER PLANT (*Cleome gynandra*) TO DEFLOWERING AND NITROGEN TOP DRESSING

S Mavengahama[1]

[1]*University of Zululand, Private Bag X1001, KwaDlangezwa 3886*

E-mail: sydmavengahama@yahoo.co.uk

INTRODUCTION

Spider plant or Cat's whiskers (*Cleome gynandra*) is a wild species which is commonly consumed as a vegetable in various parts of Africa. Besides its culinary value, the plant is also used as a medicinal herb for the treatment of various ailments (Opole *et al*., 1995 cited in Mauyo *et al*., 2008). Among the wild vegetables *C. gynandra* has been reported to flower prematurely. This phenomenon is known as bolting and is common in many vegetable crops. It can be as a response to temperature extremes and photoperiod and affects many other vegetables such as lettuce (*Lactuca sativa*), spinach (Royal Horticultural Society, 2012) and mustard rape (*Brassica juncea)*. In general bolting leads to production losses as crops flower before they have produced an economic yield. The objective of this study was to investigate the effect of deflowering and nitrogen top dressing on the leaf yield of bolted *C*. *gynandra* plants.

MATERIALS AND METHODS

The experiment was conducted in 2.5 litre polythene pots filled with soil in the greenhouse at the University of Zululand. Transplanting of bolted seedlings was done 5 weeks after sowing. There were two factors in this experiment: flowering and nitrogen topdressing. Flowering had two levels – not deflowered and deflowered. Nitrogen had three levels, 0 kg/ha, 150 kg/ha and 300 kg/ha lime ammonium nitrate (LAN) (28% N). Harvesting was done thrice on 23 September 2012 and 7 and 21 October. A basal fertilizer application of 2:3:2 (22) was applied pre-transplant at 5 grams per pot.

RESULTS AND DISCUSSION

Removal of flowers and nitrogen application resulted in significant increases in the fresh and dry mass of cleome leaves. Removal of flowers resulted in a 31% increase in fresh mass. The observed positive response of leaf yield to removal of flowers offers a possible way to deal with the problem of bolting. It would appear that deflowering stimulates vegetative growth.

CONCLUSIONS

Removal of flowers and application of nitrogen leads to renewed vegetative growth and increased utilisable leaf yield in C. *gynandra*.

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Keywords: Bolting, deflowering, nitrogen, *Cleome gynandra*

STRAW MULCHING AFFECTS MICROBIAL ENZYME ACTIVITY IN APPLE ORCHARD SOILS

AH Meyer[1], J Wooldridge[1], J Dames[2] and M Joubert[1]

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

E-mail: meyera@arc.agric.za

INTRODUCTION

Microorganisms are the driving forces of fundamental metabolic processes in soil involving specific enzyme activities. *ß*-glucosidase and urease are involved in the carbon (C) and nitrogen (N) cycles, respectively. Their activities potentially enable short (Bandick & Dick, 1999) and long-term (Jin *et al.*, 2009) changes in organic carbon and nitrogen pools to be determined. In this regard, their role in organic mulch decomposition has particularly been noted (Cherr *et al*., 2006). This research aimed to determine the effects of repeated straw mulching on *ß*-glucosidase and urease activities at different soil depths in relation to %C, NO_3-N, NH_4-N and pH, in an apple orchard soil.

MATERIALS AND METHODS

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

RESULTS AND DISCUSSION

ß-glucosidase and urease activities were highest in the top soil, decreasing with increasing depth. *ß*-glucosidase and Urease activities were higher in mulched than in unmulched treatments as confirmed by Discriminate Analysis (DA). The marked positive effects of mulching on microbial enzyme activities were consistent with positive mulch-induced effects on %C, NO_3-N, and pH.

CONCLUSIONS

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

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ACKNOWLEDGEMENTS

Fruitgro Science and the ARC for financial support.

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

THE EVALUATION OF NITROPHOSPHATE AS A PHOSPHATE FERTILIZER FOR THE PRODUCTION OF HIGH VALUE, SHALLOW ROOTING CROPS

M Mlalazi[1], TCL Mokoena[1], RM A'Bear[1] and JJ Bornman[1]

[1]*Omnia Fertilizer, a division of Omnia Group (Pty) Ltd, PO Box 69888, Bryanston 2021*

E-mail: mmlalazi@omnia.co.za

INTRODUCTION

Nitrophosphates are fertilizers containing nitrogen and phosphorus as well as the secondary nutrients calcium, sulphur and magnesium. Mono-ammonium phosphate (MAP) is another phosphate fertilizer supplying both N and P which is commonly used by farmers. We tested the hypothesis that the inherent efficiency of Nitrophosphate, containing nitrates and secondary nutrients, is equal to MAP when used as a preplant fertilizer on a near neutral sandy soil deficient in magnesium and sulphur.

MATERIALS AND METHODS

A greenhouse experiment was implemented using spinach in Sasolburg, South Africa to evaluate the benefits of Nitrophosphate as compared to MAP. Spinach was grown in 10L pots containing a near neutral, sandy soil low in P (pH KCl 6.2, P Bray 1-7 $mgkg^{-1}$) and placed on a rotating table. The experiment was laid out as a completely randomised design with two fertilizers, applied at four rates (0, 15, 30 and 30 kg P ha^{-1}) and replicated five times; applications of Mg and S increased with increasing applications of Nitrophosphate. All treatments received equal applications of N and K. Fertilizer treatments and supplementary calcium were thoroughly mixed with the top 15cm of the soil. Data was analysed using STATISTICA and an ANOVA was used to indicate significant effects, and then the means were separated using Fishers' least significant test at 5%.

RESULTS AND DISCUSSION

The results showed that both main effects (product and rate) and their interaction (product x rate) increased dry leaf mass at harvest ($p < 0.05$), 7 weeks after transplanting. Nitrophosphate and MAP significantly increased dry leaf mass by 52% and 10% respectively when compared to the control. In terms of rates, MAP significantly outperformed Nitrophosphate at the first level of application but depressed dry matter production at levels of P above 15 kg ha^{-1} whereas Nitrophosphate steadily increased the plant's dry matter, which is attributed to the relatively lower salinity of Nitrophosphates. The depression in growth at the higher application rates of MAP is attributed to its osmotic effect. A Relative Agronomic Efficiency (RAE) per unit of P of 176% was calculated for Nitrophosphate when the slopes of response (dry leaf mass) were compared for the two fertilizers. Tissue analysis revealed that Nitrophosphate significantly increased the uptake of nitrogen, phosphorus, potassium, calcium, magnesium and sulphur as compared to MAP, which is attributed to the presence of secondary elements in Nitrophosphate. Micronutrient uptake in the Nitrophosphate treatments was also superior to the MAP treatments most probably as a result of the highly acidic reaction of the superphosphate within Nitrophosphate.

CONCLUSIONS

We reject our hypothesis because Nitrophosphate was superior to MAP when applied as a preplant fertilizer for spinach production on a near neutral, sandy soil. The increased efficiency is primarily attributed to the presence of secondary elements in Nitrophosphate.

Keywords: efficiency, mono-ammonium phosphate, nitrophosphate, phosphates

GENETIC INTERRELATIONSHIP AMONG SOUTH AFRICAN SORGHUM GENOTYPES USING SSR MARKERS

MA Mofokeng [1], H Shimelis[1], P Tongoona[1], J Danson[1] and MD Laing[1]

[1]University of KwaZulu-Natal, School of Agricultural, Earth, and Environmental Sciences, African Centre for Crop Improvement, Private Bag X 01, Scottsville 3209, Republic of South Africa

E-mail: alina.muedi9@gmail.com

INTRODUCTION

Sorghum (*Sorghum bicolor* [L.] Moench) is one of the most important cereal crops grown for food security in South Africa. Farmers grow a number of diverse landraces of which the level of genetic diversity is not known for effective breeding. Assessing genetic relationships among accessions allows breeders to select novel genetic material for breeding (Reddy *et al*., 2012). Genetic diversity is essential for successful breeding programmes. The objective of the study was to assess the genetic relatedness among the South African sorghum genotypes using simple sequence repeats (SSR) markers.

MATERIALS AND METHODS

Eighty one landraces obtained from the Department of Agriculture, Forestry and Fisheries-Plant Genetic Resources and 22 breeding lines from Agricultural Research Council-Grain Crops Institute and the African Centre for Crop Improvement were genotyped at the Biosciences eastern and central Africa (BecA) Hub at the International Livestock Research Institute (ILRI) in Kenya. Genotypes were fingerprinted using thirty SSR primers obtained from the Generation Challenge Programme-Genotyping Support Service.

RESULTS AND DISCUSSION

The SSR primers generated a total of 3058 alleles with the allele size ranging from 90.09 to 294 bp. The numbers of alleles generated ranged from 2 to 15 with an average of 6.4 per locus. The polymorphic information content (PIC) ranged from 0.0192 to 0.8351 (average of 0.5031) with heterozygosity values of 0.0194 to 0.8524 (average 0.5483). The Euclidian genetic distances varied from 0 to 8.4 with an average of 5.67. The dendrogram based on the unweighted pair-group method with arithmetic mean revealed two distinct clusters and landraces were allocated in various sub-clusters irrespective of geographic origin and source of collection. The analysis differentiated between breeding lines and landraces. Most genotypes were closely related to the widely cultivated South African landraces Motlerane, Manthate, Maseka-a-swere, and Mammopane.

CONCLUSION

A considerable genetic diversity was established among the sorghum genotypes of which potential candidates can be used for selections and in further breeding programmes.

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ACKNOWLEDGEMENT

The Generation Challenge Programme is sincerely thanked for financial support.

Keywords: Genetic diversity, landrace, *Sorghum bicolor*, SSR markers

PRELIMINARY INVESTIGATION ON THE GENETIC DIVERSITY OF BAMBARA GROUNDNUT LANDRACES USING SEED MORPHOLOGY

MS Mohammed[1], H Shimelis[1] and MD Laing[1]

[1]*School of Agricultural, Environmental and Earth Sciences, University of KwaZulu-Natal, Private Bag X 01, Scottsville 3209, Pietermaritzburg, Republic of South Africa*

E-mail: sagir007@gmail.com

INTRODUCTION

Bambara groundnut (*Vigna subterranean* [L.] Verdc. 2n=2x=22) is one of the most important, yet underutilized, indigenous legume crops in Africa. It is rich in carbohydrates (60-70 %), protein (18-20 %) and oil (6-8 %). The crop has the foreseeable potential to boost food security, foster rural development and livelihood and support sustainable land use (Poulter and Caygill, 2006). Its improved nutritional qualities make it an ideal complement for cereal-based diets of most rural communities in Africa. The crop shows wide genetic diversity under a wide range of conditions in Africa, from marginal, drought-prone areas to those with a high agronomic potential. Systematic breeding of this crop using the landraces can utilize the agro-morphological diversity and seed morphology, as a basis for screening for enhanced productivity. The objective of this study was to investigate the genetic diversity of landrace collections of Bambara groundnut using seed morphology as the basis seed separation.

MATERIAL AND METHODS

The study phenotyped a total of 58 accessions of landraces of Bambara groundnut collected from several African countries, research centres and seed company. These include Zimbabwe, Zambia, ARC in South Africa, Pietermaritzburg farmers, Capstone Seed Company, IITA, and Kano in Nigeria. The landraces were sorted and characterized using definite seed morphology, specifically seed coat colour and pattern, seed eye colour and pattern, and hilum colour and pattern. Sorting and characterization were done by visual observation.

RESULTS AND DISCUSSION

The Bambara groundnut landraces displayed numerous variations with respect to the morphological features used for classification. The 58 accessions were systematically re-classified into 353 seed categories based on seed morphology. Initial collections from the Capstone Seed Company (CAPS) with only one seed lot had the ranked 1st and had higher percentage of morpho-types (7700.0%). This means CAPS manages and sells seeds of several seeds mixtures. The least percentage of (128.6 %) was recorded for IITA seeds ranking 7th from 14-18 morpho-types which means, some sorting was done at IITA.

CONCLUSION

Bambara groundnut landraces displayed numerous variations with respect to the morphological features used for classification. This classification of phenotypic expression will contribute to further breeding of the crop using selection for farmers-preferred traits, yield and other agronomic characteristics including resistance and drought tolerance. This could ensure proper utilization of the genetic worth of Bambara groundnut landraces.

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Keywords: Africa, Bambara groundnut, landraces, morpho-types, seed morphology

EVALUATING MUNGBEAN GENOTYPES FOR ENHANCED SYMBIOTIC N_2-FIXATION, WATER-RELATION AND GRAIN YIELD UNDER FIELD CONDITIONS AT MPUMALANGA, SOUTH AFRICA

KF Mokobane[1], C Mathews[2] and FD Dakora[3]

[1]Department of Crop Sciences, Tshwane University of Technology, Private Bag X680, Pretoria 0001; [2]Department of Agriculture, Rural Development and Land Administration, Private Bag X11318, Nelspruit 1200; [3]Department of Chemistry, Faculty of Science, Tshwane University of Technology, Private Bag X680, Pretoria 0001

E-mail: mokobanefrans@gmail.com

INTRODUCTION

Mung bean a grain legume with its origin in India, was introduced into Central and East Africa during the 17th Century (Tateishi, 1996). In South Africa, it is a high protein source, when eaten raw, sprouted or cooked, especially by the Indian community. Nutritionally, it provides important vitamins and, minerals (Anon, 2002). Little is known about the growth and dependency of mung bean on symbiotic N_2 fixation for its N nutrition in South Africa. This study evaluated plant growth, symbiotic performance and C accumulation of 15 mung bean genotypes grown in the field.

MATERIALS AND METHODS

Field experiments were conducted at the Department of Agricultures Research Station, Nelspruit Mpumalanga, South Africa during 2010 and 2011. A randomized complete block design with three replicates was used. Samples were collected at flowering, oven-dried at 60°C and dry matter yield determined. The dry matter was milled and sieved (0.85 mm sieve) for $d^{15}N$ isotope analysis. The data was subjected to analysis of variance using STATISTICA.

RESULTS AND DISCUSSION

Of the 15 mung bean genotypes tested, VC6372 (45-8-1) achieve the highest biomass (17.3 $g.plant^{-1}$), followed by VC6370A (16.6 $g.plant^{-1}$) and VC3960-88 (16.3 $g.plant^{-1}$) with VC6153B-20G showing the lowest dry matter yield (5.1 $g.plant^{-1}$). Ten of the 15 genotypes could derive over 50% of the N nutrition from symbiotic fixation. The actual amounts of N-fixed ranged from 10.4 kg $N.ha^{-1}$in VC61538-20G to 46.0 $kgN.ha^{-1}$ in VC3960-88. As a result, the genotypes with high dry matter yield accumulated the most C, while those with low biomass yielded a low C content. Six genotypes exhibited low ^{13}C discrimination (i.e. less negative), thus indicating greater water-use efficiency compared to the other genotypes.

CONCLUSIONS

The generally low amount of N-fixed was due to the small growth habit of the species (i.e. low biomass) rather than the symbiosis. Although these genotypes showed differences in C concentration, the amount of C accumulated was more marked due to the large differences in biomass.

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Keywords: grain yield, mung bean, N-fixed, N nutrition

GROWTH STAGE EFFECTS OF RYEGRASS (*Lolium* spp.) ON THE EFFICIENCY OF GLUFOSINATE AMMONIUM

BP Molefe[1] and PJ Pieterse[1]

[1]*Department of Agronomy, University of Stellenbosch, Private Bag X1, Matieland 7601*

E-mail: bontleng@sun.ac.za

INTRODUCTION

Glufosinate ammonium (GA) has been used profitably as non selective herbicide for weed control in minimum tillage systems, orchards, vineyards and chemical fallows since the mid 1980s (Steckel *et al*., 1997; Kumaratilake & Preston, 2005). Growth stage and rate appears to have an influence on glufosinate efficacy. The aim of the study was to investigate the effect of applying different doses of glufosinate ammonium to ryegrass seedlings at different growth stages in a glasshouse.

MATERIALS AND METHODS

A glasshouse study was conducted to determine the optimum time of application of glufosinate ammonium on ryegrass (*Lolium* spp). Ten ryegrass seeds were sown directly into 8 X 8cm pots and thinned to four plants per pot 7 days after planting (DAP). The design was a 5 X 5 factorial arranged in a randomized complete block with four replicates. The experimental factors were five growth stages (2, 4, 6, 8 and 10 weeks after planting) and five glufosinate rates (0, 2.5, 5, 7.5 and 10 L ha^{-1}). Herbicide treatments were applied on the same day to the different aged plants. Dry mass was measured 6 weeks after treatment (WAT) by cutting the top part of the plants and drying it in an oven at a constant temperature of 80^0C for two days. Visual estimates of the percentage control were, based on the level of leaf necrosis on a scale of 0- 100% (0 = 'no plant damage', 100 = 'total plant death') and were carried out at 3 and 6 WAT.

RESULTS AND DISCUSSION

Preliminary assessment of percentage control at 3 WAT showed interesting trends in that the percentage control by glufosinate ammonium on older plants (6-10 weeks) at 7.5 and 10 L ha^{-1} was significantly higher than on the 2 and 4 weeks old plants. The second assessment of percentage control and dry mass assessment will be determined at 6 WAT to establish whether the trend observed at 3 WAT is still evident.

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Keywords: Glufosinate ammonium, *Lolium* spp.

EFFECT OF POPULATION DENSITY AND MULCHING ON YIELD OF WILD WATERMELON

NP Mtumtum[1], AT Modi[1], NP Mkula[2] and TT Silwana[2]

[1]School of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal;
[2]Döhne Agricultural Development Institute (DADI), P/Bag X15, Sutterheim 4930

E-mail: noxmtumtum@gmail.com

INTRODUCTION

There are generally no agronomic packages available to advise traditional farmers about indigenous crops. Development of appropriate technical packages dealing with agronomic issues such as optimum population density will benefit farmers in terms of improved yields (Sangoi, 2000). Determination of optimum population density in any production system is of major agronomic importance, because population density has a direct influence on yield. Mulching provides a favourable environment for plant growth by suppressing weeds, conserving moisture and regulating temperature (Korir, *et al*., 2006). The objective of this study was to determine the effect of population density and mulching on yield of wild watermelon.

MATERIALS AND METHODS

The study was conducted at Döhne Agricultural Development Institute (DADI) in Stutterheim, Eastern Cape Province. A field study was conducted to evaluate the effects of different population densities (3000, 6000, 9000 and 12000 plants ha^{-1}) and mulching rates (0, 2.5 and 5 t ha^{-1}) using *Panicum maximum* Jacq. on growth and yield of wild watermelon as it is readily available to traditional farmers. The experiment was a randomized block design with three replications. Soil water content, temperature, vine length, number of branches and leaves per plant, fruit number per plant, fruit size, weed occurrence and yield were determined. Analysis of variance was determined using Genstat® Version 14 and means were separated by LSD at 5% level of significance. Only data on final yield are presented in this paper.

RESULTS AND DISCUSSION

The yield increased significantly ($P<0.05$) and linearly as the population density increased. This resulted in a 50.5% difference in yield between low (3000 plants ha^{-1}) and high (12000 plants ha^{-1}) population densities. Mulching, however, had no effect on yield, while there was a significant ($P<0.05$) interaction between population density and mulching, with respect to yield. In general high population density had higher total yields than low population density irrespective of mulching. This showed that plant population density had a profound influence on yield whether mulched or not (Ban, *et al*., 2006).

CONCLUSIONS

Wild watermelon yield was affected by plant population but not by mulching. Yields increased as plant density increased.

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Keywords: Citrullus lanatus L., fruit yield, mulch, plant spacing, *Panicum maximum* Jacq.

SYMBIOTIC N NUTRITION AND C ACCUMULATION OF PIGEONPEA RATOONED GENOTYPES AT NELSPRUIT, SOUTH AFRICA

KM Murwa[1], M Cherian[2] and FD Dakora[3]

[1]Department of Crop Science; [2]Department of Agriculture, Rural Development And Land Administration, Private Bag X11318, Nelspruit 1200; [3]Department of Chemistry, Faculty of Science, Tshwane University of Technology, Private Bag X680, Pretoria 0001

E-mail: kagiso.mamashela@gmail.com

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is a grain legume that was introduced from India into West Africa in 2000 BC (Van der Maesen, 1990). The crop has since spread from West Africa to other parts of Africa. The demand for pigeonpea by the Asian community in South Africa has risen considerably, and is currently met through importation. Therefore, there is a need to select locally adapted genotypes with high symbiotic performance, and increased grain yield for pigeonpea production in South Africa. This study evaluated plant growth, symbiotic performance and C accumulation of 18 monocultured pigeonpea ratoon crops.

MATERIALS AND METHODS

Plant samples were collected from the Department of Agriculture Research Station in Nelspruit, Mpumalanga, South Africa. The experiment was laid out in a CRBD with five replicates and five plants were sampled per plot. Samples were oven-dried at 60°C and weighed to determine dry matter yield. They were further ground (0.85 mm sieve) for $\delta^{15}N$ isotope analysis using mass spectrometry.

RESULTS AND DISCUSSION

Significant (p= 0.05) differences were shown for dry matter yield, N content, $\delta^{15}N$, and %Ndfa. Of the 18 genotypes tested, ICEAP 01487/16 accumulated the most biomass (607 g plant^{-1}), followed by ICEAP 01143/9 (554 g plant^{-1}), and ICEAP 01480/32 (472 g plant^{-1}), while ICEAP 014497 (173 g plant^{-1}) had the lowest biomass. Isotopic analysis generally revealed low $\delta^{15}N$ values varying from -0.10% in ICEAP 01499/7 to 0.41% in ICEAP 01508/10. The %Ndfa values also ranged from 64.89% in ICEAP 01508/10 to 73.75% in ICEAP 01499/7. The actual amount of N-fixed was much higher in ICEAP 01487/16 (143.9 N kg ha^{-1}) and least in ICEAP 01499/7 (35.88 N kg ha^{-1}). Similarly soil mineral N uptake differed markedly and ranged from 13 to 60 kg N ha^{-1} in ICEAP 01499/7 and ICEAP 01143/9 respectively. Genotypes that had low soil mineral N uptake indicated greater dependence on N_2 fixation for their N nutrition. Although these genotypes varied in C concentration, the huge differences in the amounts of C accumulated was due more to the large differences in plant biomass than the actual amounts.

CONCLUSION

This data suggest that all 18 genotypes depended more on symbiotic fixation than on soil N for their N nutrition. Genotypes with high dry matter yield accumulated the most C, while those with low biomass yielded a low C content.

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Keywords: C accumulation, N fixed, pigeonpea, plant growth

INTERSTORM DRYING EFFECTS ON SPLASH EROSION IN SOILS DOMINATED BY PRIMARY MINERALS

AD Nciizah[1] and IIC Wakindiki[1]

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

E-mail: 200905562@ufh.ac.za

INTRODUCTION

Dry periods between rainstorms may influence splash erosion through their effects on soil hydraulic properties. The extent of soil loss may however be influenced by soil properties such as texture, mineralogy and soil organic matter. The objective of this study was to determine the effects of continuous and subsequent rainfall treatments on splash erosion in 14 ecotopes dominated by primary minerals.

MATERIALS AND METHODS

Soil samples with varying texture and mineralogy were collected from 14 ecotopes. The samples were passed through a 2 mm sieve, packed into splash cups in three replicates and pre-wetted, placed in a splash plate and exposed to 360 mm h^{-1} simulated rainfall. The rainfall was either continuous or split into four storms separated by a 48 hr drying period. The sediment from each rainfall event was collected, dried and weighed.

RESULTS AND DISCUSSION

Splash erosion among the ecotopes was significantly different and ranged between 0.15 and 0.32 kg m^{-2}. Alice Jozini, which had the least hematite, clay and the highest quartz content had the highest soil loss (0.32 kg m^{-2}). The effect of intermittent rainfall on splash erosion was also significant Splash erosion was highest for the first rainfall (0.25 kg m^{-2}) whilst the second rainfall had the lowest splash erosion (0.14 kg m^{-2}). Splash erosion slightly increased after the third rainfall event (0.21 kg m^{-2}) and furthermore after the fourth (0.22 kg m^{-2}). This could be due to the formation of a seal and consolidation and reduction of erodible sediment after the first rainfall which reduced splash detachment. Interaction between ecotope and rainfall treatment was not statistically significant. Total splash erosion from the four storms was 27% higher than from the continuous storm suggesting that intermittent storms can be more damaging for the studied ecotopes.

CONCLUSION

For the studied ecotopes an increase in clay and hematite reduced splash erosion whilst an increase in quartz increased it. Short duration and recurrent storms may result in more soil loss than non-recurring and longer storms. During intermittent storms the initial storm resulted in the highest soil loss from splash than the subsequent storms due to seal.

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Keywords: Ecotope, detachment, hematite, mineralogy, quartz, texture

PROTEIN, OIL AND STARCH CONTENT OF MAIZE GROWN UNDER LOW AND OPTIMUM SOIL NITROGEN

EN Ndou[1], G Chigeza[1], LL Molefe[1], L Moremoholo[1] and K Mashingaidze[1]

[1]Agricultural Research Council-Grain Crops institute, Private Bag X1251, Potchefstroom 2520

E-mail: ndoue@arc.agric.za

INTRODUCTION

Nitrogen (N) deficiency is one of the most limiting factors in maize production and its deficiency exerts adverse effects on crop development, yield and quality especially among the small-holder farmers in sub-Saharan Africa. Increasing N supply to maize generally results in increased grain yield and protein concentration (Oikeh *et al*., 1998). Therefore, the study objective was to compare protein, oil and starch content of difference maize hybrids grown under low and optimum soil N conditions in order to identify for use as breeding checks for low nitrogen tolerance in South Africa.

MATERIALS AND METHODS

Twenty commercial white maize hybrids were grown in N depleted soils and optimum N (80kg of lime ammonium nitrate fertilizer) at Potchefstroom and Taung during the 2011/12 growing season under irrigation at a planting density of 53 000 plants ha^{-1}. An alpha lattice (0.1) design with two replications was applied. After harvest the grain was collected and analysed for protein, oil and starch content at 13.5% moisture using a Foss Infrared ^{TM} 1241 Grain Analyzer. The data were analysed with GENSTAT for Windows.

RESULTS AND DISCUSSION

In N depleted soil the protein content varied between 6.8% to 9.70% as compared to 8.70% to 11.75% under optimum soil N conditions irrespective of locality. Significant differences were shown among hybrids and between environments ($p > 0.05$). The oil content varied from 4.1% to 5.8% in N depleted soil and from 4.05 to 5.55% under optimum soil N conditions. The starch content ranged from 69.15% to 72.90% in N depleted soil and from 68.35% to 71.45% under optimum soil N conditions.

CONCLUSIONS

The results showed that there is a considerable variability for protein, oil and starch among maize hybrids in South Africa. Four maize hybrids showing high protein, oil and starch content in N depleted soils were identified and can be used as checks in the breeding programme for low N tolerance.

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ACKNOWLEDGEMENTS

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Keywords: Oil, protein, starch

EVALUATION OF EXOTIC TROPICAL SOYBEAN GERMPLASM FOR POD-SHATTERING

KM Nevhudzholi[1], LR Managa[1] and ET Gwata[1]

[1]*University of Venda, Department of Plant production, Private bag X5050, Thohoyandou 0950*

E-mail: ectgwata@yahoo.com

INTRODUCTION

Soybean (*Glycine max* L) is an important leguminous crop world-wide. Conventional production of soybean requires inoculation of the seed with commercial *Bradyrhizobium japonicum* inoculants in order to develop effective nodules thus reducing the need for applying expensive chemical nitrogenous fertilizers. In contrast, tropical (or promiscuous) soybean types are compatible with indigenous rhizobia that are ubiquitous in African soils, making them suitable for cultivation particularly in smallholder cropping systems in Africa where commercial inoculants may not be readily available. However, some tropical soybean genotypes are susceptible to severe pod-shattering leading to loss in grain yield. Information is necessary for designing an efficient soya bean breeding program aimed at introgressing pod-shattering resistance into tropical germplasm possessing otherwise a good genetic background. The objective of this study was to evaluate exotic tropical soybean genotypes for pod-shattering under natural field conditions in Limpopo.

MATERIALS AND METHODS

Thirty-five genotypes obtained from the International Institute for Tropical Agriculture (IITA) (Ibadan, Nigeria) together with a standard non-shattering check were planted at the University of Venda Experimental Station at the beginning of the cropping season in 2011. At IITA, the genotypes were classified as early or late maturing types. Each genotype was planted manually in a plot consisting of three rows each 3.0 m long and spaced at 0.45 m apart. In each row, the seed was planted at 0.1 m. The experiment was arranged as a 6x6 lattice design replicated thrice. Both the total number of pods per plant (TNPP), number of shattered pods per plant (NSPP) as well as duration to 75% maturity (75% DM) was measured.

RESULTS AND DISCUSSION

The results showed highly significant ($P < 0.01$) differences among the genotypes for pod-shattering suggesting the potential for selecting this trait in the experimental genotypes. The highest loss in grain yield per plant (73%) occurred in the early maturing types. However, there was no significant positive correlation between TNPP and NSPP. In addition, there was no seed loss due to pod-shattering in the standard check in spite of maturing early thus suggesting that the two traits are not linked.

CONCLUSIONS

The observed variation in pod-shattering among tropical soybean genotypes was useful for designing efficient genetic enhancement approaches for developing tropical soybean types that are resistant to shattering. Currently, the second phase of the investigation is deriving segregating populations from reciprocal crosses between shattering tropical types x non-shattering types in order to examine the mode of inheritance and heritability of pod-shattering as well as the number of genes involved in controlling this trait in the germplasm.

Keywords: Germplasm, pod-shattering, tropical soybean

YIELD RESPONSES OF PIGEONPEA TO INTERCROPPING WITH MAIZE UNDER VARIABLE PHOSPHORUS APPLICATION RATES

FH Nndwambi[1], IK Mariga[1] and FR Kutu[1]

[1]University of Limpopo, School of Agriculture and Environmental Sciences, Private Bag X1106, Sovenga 0727

E-mail: nndwambif@gmail.com

INTRODUCTION

Many farmers intercrop grain legumes with maize primarily to produce more food, but also to maintain soil fertility (Waddington, 1997). Although intercropping is widely practiced in the arid and semi-arid tropics, information on fertilization practices is still limited. A study was conducted to investigate grain yield performance of pigeonpea intercropped with maize under variable P application rates.

MATERIALS AND METHODS

Field experiments were conducted in the 2009/10 and 2010/11 growing seasons at University of Limpopo Experimental Farm (23°51' S; 29°42' E, 1250m.a.s.l.). Five P rates (0, 15, 30, 45, and 60 kg P ha^{-1}) were applied to both sole and pigeonpea intercropped with maize in a RCBD with 4 replicates. Additional sole maize plots were included in the experiment. Maize variety SNK 2147 and pigeonpea ICPL 87091 were sown at populations of 37037 and 111111 plants ha^{-1}, respectively. Yield data were subjected to ANOVA while treatment means were separated at 5% probability level.

RESULTS AND DISCUSSION

There was significant difference on grain yield of pigeonpea as influenced by P rates in both seasons. In addition, grain yield was ranging from 294.10 to 781.26 and 466.78 to 894.10 kg ha^{-1}during 2009/10 and 2010/11, respectively. Cropping system significantly influenced grain yield of pigeonpea in the 2010/11 season. Highest grain yield of 781.26 kg ha^{-1} during 2009/10 and 894.10 kg ha^{-1} during 2010/11 were obtained at P rates of 45 kg ha^{-1}. There was 21.83% increase in grain yield across two seasons as influenced by P rate. Intercrop pigeonpea plots achieved higher yield of 849.07 kg ha^{-1} than sole pigeonpea plots during 2010/11. Grain yield decreased by 37.1% from intercrop to sole during 2010/11 season. Interaction between cropping system and P rates exhibited significant effect on grain yield during both seasons. Intercrop pigeonpea plots and 45 kg P ha^{-1} produced highest grain yield of 922.04 and 1141.7 kg ha^{-1} during 2009/10 and 2010/11, respectively.

CONCLUSIONS

The results from the study showed that P application increased pigeonpea grain yield significantly especially in intercropped plots.

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Keywords: Grain yield, intercropping, phosphorus

EFFECT OF ROOTSTOCK ON GROWTH AND PRODUCTION OF 'FORELLE' PEAR: STETTYN RESULTS

MS North[1], K de Kock[1] and M Booyse[2]

[1]ARC Infruitec-Nietvoorbij, Stellenbosch 7600, South Africa; [2]ARC Biometry Unit, Stellenbosch 7600, South Africa

E-mail: northm@arc.agric.za

INTRODUCTION

Commercially produced European pears (*Pyrus communis* L.) are planted either on pear, (*Pyrus communis* L.) or quince, (*Cydonia oblonga* L.*),* rootstocks. Pear rootstocks are reasonably precocious, but tend to be too vigorous for intensive orchards. Quince rootstocks are more dwarfing, but degrees of incompatibility exist between pear scions and quince. The South African pear rootstock selections BP1 and BP3 tend to be too vigorous and are susceptible to pear decline, crown gall and fireblight. 'Old Home' by 'Farmingdale' (OHxF) rootstocks were selected for a range of vigour, easy propagation and tolerance to fire-blight and pear decline.

MATERIALS & METHODS

The growth and production of 'Forelle', a blushed pear cultivar, on BP1 and BP3 were compared with that on four OHxF selections (OHxF333, OHxF40, OHxF97, OHxF217) between 2002 and 2011 at Stettyn, near Villiersdorp, on deep, well drained, fine alluvium sand. Single tree plots, replicated five times, were used to record fruit per tree, yield mass per tree and fruit quality at commercial harvest time.

RESULTS AND DISCUSSION

After nine years, BP1 (214 cm^2) had the largest Trunk Cross-sectional Area (TCA), followed by BP3 and OHxF40 with OHxF333 being the most dwarfing. BP1 had the highest yield in the third (17 kg/tree) and fourth (63 kg/tree) harvests. In the fifth and final harvest, BP1and OHxF40 had the highest yield. In the fourth harvest, OHxF217 and OHxF333 (0.43 kg/cm^2 TCA) had the highest efficiency. In the fifth harvest, OHxF40 and OHxF333 had a higher efficiency than BP1 and BP3. OHxF333 had higher cumulative yield efficiency (0.84 kg/cm^2 TCA) than BP3 and OHxF97. OHxF217, OHxF333 and OHxF40 tended to have the largest fruit (~160g) and BP1 the smallest (140g).

CONCLUSION

More dwarfing and efficient rootstocks than BP1 and BP3 for 'Forelle' were evaluated. It is recommended that under conditions at Stettyn, BP1, BP3 and OHxF40 should be planted up to 1250 tree/ha, with OHxF97 and OHxF217 up to 1666 trees/ha and OHxF333 up to 2500 trees/ha

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ACKNOWLEDGEMENTS

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Keywords: Compatibility, dwarfing, yield efficiency

EVALUATING SEED QUALITY OF COWPEA (*Vigna unguiculata*)

Z Ntombela[1] and AT Modi[1]

[1]*Crop Science, School of Agricultural, Earth & Environmental Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg 3209*

E-mail: 208504646@stu.ukzn.ac.za

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important legume, especially in hot, dry tropics and subtropics of sub-Saharan Africa. However, the crop is still classified as a neglected and underutilised African indigenous species. This is because legume research focus has been mainly devoted to established legumes such as common bean and soybeans. As a result, there is limited information describing aspects of cowpea growth and seed quality. The objective of this study was to determine seed quality of two locally-sourced varieties of cowpea differing in seed coat colour (White birch and Brown birch). The hypothesis is that seed coat colour influences seed quality.

MATERIALS AND METHODS

In order to assess seed quality, standard germination (SG) and electrolyte conductivity (EC) tests were performed under laboratory conditions. The SG test was done according to the International Seed Testing Association (ISTA, 1996). Seeds were incubated in a germination chamber at 25°C for 8 days. Germination counts were taken daily until the eighth day. Seedling growth parameters, namely, shoot length, root length, root:shoot ratio, fresh and dry mass were measured on the 8th day. Germination velocity index (GVI) and mean germination time (MGT) were used to determine seed vigour. Electrolyte conductivity (EC) was determined using a CM100-2 EC Meter, using 50 seeds of each variety monitored at hourly intervals over a period of 24 hours.

RESULTS AND DISCUSSION

Brown and white birches showed highly significant differences ($P < 0.001$) with respect to dry mass, root length and shoot length. White birch was found to germinate faster (low MGT and high GVI) but had lower fresh and dry mass. This suggested that Brown birch germinated slowly, but was able to accumulate relatively more biomass for further growth, while the white variety may have lost nutrients (electrolytes) during germination. This suggestion was confirmed by the finding that the two varieties showed significant differences ($P < 0.05$) in terms of electrolyte conductivity. White birch had more electrolyte leakage than brown birch.

CONCLUSIONS

Based on the germination indices and EC results, Brown birch had better seed quality than White birch. The overall results of the study confirmed that light coloured seeds had lower seed quality compared with dark coloured seeds. Therefore it is expected that Brown birch will perform better than White birch under field conditions due to its ability to retain electrolyte nutrients during germination. There is a need to investigate the seed morphological and physiological characteristics that might be linked to electrolyte retention during germination.

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Keywords: Conductivity, germination, seed colour

SEQUENTIAL CROPPING OF COWPEA (*Vigna unguiculata*) AND MAIZE (*Zea mays* L.) IN A CONTRASTING ENVIRONMENT IN SOUTH AFRICA

LG Owoeye[1], LM Medupe[1] and JM Steyn[2]

[1]ARC-Institute for Industrial Crops, Private Bag X 82075, Rustenburg 0300, South Africa;
[2]Department of Plant Production and Soil Science, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa

E-mail: OwoeyeL@arc.agric.za

INTRODUCTION

In South Africa, maize is the main staple food crop produced under diverse conditions and environments. The principle of crop sequence relates to crop rotation and refers to crop succession on the same piece of land. N-enrichment of the soil by leguminous plants is often achieved in an intercropping or rotational system; this allows improvement of the soil structure and to reduce soil erosion.

MATERIALS AND METHODS

The experiment was a factorial design incorporated in a randomized block design with three replications. The treatments were four cowpea cultivars (PAN 311, Bechuana white, TVU 112 and CH 84) and four planting densities (10 000,15 000, 20000 and 40 000 plants ha^{-1}) and maize mono-cropping. Maize was planted following cowpeas cropping season and monocropping to determine the residual effects of different populations of cowpea.

RESULTS AND DISCUSSION

Maize grain yield and yield components responded differently to different residual effects contributed by cowpea treatments. Cob length, numbers of seeds per cob, 100 seeds per cob were significantly higher on cowpea plots compared to maize monocropping at Taung and Potchefstroom. Soil NO_3^-content of maize following cowpea also showed a considerable improvement compared to maize monocropping.

CONCLUSIONS

Results confirmed the potential of cowpea to N contribution for subsequent maize as sequential cropping system increased maize yield at both locations.
NO_3^- content was significantly affected by cropping system and this was strongly correlated with maize grain yield following cowpea cultivars at both locations.

ACKNOWLEDGEMENTS

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Keywords: Grain yield, sequential cropping, cowpea, maize, monocropping

EFFECTS OF INTERCROPPING CABBAGE WITH GARLIC FOR PEST CONTROL IN MPUMALANGA PROVINCE

ON Phosa

Department of Agriculture, Rural Development and Land Administration, Private Bag X9019, Ermelo 2350

E-mail: olivephosa@webmail.co.za

INTRODUCTION

Cabbage (*Brassica oleracea*) is one of the most popular vegetables in South Africa. Cabbage is grown country-wide but production is more centralized in Mpumalanga and KwaZulu Natal. Cabbage is attacked by several pests, including diamondback moth (*Plutella xylostella*), bagrada bug (*Bagrada hilarus*), aphids and the greater cabbage moth. Their larvae suck sap from tender growth, resulting in a whitish scarred appearance. Growth and yields can be seriously reduced by heavy infestation. The feeding activity of these pests reduces the quality of cabbage heads, and subsequently its market value, leading to financial loss to the farmer.

Allium sativum L., commonly known as garlic, is a species in the onion family, Alliacease. Garlic has been used throughout recorded history for both culinary and medicinal purposes. Garlic is easy to grow and can be grown all year round in mild climates. Garlic plants are not attacked by pests and garlic is claimed to help prevent a number of plant diseases.

Ideally, combating pests should be carried out with sustainable, non-polluting techniques, which represents a challenge to famers. Intercropping is an ancient and traditional agronomic practice which, if utilized correctly, can contribute significantly to reduced pest problems. Intercropping can be explained as a system where two or more crop species are grown at the same time during the growing season. The rationale behind intercropping is that the different crops planted are not likely to be attacked by the same pests.

The purpose of intercropping is to generate beneficial interactions between the crops, and produce greater yields on a given piece of land, Sullivan (2003). Intercropping reduces pest population because of the diversity of crops grown. Intercropping can increase yields. This poster discusses the methodology and expected outcomes of a proposed trial.

MATERIALS AND METHODS

The experiment will be conducted in a randomized complete block design with four treatments, namely cabbage only, which will be used as a control (T1), 2 rows of cabbage to 1 row of garlic (T2), 3 rows of cabbage to 1 row of garlic (T3) and 4 rows of cabbage to 1 row of garlic (T4). Each treatment will be replicated three times. Data will be collected on pest numbers, plant height, damaged leaves at harvest, canopy spread, number of damaged heads and fresh weight. Harvested cabbages and garlic will be weighed and estimates of their prices in local markets made, to calculate the effect of intercropping and cost benefit ratio among single crop and intercropped blocks. Analysis of variance (ANOVA) will be carried out to test the significance of the results.

DISCUSSION

Insecticides have been used against insects in vegetable crop production. However several problems are associated with the use of chemical insecticides. These include the development of resistance, environmental contamination, and increased health hazards to applicators and danger to consumers of high toxic residues according to Roush and Tabashnic (1990). The rapid increase in the numbers of these pests necessitates the application of high doses of pesticides (Kim *et al.,* 2001). The use of insecticides in vegetable production is on the increase despite the problems associated with their use. This study on intercropping is expected to help reduce the spread of pests and the diseases they carry in vegetable plantations. It is also expected to show that farmers can control the pests that harm crops without harming the environment.

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Keywords: intercropping, *Allium sativum* L., *Brassica oleracea*

ATTRIBUTES OF AN IDEAL GREEN MAIZE HYBRID AND PRODUCTION CONSTRAINTS IN KWAZULU-NATAL, SOUTH AFRICA

FNP Qwabe[1], J Derera[2] and P Tongoona[2]

[1]KZN Department of Agriculture and Environmental Affairs, P/Bag X004, Jozini 3969;
[2]School of agricultural, earth and environmental sciences, University of KwaZulu-Natal, P/Bag X01, Scottsville 3209

E-mail: fikile.qwabe@kzndae.gov.za

INTRODUCTION

Green maize provides food security, with potential to generate cash income for rural households in South Africa. However, research on green maize production has been scarcely reported, which negatively impacts on both variety development and management. The study aimed to determine the "ideal" quality and agronomic traits, production constraints, production trend and enterprise viability for green maize hybrids.

MATERIALS AND METHODS

A case study was conducted at Mjindi and Ndumo irrigation schemes in KwaZulu-Natal. A formal questionnaire was deployed on 64 out of 100 green maize producers interviewed in a structured, one-on-one format. The data were analyzed using the SPSS computer programme.

RESULTS AND DISCUSSION

There are limited hybrid options for green maize production due to lack of general adaptation and value for use. The current hybrids were bred for grain production and lack some key green maize traits. There are no suitable green maize hybrids which are adapted to extremely hot conditions in summer, while only two hybrids SR52 and SC701 are grown in winter. The desired traits were a combination of sweet taste, long shelf life and large ears. Complementary traits were high grain yield potential, high selling ability, flint and white grain, medium ear placement, short maturity period, medium plant height, and good roasting ability. Enterprise budget analysis revealed a total production cost of R11000 ha^{-1}. The study showed an average return of R21000 $ha^{-1}$and gross margin of R10000 ha^{-1}. Green maize was produced in two seasons per year; because the niche environment allows both winter and summer production (May-October, and November-April). Consequently, income was doubled to about R35000 ha^{-1}. Nonetheless, the study also reveals that there is room for improvement which can be achieved by growing appropriate hybrids under better management to obtain first grade green ears which can earn market premium price. The major constraints included poor cultural practices which compromised both quality and yield. Thus a declining production trend was observed.

CONCLUSIONS

There is thus a great potential for green maize production in the study area. However, lack of suitable green maize hybrids appeared to be the major hindrance. Future studies should aim to improve both the genetics and production economics. More income can be generated if desired traits for the consumers can be incorporated in hybrids to enable farmers to obtain a premium on green maize sales.

Keywords: Green maize hybrid attributes, enterprise budget

SELECTED CHEMICAL AND MICROBIAL PROPERTIES OF SOILS FROM FARMLANDS AROUND THREE MINING SITES IN PHALABORWA, LIMPOPO PROVINCE

MN Ramahlo[1], FR Kutu[1], VL Mulaudzi[2] and OHJ Rhode[3]

[1]University of Limpopo, School of Agricultural and Environmental Sciences, P/Bag X1106, Sovenga 0727; [2]University of Limpopo, School of Physical and Mineral Science, P/Bag X1106, Sovenga 0727; [3]ARC-Grain Crops Institute, P/Bag X1251, Potchefstroom 2520

E-mail: ramah@webmail.co.za

INTRODUCTION

Limpopo is one of the country's provinces with enormous mineral reserves that are currently heavily mined. Apart from the socio-economic benefits of mining, the activity often poses serious threats to natural resources and impact negatively on human livelihood. The discovery of more mineral reserves in other parts of the province points to the fact that increase hazardous by-products will continue to be produced following increased mining activities. The study therefore aimed to quantify the impact of mining activities on selected soil chemical and microbial properties.

MATERIALS AND METHODS

Fifteen soil samples were each collected from three farmlands (Hans Merensky, Mogoboya, and Leon Tom) around mining sites and from un-polluted farmland (Waterbok) in Phalaborwa, Limpopo Province. Samples were collected at 0–15, 15–30, 30–45, 45–60 and 60–75 cm depths at three sampling points for chemical characterization. Surface soil samples (0-15 cm) were used for microbial activities, which included bacterial, actinomycete and fungal counts. Chemical properties determined included pH, electrical conductivity (EC), exchangeable acidity (EA); as well as heavy metal concentration (Mn, Zn, Cu, Pb, Cd, As, Sb and Au) using EDTA extraction (Herbert *et al*., 1994).

RESULTS AND DISCUSSION

Results revealed that pH values ranged from3.94 to7.86 while EC varied between 5.92 and 7.86 mS cm^{-1}. Heavy metal contamination decreased with soil depth but increased further away from the pollution source. Significantly higher Pb, As and Sb concentrations were obtained in polluted samples than unpolluted samples; with Pb constituting the greatest pollutant across the three farms. Soil microbial levels were significantly higher in polluted than non-polluted soils except in Hans Merensky samples where bacterial and actinomycete counts were lower. The highest count of 3.82 and 6.20 CFU g^{-1} for fungi and actinomycete, respectively were both from Leon Tom farm while 6.46 CFU g^{-1}counts for bacteria was obtained from Mogoboya farm.

CONCLUSIONS

Results of the study revealed that both pH and EC values decreased marginally in polluted soils across sampling depths and points while EA was increased. High load of Pb, As and Sb were recorded at all depths on the three farms but worst on Leon Tom farm. Interestingly, fungal activity was more sensitive to heavy metal contamination than either of bacteria and actinomycetes levels.

Keywords: Mining, soil pollution, soil microbes, exchangeable acidity, heavy metals

SOUTH AFRICAN INDIGENOUS PLANTS WITH POTENTIAL FOR THE FLORICULTURE TRADE

EY Reinten[1] and JH Coetzee[2]

[1]ARC Infruitec-Nietvoorbij, P/Bag X 5026, Stellenbosch 7599; [2]P.O. Box 2086, Dennesig 7601, South Africa

E-mail: reintene@arc.agric.za

INTRODUCTION

International interest in South African indigenous floriculture increased since the middle of the eighteenth century, when Linnaeus started naming and describing the rich abundance of new botanical biodiversity, a potential source for commercialization.

OBJECTIVES

The annual Hortifair (http://www.hortifair.nl/) in The Netherlands and other Flora Expo's in Europe and Asia is proof of the demand for South African ornamentals. South African plant species well known internationally are used as the source of genetic material for ornamentals that have been hybridized, registered with plant breeder's rights and distributed world–wide. These include species of *Clivia*, *Freesia*, *Gerbera*, *Gladiolus*, *Protea, and* species and hybrids of several other genera are currently the subject of international interest among breeders.

MATERIALS AND METHODS

A study was done to review published material to provide an overview of the potential of indigenous plants and to determine the obstacles towards commercialization. New trends were observed in the market.

RESULTS AND DISCUSSION

South African plants, being a rich generic resource, have made a substantial contribution to the world trade in ornamental plants and cut flowers, and are continuing to do so. The conservation of the biodiversity by maintaining genebanks is the responsibility of society (Littlejohn, de Kock, 1997; Niederwieser *et al*., 1998). The advancement of biotechnology techniques, *in vitro* breeding techniques, transgenic plants provide additional advantages in plant breeding.

CONCLUSIONS

There is a large opportunity for commercialization of indigenous floriculture plants, restrictions being mainly funding for research. Successful commercialization of South African plants, does not only rely on their unique attractiveness, but in order to compete on international flower markets, need to be available true to type in quantities for a relative marketable period, and support an acceptable vase life. This requires sustainable propagation and cultivation practices with plant protection measures against pests and diseases in place (Reinten *et al*. 2011).

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Keywords: Commercialisation, Hortifair, new floriculture products

CHANGES IN SOIL MICROBIAL ACTIVITIES UNDER CONSERVATION AGRICULTURAL PRACTICES IN LOCAL MAIZE PRODUCTION

OHJ Rhode[1], AA Nel[1] and CC Bezuidenhout[2]

[1]ARC-Grain Crops Institute, Private Bag X1251, Potchefstroom 2520; [2]Faculty of Natural Sciences, School of Environmental Sciences and Development, North-West University (Potchefstroom Campus), Private Bag X6001, Potchefstroom 2520

E-mail: RhodeO@arc.agric.za

INTRODUCTION

Conservation Agriculture (CA) is recognised as a way to combat soil deterioration brought upon by conventional cultivation crop production. CA is governed by principles that include minimum disturbance of the soil, multiple cropping systems and a soil cover of crop residues. These practices may induce major shifts in the population and composition of soil microbial fauna and flora, which may impact on soil physical and chemical conditions such as soil structure, organic matter decomposition and nutrient cycling. Although CA has been widely studied, limited research has been done on the impact local CA maize based systems have on soil microbiology. The effect of CA systems on early soil microbial activity in local maize production was studied.

MATERIALS AND METHODS

Soil samples were taken from a field trial comprising of a sandy loam soil, with 600mm summer rainfall. Treatments consisted of conventionally and CA production systems. Soil samples were taken on maize crop during the active growing phase at 0-5, 5-15, 15-30cm depths. Microbial activities were determined using ß-glucosidase and urease soil enzyme assays. 16S and 18S rDNA based PCR-denaturing gradient gel electrophoresis (DGGE) for bacterial and fungal community profiling were done on soil samples. Data were statistically analysed.

RESULTS AND DISCUSSION

Urease activity levels differed significantly between treatments. DGGE analysis showed changes in DNA banding profiles at various depths between treatments for both bacteria and fungi.

CONCLUSIONS

Initial indications showed that changes occurred at microbial community level with different structural diversity when switching from conventional agricultural to CA practices.

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ACKNOWLEDGEMENTS

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Keywords: CA, maize production, PCR-DGGE, soil microbial enzymes

EVALUATION OF BAMBARA GROUNDNUT LANDRACES FOR YIELD TRAITS IN LIMPOPO

T Rikhotso[1] and ET Gwata[1]

[1]*University of Venda, Department of Plant production, Private Bag X5050, Thohoyandou 0950*

E-mail: ectgwata@yahoo.com

INTRODUCTION

Bambara groundnut (*Vigna subterranea*) is an important food legume in many parts of Africa. The crop is grown mainly by smallholder farmers. Apart from its ability to improve soil fertility through biological nitrogen fixation, the crop is drought tolerant. However, there are no reports of improved commercial cultivars of the crop particularly in southern Africa. In the dry land belt of the Limpopo basin, farmers rely largely on landraces that are retained annually from previous harvests. This study was designed to evaluate accessions of Bambara groundnut for agronomic performance.

MATERIALS AND METHODS

Ninety-four accessions of Bambara groundnut that were collected from local farmers were planted in observation plots during December at the beginning of the 2011/2012 cropping season. The experiment was conducted under rainfed conditions in Limpopo using an ecologically representative location at the University of Venda Experimental Station. Plant rows were spaced at 0.6 m apart and the seed in each row was spaced at 0.3 m in order to allow optimum space for each individual genotype to express its genetic potential. The experiment was arranged as a completely randomized design replicated three times. The germplasm was evaluated for yield traits including time to 75% maturity (75% DM), number of pods per plant (NPP), shoot dry weight (SDW), root dry weight (RDW) and seed size.

RESULTS AND DISCUSSION

There were highly significant ($P < 0.01$) differences among the accessions for both 75% DM and NPP. Eighteen accessions that matured within 80 d were classified as early while 31 which required at least 121 d to attain maturity were classified as late types. The remainder of the germplasm (81 to 120 d) was categorized as medium-duration type. Approximately 13% of the germplasm showed superiority in pod yield as measured by NPP suggesting that these genotypes can be exploited in future genetic enhancement of the crop aimed at developing high yielding cultivars of Bambara groundnut for growers in the Limpopo basin. Both SDW and RDW showed significant ($P<0.05$) differences among the accessions.

CONCLUSIONS

The study identified a preliminary set of accessions that merit further evaluation at more testing locations across the Limpopo basin in order to determine the stability of their performance in terms of selected yield traits.

Keywords: Accessions, Bambara groundnut, maturity, yield

COMPARISON OF COUMARIN CONTENT IN THE LEAVES AND ROOTS OF CULTIVATED *Pelargonium sidoides*

NR Sathekge[1], P Mthinyane[2] and R Kleynhans[1]

[1]Agricultural Research Council - Roodeplaat Vegetable and Ornamental Plant Institute (ARC-Roodeplaat VOPI), Private Bag X 293, Pretoria 0001; [2]University of Zululand, Private Bag X1001, KwaNdlagezwa 3886

E-mail: RSathekge@arc.agric.za

INTRODUCTION

Pelargonium species have been used in southern Africa as useful medicinal plants for many years providing relief for colic, diarrhoea and dysenteries (Watt and Breyer-Brandwijk, 1962*). P. sidoides* forms part of a group of *Pelargonium* species recognized by its red-coloured fleshy roots and pink to maroon-coloured flowers. Recently, *P. sidoides* species have become an ingredient in a number of commercially-produced medicinal remedies, including one called "Flucagon" used to treat bronchitis in both adults and children. These species are unsustainably harvested from the wild, mainly in the Eastern Cape Province of South Africa, and in the south-eastern and north-western districts of Lesotho. Cultivation can address this problem, but the active ingredients (coumarins) have to be determined to ensure the same activity in the different variants utilized for medicinal purposes.

MATERIALS AND METHODS

High performance liquid chromatography (HPLC) and aluminium thin layer chromatography (TLC) plates (20x20 cm) covered with silica gel (0.2 mm thickness) were used to detect the secondary metabolites in both leaf and root samples from nine variants of *Pelargonium sidoides*. Chemical analysis was carried out according to the European pharmacopoeia. The plates were viewed under a UV lamp and fluorescent bands were marked and captured with a Sony camera. Umckalin, esculin and scopoletin were used as standard references.

RESULTS AND DISCUSSION

The TLC plates showed that the roots contain esculin, scopoletin and umckalin (coumarin derivatives), whilst the leaves contain only umckalin and esculin. Total concentrations in the roots were much higher than in the leaves. No significant differences in the concentration of the three compounds were detected within the nine variants. HPLC results confirmed the variation in the chemical profile between the leaves and the roots.

CONCLUSION

The variants utilised in this study seem to have similar compounds and could therefore all be utilised in future research on cultivation practices. The higher total concentration of umckalin and esculin in the roots probably contributes to unsustainable harvesting from the wild. Future research should include studies on the biological activity of the coumarin derivatives.

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Keywords: Coumarins, thin layer chromatography, secondary metabolites

WEB-BASED NEAR REAL-TIME SURFACE ENERGY BALANCE SYSTEM ABOVE SHORT GRASS

MJ Savage

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

E-mail: savage@ukzn.ac.za

INTRODUCTION

Increasingly, near real-time evaporation and surface energy fluxes and micrometeorological data using relatively inexpensive methods are required, for example, for comparison with satellite flux estimates or for use when remotely-sensed estimates are compromised by the occurrence of cloud, particularly for summer-rainfall areas. In this work, methodology and results for near real-time estimation of evaporation are reported using temperature-based methods for obtaining sensible heat flux (H) with unattended updates on a web-based system.

MATERIAL AND METHODS

Net irradiance was measured above short grass at Tower 1 using a four-component net radiometer with soil heat flux measured using a self-calibrating heat flux plate. For measurement of H at Tower 2, two unshielded type-E fine-wire thermocouples were positioned at 0.46 m above the soil surface. Measurements were at 10 Hz with calculations of H by surface renewal (H_{SR}), temperature variance (H_{TV}) (including stability-correction using air temperature skewness) and SR-dissipation theory (H_{SRDT}) performed in near real-time and displayed on the Web. For SR and SRDT methods, lag times of 0.4 and 0.8 s were used. An iterative procedure, applied in the logger program, was used to calculate the air temperature ramp amplitude and the (sum of) quiescent and ramping periods from which H_{SR} and H_{SRDT} were calculated. For the TV method, the mean, variance and skewness of air temperature were calculated from high frequency air temperature measurements from which H_{TV} was calculated in near real-time. Dataloggers of Towers 1 and 2 were connected via COM ports. A radio was connected to the datalogger at Tower 1 and another radio on a nearby building which was in turn connected to a server running software for display of near real-time fluxes, including evaporation, and totals for current week/month.

RESULTS AND DISCUSSION

The SRDT method underestimated H compared to SR and TV (with skewness) methods. With adjustment for stability using skewness, the TV method showed good agreement with the SR method.

CONCLUSIONS

A web-based shortened surface energy balance system was used to determine the latent energy (evaporation) from net irradiance, soil heat flux and H, the latter using SR or TV methods. Current daily, weekly and monthly totals, updated frequently, are made available on a web-based system:
http://agromet.ukzn.ac.za:5355/?command=RTMC&screen=Energy%20balance

ACKNOWLEDGEMENTS

UKZN Teaching and Learning Office, NRF and WRC funded this research.

Keywords: Dissipation theory, surface renewal, temperature variance

THE RESPONSE OF ROSE GERANIUM *(Pelargonium graveolens)* TO PHOSPHORUS AND IRRIGATION SYSTEMS

MM Sedibe[1] and J Allemann[2]

[1]Central University of the Technology, Private Bag X20359, Bloemfontein 9301; [2]University of the Free State, PO Box 339, Bloemfontein 9300

E-mail: msedibe@cut.ac.za

INTRODUCTION

Water availability has been a prime concern in cultivated crops. Therefore, an irrigation system with a better water distribution need to be selected (Sedibe *et al*., 2006). Ebb-and-flood system has been introduced for effective sub-irrigation and nutrient delivery within a closed system (Fischer *et al*., 1990; Sedibe *et al*., 2006).

In an ebb-and-flood system salts that are not absorbed by plants accumulate in the upper part of the substrate, where most of the roots are less present. In contrast, salts tend to accumulate in the substrate when drip irrigation is used and it might require flushing or replacement at some stage. The main objective of this study was to determine the effect of P and irrigation system on yield and mineral composition of rose geranium.

MATERIALS AND METHODS

This trial was conducted at the Experimental Farm of the University of the Free State in Bloemfontein, situated at an altitude of 1351 m above sea level (29^{o}06'S and 26^{o}18'E). A split plot layout was assigned in a randomized complete block experimental design. Phosphorus treatments of 0.1, 0.8, 1.50 and 2.20 mmol L^{-1} were allocated to the main plots, while subplots were allocated to the two irrigation systems (drip and ebb-and-flood). The pH of the nutrient solution was maintained at 5.5. Dry mass, fresh mass, plant height, leaf area, oil yield and oil content were measured. Foliar minerals that were measured are Mg, Ca, P and K.

RESULTS AND DISCUSSION

The results showed that rose geranium was not significantly affected by the P levels and the interaction between irrigation systems and phosphorus. However, all the agronomic parameters measured were affected significantly by irrigation system. Drip irrigation was the best irrigation system to be selected for the production of rose geranium. Foliar Ca, P and K were affected significantly by changes of P in the nutrient solution.

CONCLUSIONS

There was no significant effect of P and the interaction on rose geranium yield. Drip irrigation need to be considered when choosing an irrigation system which will result in better dry mass.

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ACKNOWLEDGEMENTS

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Keywords: Drip, ebb-and-flood, phosphorus, rose geranium

EFFECT OF Si ON POTATO *(Solanum tuberosum)* YIELD

DG Seome[1], D Marais[1] and JE van der Waals[2]

[1]*University of Pretoria, Department of Plant Production and Soil Science, Pretoria 0001;*
[2]*University of Pretoria, Department of Microbiology and Plant Pathology, Pretoria 0001;*

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

INTRODUCTION

Potato (*Solanum tuberosum*) is an important cash crop in South Africa. This crop can also play an important role in reducing food shortages due to its high yield, nutritional value and keeping quality over a long period of time. To obtain high yield and quality, crop nutrition is of the utmost importance. One element which has been ignored so far in potato cultivation is Si. Si is abundant in the soil with no known deficiency symptoms and is therefore classified as a non-essential nutrient element. However, there have been reports of improved yield, crop protection and uptake of phosphorus due to the application of this nutrient. The aim of this study was therefore to evaluate the use of different Si sources in the production of potatoes and to report on its effect on tuber number and yield.

MATERIALS AND METHODS

A glasshouse pot trial was conducted during the 2007/08 season at the Hatfield Experimental Farm of the University of Pretoria, using BP1 as test cultivar. The trial was repeated twice during the season, using three Si sources (Calmasil slag (Middleburg) (30% Si- containing liming material), fly ash (50% Si non-liming material), and Si fume/ash (99% Si non-liming material)), lime ($CaCO_3$) and an untreated control. The Si sources and lime was applied at three levels nl. 0, 2 and 4 t ha^{-1}. Supafeed was applied during the trials to address N, P and K requirements. The treatments were completely randomized (CRD). Pots were rearranged from time to time to limit glasshouse orientation effect. Data was analyzed statistically and least significant differences (LSD) at 5% probability were determined.

RESULTS AND DISCUSSION

The number of tubers per plant, produced with either slag treatment was similar to that of the control, while the yield was much higher for the slags as compared to the control as well as the other Si sources. Apart from Si Fume 2 (4 t ha^{-1}), all the other treatments resulted in almost one tuber less per plant than the control. Despite this, the tuber mass per plant for these treatments were similar or higher than that of the control, with the exception of Si fume 1 (2 t ha^{-1}) which was lower. For all the Si sources, the higher application rate resulted in a higher tuber mass per plant as compared to the lower application rate. Lime application resulted in the fewest number of tubers and also the lowest tuber mass per plant as compared to the control and the three Si sources. Ameliorating soil with Calmasil slag resulted in similar number of tubers per plant as under control conditions, while applying this Si source resulted in higher, although not significantly so, yield per plant than any of the other treatments.

CONCLUSIONS

Calmasil slag can replace agricultural lime without decreasing the number of tubers, nor the yield per plant. To replace it or not will, however, depend on the financial feasibility thereof.

Keywords: Calmasil slag, fly ash, Si fume/ash, lime, tuber number, tuber yield

THE MORPHOLOGICAL AND GROWTH RESPONSES OF SOYBEAN (*Glycine max*) PLANTS TO ELEVATED CONCENTRATIONS OF COPPER AND ZINC IN HYDROPONICS CULTURE

PM Sepadi[1], RV Nikolova[1], HJ du Plessis[1] and F Nukeri[1]

[1]*University of Limpopo, Private Bag X1106, Sovenga 0727*

E-mail: manyakusepadi@gmail.com

INTRODUCTION

Pollution and subsequent contamination of the environment with heavy metals is generated by mining and smelting activities, long term use of heavy metal containing fertilisers, sewage sludge application and waste water irrigation in agricultural lands (He et al. 2005). Soybean is an important agricultural crop but it has been reported to accumulate high concentrations of heavy metals when grown in contaminated areas (Hang et al. 2010). In this study we determined the effects of elevated concentrations of copper and zinc on hydroponically grown plants.

MATERIALS AND METHODS

Seeds were sown in pots filled with vermiculite and kept under controlled conditions at 24°C with 16 hours photoperiod for eleven days. Uniform seedlings were selected and transferred to hydroponics culture in glass tubes filled with half strength Hoagland nutrient medium (HGM) for 3 days prior to the transfer to full strength HGM supplemented with various excess concentrations of Cu (150, 400 and 1000 µM) and Zn (300, 600 and 1000 µM). Plants grown in full strength HGM and distilled water were used as controls. Each treatment had 12 replicates and the experiment was repeated twice. Visible morphological changes were recorded on a weekly basis. At the end of the third week, growth parameters such as root and shoot length and fresh and dry weight were measured for all heavy metal treatments and the controls. Data was analysed using one way ANOVA, SPSS.

RESULTS AND DISCUSSION

Plants exposed to high copper and zinc concentrations showed severe toxicity symptoms such as chlorosis, necrosis and death of aerial parts depending on the metal concentration and duration of exposure. These symptoms appeared earlier in copper treated plants visible initially in older leaves in contrast to zinc treatments where young leaves were first affected. In both copper and zinc treatments, plants showed reduced shoot and root length, however the reduction was more pronounced in shoots. Plants treated with the highest copper concentration showed more than 80% and 60% reduction in dry shoot weight and dry root weight respectively, and severe reduction in lateral root formation. Biomass production in zinc treated plants was less affected.

CONCLUSION

Hydroponically grown soybean plants showed higher sensitivity to copper than zinc toxicity.

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ACKNOWLEDGEMENTS

The University of Limpopo is acknowledged for financial support.

Keywords: Copper, hydroponics, soybean, zinc

GENETIC DIVERSITY, CORRELATIONS AND PATH COEFFICIENT ANALYSIS IN POPCORN (*Zea mays*)

SF Shandu

University of KwaZulu-Natal

E-mail: sphiwoh@gmail.com

INTRODUCTION

Production of and the market for popcorn is limited in South Africa as a result of the lack of adapted local varieties with high genetic diversity. The number of research studies evaluating genetic variation in popcorn is also scanty. High genetic diversity among popcorn inbred lines is essential for the development of transgenic segregants and to increase the potential for future genetic gains. The objective of the study was to evaluate the level of genetic diversity among popcorn inbred lines.

MATERIALS AND METHODS

Eighty three inbred lines planted in two locations, Ukulinga (Experimental farm of the University of KwaZulu-Natal, Pietermaritzburg) and Cedara (KwaZulu-Natal Department of Agriculture) were used in the study. Using Genstat 14th edition, dissimilarity distance matrix of the top twenty inbred lines was computed based on seed yield; hierarchical cluster analysis was performed on the matrix.

RESULTS AND DISCUSSION

Large genetic diversity was observed among the inbred lines. The Inbred lines were grouped into 3 clusters at 0.98 cut off point, and 4 clusters at 0.993 cut off point, at 0.98 cut off point, inbred lines in cluster one included 11mak2-13 and 11 MAK2-18, these inbred lines were characterized by high yield which ranged from 1.5 – 2.0 t ha^{-1}. Yield of inbred lines from cluster 2 ranged from 1.3 - 1.4 t ha^{-1}, these inbred lines had moderate yield, they included 11MAK2-15, 19, and 11MAK2-20. Cluster 3 contained inbred lines with low yield ranging from 0.5 -1.1 t ha^{-1}. At 0.993 cutoff point, the inbred lines were divided into similar clusters (low yielding) than at 0.998, however the low yielding inbred lines were divided into two, those with moderately low yield and those with a very low yield which ranged from 0.5-0.8 t ha^{-1}, this included inbred line 11MAK2-3 to 4, 6 to 10, and 11MAK2-14, seed yield of moderately low yielding inbred lines ranged from 0.8 to 1.1 t ha^{-1} this included inbred line 11MAK2-1, 2, 11, 5, 12, 16 and 11MAK2-17.

CONCLUSIONS

The results suggested that, these inbred lines have different genetic backgrounds and hence the range of genetic variation is high in relation to grain yield which is also influenced by various components. Therefore, these lines can be useful in the long term improvement of popcorn genotypes and subsequently the local and adapted popcorn varieties with a wide range of genetic diversity can be developed by crossing these inbred lines.

Keywords: Genetic diversity, genetic distance, popcorn inbred lines

PRELIMINARY ASSESSMENT OF GENETIC DIVERSITY USING PHENOTYPIC MARKERS IN BAMBARA GROUNDNUT [*Vigna subterranea* L. Verdc.] GENOTYPES IN SOUTH AFRICA

A Shegro[1], WS Jansen van Rensburg[1] and PO Adebola[1]

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

E-mail: agerrano@arc.agric.za

INTRODUCTION

Bambara groundnut *(Vigna subterranea)* is one of the neglected and underutilized African legumes widely cultivated in the African continent. Understanding the extent of distribution and the nature of genetic diversity in Bambara groundnut in the country would help in selection of potential parent lines for the improvement programme. Therefore, the objective of the study was to determine the extent of genetic variability and its relationship in Bambara groundnut based on quantitative morphological traits.

MATERIALS AND METHODS

A field experiment was conducted at Roodeplaat Research Farm of the ARC-VOPI (latitude 17º 49'S, longitude 31º 04'E), during the 2011-2012 cropping season. The genotypes were evaluated using a randomized complete block design with three replications. Phenotypic data was analysed by means of ANOVA and correlations using Agrobase Generation II (2008) statistical software. Data was also subjected to Principal component and cluster analyses using the Number Cruncher Statistical System (NCSS, 2004).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant (p=0.01) differences among the Bambara groundnut genotypes for all phenotypic traits indicating the existence of high genetic variability among them. The Pearson correlation coefficient for the traits showed that there were significant (P=0.01) correlations among some of phenotypic traits. Genetic distances varied from 0.88 to 1.79 were observed in the pair-wise combinations, indicating that the Bambara groundnut genotypes were diverse for the phenotypic traits measured. Cluster analysis grouped the genotypes into three groups based on their genetic similarity.

CONCLUSIONS

Morphological characterisation and evaluation of Bambara groundnut germplasm and clustering them on the basis of their genetic similarity will help in identification and selection of the best parents for future breeding programmes in the country. Therefore, the grouping of genotypes by multivariate methods of analysis based on their similarity in the present study would be valuable in that the most important genotypes in the population may be selected for the traits of interest and also selected from different clusters for improvement programmes in South Africa.

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Keywords: Bambara groundnut, genetic diversity, genotype, phenotype

PROBABLE ERROR OF SAMPLING ON ASSIMILATED PATCHES ACROSS SITE-SPECIFIC MANAGEMENT ZONES

K Sirakalala[1] and ME Moshia[2]

[1]Dept. of Plant Production and Soil Science, Univ. of Pretoria, Private Bag X20, Hatfield 0028; [2]Department of Crop Science, Tshwane University of Technology, Private Bag X680, Pretoria 0001

E-mail: MoshiaME@tut.ac.za

INTRODUCTION

When site-specific management zones are delineated in an agricultural field for precision nutrient management, an unsupervised classification, and cluster analysis procedures using remote sensing image analysis software are performed on the basis of the assumption that grouping of data points into naturally occurring clusters would reduce within-zone variability. The objective of this study was to determine the probability of soil sampling on patches assimilated during delineation of management zones after a cluster analysis is performed.

MATERIALS AND METHODS

The study was conducted on a 5 ha (25°05'34.46''S and 28°18'30.01''E) and 24.4ha (23°59'04.61''S and 28°52'29.43''E) fields in the Waterberg district of the Limpopo Province in South Africa. A high resolution Quickbird satellite imagery of the field was used to develop site-specific management zones of the field (Digital Globe, 2010). Soils were sampled using a systematic unaligned sampling, on a 35 and 30-m grids for a 24.4 and 5 ha fields respectively. Statistical formulae were used to calculate probabilities based on percentage area assimilated during cluster analysis procedure that was performed using remote sensing mage analysis software.

RESULTS AND DISCUSSION

The results indicate that in a 24.4 ha field; there were 2.5 ha patches of high and medium zones that were all assimilated within the low zone, and thus making low zones inhomogeneous. After cluster analysis and assimilation of patches, a low zone in the 24.4 ha field increased by 45.45% (2.50ha) while the high zone was 16.4% (2.4ha) lesser in size. In a smaller field of 5.0 ha, the high zone, which was originally 3.20 ha, lost 0.37 ha (11.6%) that was assimilated in either low or medium zone. For example, should one composite sample be taken within a low zone in a 24.4ha field with an assumption that soils within a zone are homogeneous or have homogeneous yield limiting factors (Doerge, 1999); there are 45.5% chances (probability) that such a sample can be taken on assimilated patches, which are not a true representative of the low zone. When a small number of samples are collected in the zone, the sample variation will be high and the level of accuracy of the mean value may not be achieved because there is a relationship between the variance of the samples and the sample volume (Hawley et al., 1982).

CONCLUSION

Therefore, the results from this study indicate that unequal probability proportional to size sampling should be employed in sampling across site-specific management zones because the low, medium, and high zones are not of equal sizes and cannot contribute equally towards the mean values of soil samples.

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Keywords: Precision agriculture, sampling error, site-specific management zones

EFFECT OF GREENLEAF DESMODIUM AND NAPIER GRASS ON *Chilo partellus* POPULATIONS

NL Skenjana[1] and NP Mkula[1]

[1]*Döhne Agricultural Development Institute, Stutterheim, RSA*

E-mail: leo_mlanj@yahoo.com

INTRODUCTION

Chilo partellus (Swinhoe) (Lepidopteara: Pyralidae), an invasive pest, introduced from India in the early 1930's has been recorded as one of the most important pests of cereals including sorghum (*Sorghum bicolor L.*) (Moench) in South Africa (Kfir *et al*., 2002). Recently, farmers in the East London area have reported field infestations of up to 45% on sweet sorghum. An alternative to chemical control alone was investigated due to farmers' preferences. Therefore, a study was conducted to investigate whether Greenleaf desmodium (*Desmodium intortum*) can be used as a 'pusher', with napier grass (*Pennisetum purpureum)* as a 'puller' to reduce *C. partellus* populations.

MATERIALS AND METHODS

A field trial was established at Forest Vale farm in the Chintsa East areaof East London, South Africa. The trial was conducted over two growing seasons (2010/11-2011/12). The experiment was laid out as a Randomised Complete Block Design (RCBD) with three replicates and plot size was maintained at 5m x 4m. Treatments comprised of 1) sorghum spaced at 60cm (sole crop), 2) sorghum intercropped with a single strip legume spaced at 30/60cm (legume/sorghum) and 3) sorghum intercropped with double strips of legume spaced at 30/90 cm (legume/sorghum). Napier grass was planted around the trial as a trap crop in a single row at a 1m distance from the plots. Natural infestation was allowed to take place, no augmentation was done, and no other pest control measures were applied. Five samples were done in each treatment/replicate, starting at four weeks after planting. The sampling continued at two week intervals except for the fifth sampling which was done at physiological maturity. The incidence of plants exhibiting whorl damage symptoms, damaged stems, and/or dead heart was determined. Stem borers collected from each sampling were characterized into small, medium-sized and large larvae sized and pupae. Only percentage infestation will be presented.

RESULTS AND DISCUSSION

Percentage infestation decreased where sorghum was intercropped with Greenleaf desmodium in both seasons. The lowest percentage of larvae was recorded in treatments where sorghum was intercropped with double strips of Greenleaf desmodium. No pupae were recorded in treatments with double strips of Greenleaf desmodium. An increase in Greenleaf desmodium populations in the intercrops reduced the percentage of sorghum infested with *C. partellus.*

CONCLUSIONS

The intercropping of sorghum with Greenleaf desmodium, and the fencing of plots with napier grass appeared to decrease the percentage of sorghum infested with *C. partellus.*

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Keywords: Chilo partellus, Greenleaf desmodium, intercropping, Napier grass, Sweet sorghum

OMNISAP® AS A MANAGEMENT TOOL FOR MAIZE CULTIVATION

S Smalberger[1] and S Michau[1]

[1]*Omnia Fertilizer, A Division of Omnia Group (Pty) Ltd, Box 69888, Bryanston 2021*

E-mail: ssmalberger@omnia.co.za

INTRODUCTION

An OmniSap® analysis or wet mass extraction is used to evaluate the plant sap for its nutrient content. Since yield potential is determined during the early growth stages, OmniSap® is used as an early warning system to detect nutritional deficiencies that could limit the ability of the plant to reach its full yield potential. Although other diagnostic tools exist to determine the nutritional status of grain crops (like soil samples, dry leaf analyses, N tester, etc.) the OmniSap® analytical tool offers an analysis of 12 essential and beneficial elements (nitrogen, phosphorus, calcium, magnesium, sulphur, sodium, zinc, manganese, copper, iron, aluminium, and silica) and is evaluated against norms developed per crop for each individual growth stage. This study aims to demonstrate the ability of an OmniSap® analysis to predict yield whilst in the vegetative growth stage of maize.

MATERIALS AND METHODS

Factor analysis was used to reduce the 12 essential nutrients in OmniSap®, into fewer factors. The factors explaining >75% of the variation in the OmniSap® analyses were selected and were used in discriminant analysis to predict yield.

Data was used from rainfed maize trials conducted during the 2009/2010 summer season, which entailed zinc (Zn) nutrition evaluation block trials in the Lichtenburg district of the North West province. In this case a randomised complete block design was followed with four Zn liquid fertilizer application rates, and 8 replicates. Secondly, strip trials conducted during the 2007/2008 to 2010/2011 seasons to evaluate the efficiency of compound fertilizer coated with micronutrients were used. This entailed data from 17 farms in the Free State, North West and Mpumalanga. Thirdly, data from nutrient surveys that were conducted in 2003, 2004 and 2005 in the Free State, North West and Mpumalanga regions was used.

RESULTS AND DISCUSSION

Discriminant analysis successfully predicted yield in the North West Zn trial in 72% of the cases. Yields from the North West strip trials were predicted 76% correctly, while in Mpumalanga and Free State yields were corrected predicted in 75% and 73% of the cases, respectively. For the nutrient surveys, yields in the North West were predicted 68% correctly, 66% correctly for Mpumalanga and 81% correctly for Free State. In above demonstrative examples, only nutrient related factors were used in the discriminant analysis and factors like weather, pest and disease which also effect maize yield, are not included in this model.

CONLUSIONS

In conclusion OmniSap® analysis is thus an effective tool to predict yield based on nutrition status in the vegetative growth stage of maize.

Keywords: Maize, manganese, nutrients, OmniSap®, plant sap, predict

THE SUITABILITY OF SWEET SORGHUM FOR BIO-ETHANOL PRODUCTION

JL Snijman[1], H Terblanché[1] and N Shargie[1]

[1]ARC, Chris Hani Avenue, Potchefstroom 2531

E-mail: snijmanw@arc.agric.za

INTRODUCTION

Sweet sorghum has many potential advantages such as high water, nitrogen and radiation use efficiency and as food and feed in various combinations such as syrup for human consumption and animal feed high in proteins and carbohydrates. The aim of the study was to evaluate sweet sorghum cultivars, high in fermentable free sugars, for their adaptability to various climatic conditions for ethanol production.During the 2011/2012 production season 22 genotypes were evaluated under dryland conditions for climatic adaptability and ethanol production in Rustenburg, Potchefstroom and Bethlehem.

Potchefstroom has a temperate climate with a clay loam textured soil. Rustenburg has a sub-tropical climate and a soil with a clay content of more than 40%. Bethlehem has a temperate climate, although cooler than Potchefstroom and a sandy soil texture. Fertilizer applied at Potchefstroom: 150 kg ha^{-1} Superphosphate and 380 kg ha^{-1} Ammonium sulphate; Rustenburg: 200 kg ha^{-1} MAP and 220 kg ha^{-1} LAN(28); Bethlehem: 320 kg ha^{-1} LAN(28). Weeds were manually removed. Bulldock (pyrethroid) was applied to combat stalk borer. The biomass yield, syrup yield and sugar content were measured and statistically analysed.

Potchefstroom received its normal amount of rain while drought prevailed at the other localities.

RESULTS AND DISCUSSION

Results on the biomass, sugar content (brix) and syrup yield of the 22 genotypes showed variance amongst localities, indicating a genotype x environment interaction. Syrup yield showed a more stable distribution amongst the genotypes. Genotypes which performed the best were S40220, S016, BMR, S007 and S008.

Genotypes HG (28.13 t ha^{-1}), S016 (118.43 t ha^{-1}) and S40220 (41.82 t ha^{-1}) ranked the best for biomass yield. There is no significant difference (l.s.d. 13.000 and F pr. 0.361) regarding biomass yield amongst the top five genotypes at Bethlehem and Rustenburg. At Potchefstroom the differences amongst the genotypes were caused by the variance in stems diameters. Rainfall and dry spells during pollination and seed setting were timeous, therefore the good yields. Hotter conditions and heavy soils at Rustenburg caused wilting in the sensitive growing stages. At Bethlehem the sandy soils and especially the cooler conditions affected the sweet sorghum's production.

Brix indicates very little variance Genotypes S120 (19.58%), S40229 (22.22%) and S859 (22.21%) ranked the best for sugar content. The brix readings of the top five genotypes indicate no significant difference (l.s.d. 5.824 and F pr. 0.130), indicating a very stable sugar production.

CONCLUSIONS

The requirements for the production of bio-ethanol are a biomass yield of at least 50 t ha^{-1} and sugar content levels of at least 16%. Above 16% more sugars per unit of syrup can be fermented which makes ethanol production more cost effective. Ten of the 22 genotypes meet the requirements for optimum ethanol production.

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Keywords: Biomass, brix %, dryland, genotypes, sweet sorghum, syrup

THE RESPONSE OF MAIZE TO SELECTED MIXED RATIOS OF ORGANIC AND INORGANIC FERTILIZERS AT NOLUKHANYO PROJECT IN NDLAMBE LOCAL MUNICIPALITY, EASTERN CAPE

M Solontsi[1], PR Celliers[2], Z Mkile[3] and S Mhlontlo[4]

[1]Department of Rural Development and Agrarian Reform, P/Bag X1, Bathurst 6166; [2]NMMU, P.O. Box 7700, Port Elizabeth 6031; [3]Department of Rural Development and Agrarian Reform, Döhne ADI, P/Bag X15, Stutterheim 4930; [4]Department of Rural Development and Agrarian Reform, P/Bag X5262, Mthatha 5099

E-mail: mhlangabezi.solontsi@agr.ecprov.gov.za

INTRODUCTION

Smallholder farmers in the Eastern Cape apply kraal manure as a fertilizer to address challenges of declining soil fertility emanating from practices of monoculture and continuous cropping which results in removal of important soil nutrients (Yoganathan *et al*, 1998). At times, they apply manure, inorganic (NPK) fertilizer and gromor as lone fertilizers or tend to mix manure or gromor with inorganic fertilizers without any basis. Hence a study aiming at achieving efficient use of inorganic fertilizers, manure and gromor either as lone fertilizers or mixed with one another in maize production was established.

MATERIALS AND METHODS

A dry-land field experiment, arranged in an RCBD with 3 replicates and treatments where cattle manure, fertilizer and gromor were mixed at different ratios as 10% fertilizer+90% manure; 25% fertilizer+75% manure; 50% fertilizer+50% manure; 100% Fertilizer; 100% Manure; 10% fertilizer + 90% Gromor; 25% fertilizer+75% Gromor; 50% Fertilizer+50% Gromor; 100% Gromor and a Control (Nothing applied), was conducted at Nolukhanyo project in Ndlambe local Municipality and maize PAN 6480 was used as a test crop. Manure, gromor and soil were analyzed for chemical composition. Data recorded involving number of days to tasselling, silking and pollen shed, number of rows per cob, number of kernels per row, cob length, grain yield and residual soil nutrients were subjected to Genstat Version 14.1 for statistical analysis.

RESULTS AND DISCUSSION

There was no significant difference observed on number of days taken to tasseling, silking and pollen shed, number of rows cob^{-1}, number of kernels $row^{-1}$and cob length except for the control which took more days. Lowest residual P and highest residual K, Ca and Mg were obtained when manure was applied while the control had lowest available K, Ca, Mg and Zn. Highest maize grain yield of 3 425 kg ha^{-1} was obtained on 50:50 manure and fertilizer ratio and the lowest 128 kg ha^{-1} was received from the control.

CONCLUSION

Maize took fewer days to tasselling, silking and pollen shed and the yield was improved significantly when manure and fertilizer were mixed at 50:50 ratio. Improved P absorption by plants was observed when 100% manure was applied.

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Keywords: Inorganic fertilizer. maize yield, manure, residual nutrients

AN ECONOMIC EVALUATION OF SHORT ROTATION CROP AND CROP/PASTURE SYSTEMS AT TYGERHOEK IN THE SOUTHERN CAPE

JA Strauss[1] and WR Langenhoven[1]

[1]*Department of Agriculture Western Cape, Private Bag X1, Elsenburg 7607*

E-mail: johannst@elsenburg.com

INTRODUCTION

The rural economy of the southern Cape is driven by dryland agricultural production. Deregulation and the withdrawal of state subsidies for commercial agricultural production since 1994 have exposed commercial agriculture to competitive international markets. These negative economic forces together with the increasing input costs, as well as highly variable and unpredictable climatic conditions have had severe negative impacts on the southern Cape. In this poster we undertook an economic analysis of a large-scale, long-term experiment that compares several crop and crop/annual legume pasture rotation systems. This was done in an attempt to determine the potential economic implications of the most feasible short rotation systems for the southern Cape.

MATERIAL AND METHODS

Conservation agricultural (No-till) practices were used for all crops in the experiment. Data from the 2002 to 2010 seasons were included in the analysis. Five rotation systems were compared, viz. 1-pure lucerne pasture (Luc), 2-PPC , 3- PCPC, 4- PPCC, 5- pure cash crop sequences (where P = pasture (medic/clover mixture), C = cash crop). System 2 and 4 consisted of 4 different cash crop variations each, system 3 had 5 different cash crop variations and system 5 consisted of two different pure cash crop sequences. Cash crops included wheat, barley, canola, lupin, oats and a variable option. Each rotation system tested was fully represented in each year and replicated twice. The experimental design therefore took into account the short- and long-term crop X climate interaction.

RESULTS AND DISCUSSION

Crop yields depend largely on seasonal climatic conditions and on management inputs such as fertilization; weed, pest and disease control; and rotation or crop sequence. Average wheat production tended to be highest in systems where wheat followed a single year of legume pasture, followed by wheat after canola. In the short term gross margins differ among rotation systems both within and between years. This was, in part, due to large variations in allocatable variable costs, in commodity prices and crop yields.

CONCLUSIONS

The gross margins obtained were the most stable in the continuous lucerne and the two continuous cropping systems. The data obtained from the Tygerhoek trial support the common practice of combining a 6 year cropping phase with a 6-year lucerne phase on farm. From the results it is clear that a combination of these two systems would potentially show more stable gross margins than the systems tested in the trial.

Keywords: Crop rotation, gross margin, no-till, sustainability

IMPACT OF CONVERSION FROM VIRGIN SOIL TO NO-TILL CULTIVATED PASTURE ON THE SOIL ORGANIC MATTER POOL

PA Swanepoel[1], PR Botha[1], CC du Preez[2] and HA Snyman[2]

[1]Western Cape Department of Agriculture, Outeniqua Research Farm, PO Box 249, George 6530; [2]University of the Free State, PO Box 339, Bloemfontein 9300

E-mail: pieters@elsenburg.com

INTRODUCTION

Kikuyu (*Pennisetum clandestinum*) pastures over-sown with ryegrass (*Lolium* spp.) by means of no-till methods form the base for milk production in the southern Cape of South Africa. When virgin soils are converted to agricultural soils, it is usually associated with a loss in soil organic matter (SOM) (Tornquist et al. 2009). However, kikuyu-ryegrass pastures usually increase SOM. The aim of this study was to evaluate the impact of management of no-till kikuyu-ryegrass pastures on the SOM pool when compared to similar soil in a native state.

MATERIALS AND METHODS

Two sites on the Outeniqua Research Farm (George), with different land uses, were compared. Site 1 consisted of an irrigated kikuyu-ryegrass pasture managed for 20 years as a no-till pasture. Site 2 was a conserved, undisturbed area. Soil samples consisted of 20 subsamples, sectioned into depth increments of 100 mm up to 300 mm deep. Active C was colorimetrically determined by oxidation with $KMnO_4$, microbial biomass C (MBC) by microwave irradiation and easily oxidizable soil C with the Walkley-Black technique. Total SOM content was estimated by loss-on-ignition (LOI). The data was normally distributed, but consequently to heterogeneous variances a significance level of P=0.01 was established *a priori*.

RESULTS AND DISCUSSION

Active C content was low in virgin soil (between 0.406 ± 0.003 and 0.523 ± 0.001 g m^{-3}). The active C concentration in the cultivated pasture soil was ca. 40 times higher (P=0.01) than in the virgin soil in the 100 and 200 mm soil layers, but similar in the 300 mm soil layer. Soil C decreased with depth, but at a higher rate in the cultivated pasture soil than in the virgin soil. The highest levels of soil C was detected in the 100 mm layer for cultivated pasture soil at 34.30 ± 0.72 kg m^{-3} and differed from that of the virgin soil at 17.09 ± 0.60 kg m^{-3} (P=0.001). MBC in cultivated pasture soil was higher in the 100 and 200 mm layers (P=0.001). MBC in the cultivated pasture soil decreased sharply in the 300 mm layer to a point where it was similar to that of the cultivated soil (P=0.092). Mean LOI of the cultivated pasture soil was higher in the 100 and 200 mm layers than in virgin soil layers (P=0.001), but similar in the 300 mm layer.

CONCLUSIONS

The SOM related parameters (active C, LOI, MBC and soil C) behaved similarly by showing higher values in the cultivated pasture soil surface layers than in the virgin soil, decreasing with depth until values became similar in the 300 mm soil layer.

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Keywords: Active C, loss-on-ignition, microbial biomass C, soil C

RAINWATER STORAGE IN THE SOIL, AS AFFECTED BY TILLAGE AND CROP ROTATION IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

NA Swiegelaar[1], J Labuschagne[2] and JE Hoffman[1]

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

E-mail: nina.swiegelaar@gmail.com

INTRODUCTION

Global warming and the rapid growth of the world's population place increased pressure on the agricultural sector to ensure food security while protecting natural resources. With the global population estimated to increase by 65% within the next 50 years, finding methods to optimize the use of natural resources, including rainwater, to ensure food security is crucial. The Western Cape is one of the most important dry-land wheat producing regions in South Africa. The aim of this study was to investigate effectiveness of rainwater storage as influenced by tillage practices and crop rotation.

MATERIALS AND METHODS

The study was a component study within a long-term tillage/cropping system trial. Three crop rotations, continuous wheat (WWWW), wheat/medic/wheat/medic (WMcWMc) and wheat/canola/wheat/lupin (WCWL) were allocated to main plots replicated four times at the Langgewens Research Farm, Moorreesburg, Western Cape. Each main plot was subdivided into four sub-plots allocated to four tillage treatments. For the purpose of this study only two of the four tillage treatments were evaluated namely: no-till – soil left undisturbed until planting and then planted with a tined, no-till planter and conventional tillage – soil scarified late March/early April, then ploughed and planted with a no-till planter. A Diviner 2000 capacitance meter was used to determine the soil water content at weekly intervals throughout the growing season in the top 200 mm of the soil. Differences in the volumetric soil water content between no-till and conventional tillage practices as well as six cropping sequences (three crop rotations with all sequences present every season) were evaluated for the period May 2012 to late August 2012.

RESULTS AND DISCUSSION

Results show that for the rotation system in which wheat was planted after canola, the no-till system retained on average 10.16 mm more water in the upper 200 mm of soil than the conventional tillage system. In the cropping sequence where wheat followed lupin, 7.34 mm more water was retained under no-till compared than with conventional tillage. No differences in soil water content for the no- and conventional-till treatments were recorded for both the wheat-medic and wheat monoculture cropping systems.

CONCLUSIONS

Preliminary results show that differences in soil water retention capacity due to tillage varied between cropping systems. More data is needed to quantify the exact amount of water retained under different tillage - and cropping systems in the Swartland sub-region of the Western Cape.

Keywords: Crop rotation, water retention capacity

EVALUATION OF SWEET SORGHUM FOR DROUGHT PRONE ENVIRONMENTS

CJ Terblanche[1], NG Shargie[1] and JL Snijman[1]

[1]ARC-Grain Crops Institute, Private Bag X1251, Potchefstroom 2520

E-mail: ShargieN@arc.agric.za

INTRODUCTION

In recent years, climate change, energy security and sustaining rural economies have become important research priorities. Bioenergy can play an important role in energy security, environmental safety and rural development. Most of the bioenergy at present is based on ethanol production from grain and sugar crops. However, new dedicated feed-stocks are needed for sustained biofuel production and to minimize competition between fuel, food and feed production. Dry-matter production, grain yield and composition of plants are important for potential use as biofuel crops. Sweet sorghum (*Sorghum bicolor* L. Moench) exploits all these possibilities due to its inherent capacity to produce high biomass and store sugars in stalks. Sweet sorghum can be grown in a very wide range of soils and climates (tropical, sub-tropical and temperate regions). However, drought is the major abiotic stress limiting the productivity of this crop. There is a wide array of genetic diversity and germplasm collections in sweet sorghum. Multilocation testing of promising genotypes at different locations provides researchers an opportunity to identify cultivars suitable for drought adaptation. The objective of the project was to identify genotypes tolerant to terminal moisture stress.

MATERIAL AND METHODS

Sweet sorghum germplasm consisting of 14 genotypes (2 ICRISAT-India; 2 UANL-Mexico; 10 ARC- SA) were grown under field conditions at Potchefstroom and Taung, South Africa, during the 2011/12 season. The experimental design used was a randomised complete block design with three replications. Each genotype was grown in a plot of four rows of 4-meter in length, with an inter-row spacing of 0.75 m and a within row spacing of 0.15 m. Moisture stress was imposed by withholding, need based irrigation, 55 days after sowing until harvesting. Data on plant height, stalk yield, juice volume, brix percentage and sugar yield were measured at physiological maturity, the stage at which the stem sugar content is the highest. Juice volume and brix value were used to estimate sugar yield. ANOVA was applied using GenStat 14th edition and genotype means were separated using LSD.

RESULTS AND DISCUSSION

The genotypic differences were significant for sugar yield and related traits (plant height, brix percentage and juice yield) under terminal moisture stress condition. The Juice yield (20.78 t/ha) of Honey Green, commercial SA hybrid check and SSLD-007 (18.13 t/ha) differed significantly ((P=0.05) from all the other genotypes. When comparing the most important selection criteria, sugar production per ha, genotypes SSLD-007 and Honey Green produced highest sugar yield, 2.09 and 2.05 t/ha, respectively. At Taung, highest sugar yield was obtained by Honey Green (3.22 t/ha), SS-120 (2.21 t/ha) and SSLD-007 (1.72 t/ha), and all three differed from each other significantly (at 5% probability level).

CONCLUSIONS

The evaluation of the sweet sorghum germplasm showed a large and significant variation in morphological and sugar yield traits associated with biofuel production. Three genotypes, Honey Green, SSLD-007 and SS-120 were found to be superior in sugar yield at both locations. Genotypes with greater potential for biofuel and terminal drought tolerance were identified and are being further investigated.

ACKNOWLEDGMENTS

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Keywords: Biofuels, drought stress, juice volume, sugar yield, sweet sorghum

CONTROL OF COUCH GRASS *(Cynodon dactylon)* WITH GLYPHOSATE

VL Thaphathi[1] and EA Nemadodzi[1]

[1]*Agricultural Research Council*

E-mail: thaphathiv@arc.agric.za

INTRODUCTION

*Cynodon dactylon i*s the most serious grass weed occurring worldwide in a range of crops. The grass spread mainly by means of an extensive system of stolons and underground rhizomes. When ineffectively controlled, it can easily re-establish from viable rhizome and stolon pieces. Soil cultivation alone cannot control *C. dactylon* effectively and could increase weed density by spreading shorter rhizomes. Successful control of *C. dactylon* can be obtained by using systemic foliar-applied herbicides which are translocated to vegetative propagules in sufficient quantity to prevent re-growth. The objectives of the study was to evaluate the effects of different glyphosate rates on *C. dactylon* and the lowest rate which is relatively cost effective and gives better control over hand weeding.

MATERIALS AND METHODS

The trial was conducted at a farm in Diekeng, J S Moroka municipality in Mpumalanga. The farm had been under *C. dactylon* infestation for a period longer than 5 years. The seedbed was cultivated with a mouldboard plough and disced. *C. dactylon* was allowed to re-generate until the seedbed surface was satisfactorily covered. Glyphosate (MAMBA 360 SL) was applied at six rates, 750, 1056, 1140, 2160, 3360, 4320 g ai ha^{-1}, with a weedy check and hand hoeing. *C. dactylon* was sampled eight times throughout the observation period using a 50cm x 50cm quadrant placed randomly in a plot, with initial *C*. *dactylon* biomass collected before spraying. The sampling intervals were 0, 9, 22, 32, 45, 60, 88, 129 days after spraying. Dry biomass was determined at 40ºC for 48 hours and weighed. The experimental design was a completely randomized design (CRD) with four replications.

RESULTS AND DISCUSSION

Biomass of *C. dactylon* did not increase in the herbicide treated plots 9 days after spraying indicating that the grass stopped growing due to the effect of the herbicide. A linear increase in biomass was observed in hand hoed plots indicating insufficient control over time. Although biomass of *C. dactylon* on hand hoed plots was lower compared to glyphosate treated plots at 22 days after spraying, this does not mean that hand hoeing did a better job in controlling *C. dactylon.* The *C. dactylon* in the hand hoed plots was actively growing whilst that in glyphosate treated plots was less fit. As the rate of Glyphosate increase the effect on *C. dactylon* also increases. Glyphosate controlled *C. dactylon* for a period of time long enough to allow crop establishment until harvesting with no or less competition from the grass and therefore, promoting a shift in weeds occurrence. The cost of *C. dactylon* control with glyphosate increased with the increase in application rates while the cost of a single hand hoeing doubled that of the highest application rate of glyphosate per hectare.

CONCLUSION

Biomass of *C. dactylon* showed significant variation in relation to different application rates of glyphosate. Except for the 750 g ai ha^{-1} application rate, glyphosate showed increased *C. dactylon* control due to a lagging growth response of the grass. Hand weeding proved to be less effective and more costly compared to the use of glyphosate to control *C. dactylon.*

Keywords: Cynodon dactylon, glyphosate

EVALUATION OF TWO BIOSTIMULANTS (VERMI PASTE AND SEAWEED EXTRACT) ON TRANSPLANT SHOCK AND GROWTH PERFORMANCE OF POTTED TOMATO PLANTS CV 'MONEY MAKER'

SS Turketti[1] and E Lötze[1]

[1]*Dept Horticultural Science, Univ Stellenbosch, Private Bag X1, Matieland 7602*

E-mail: elotze@sun.ac.za

INTRODUCTION

Previous reports showed a reduction of transplant shock of tomato plants after dipping the seedlings in a seaweed extract (Robertson-Anderson *et al*., 2001) as well as an increase in plant growth and yield after treatment with seaweed extracts (Nzanza *et al*., 2001). This trial was conducted to evaluate 'Vermi paste', which is a paste derived from vermi-compost extract which was claimed to have similar characteristics in terms of plant response, against another biostimulant, seaweed extract.

MATERIALS AND METHODS

The trial was conducted at the Welgevallen Experimental Station, Stellenbosch University, in an open glass house. Tomato seedlings (var. 'Money Maker') from a commercial nursery were transplanted on the 12th of October 2012 into 3 litre bags with drip irrigation. The average seedling height at planting was 7.7 cm above ground. An adapted version of Long Ashton complete nutrient solution (Mortimer *et al*., 2012) was applied to all treatments, commencing about 10 days after transplanting (22nd of October 2012).

The first experiment addressed the efficacy of the biostimulant as foliar fertilizer. Vermi paste (Wurmbosch) was compared against Afrikelp (a registered organic foliar product) and a control with no foliar applications. The roots of tomato seedlings were dipped in a solution of Afrikelp (1:500) according to (Robertson-Anderson *et al*., 2001) and Vermi paste (100%) according to the manufacturer's recommendations. The seedlings were then transplanted into bags filled with sand, in a randomised complete block design with 10 replicates of one plant each. Weekly spray applications were applied according to previous reports for Afrikelp (1:500) and Vermi paste according to the manufacturer's recommendation of 1:10. The control received neither dip nor foliar application.

The second experiment addressed the effect of biostimulants used in combination as soil and leaf applications. The trial layout was a randomised complete block design with 10 replicates of one plant each. Vermi compost (Wurmbosch) and commercial compost (DoubleGrow Compost) were added to sand in a 1:2 ratio and compared to the control treatment of sand only. A weekly foliar application of Vermi paste was applied to all treatments in the same concentration (1:10).

RESULTS

Approximately eight weeks after planting (end of November 2012), fruit will be harvested and thereafter, plants from both trials will be harvested destructively. Fruit number, mass and firmness will be measured. Plant height (shoot length), root length and stem diameter, leaf area per plant and root mass will be recorded. Results will be analysed statistically with ANOVA using the PPROC GLM statement in SAS 9.1.

Keywords: Biostimulants, tomato, growth, vermi paste

PATHOLOGICAL REACTIONS TO HOST PLANTS OF NINE *Heterodera schachtii* (Schmidt 1871) POPULATIONS IN THE WESTERN CAPE

J van Zyl

Department of Agriculture, Western Cape, Private Bag X1, Elsenburg 7607

E-mail: jacquesvz@elsenburg.com

INTRODUCTION

Population variability and genetic diversity exists within nematode species. The difference in species may be subtle, for example the ability to adapt to environmental stimuli or more pronounced true genetic variability. The aim of this study was to determine whether pathological differences as to their effect on host plants within the nine populations of *H. schachtii* found in the greater Cape Flats did exist in order to effectively manage and control *H. schachtii* in the Western Cape.

MATERIALS AND METHODS

Soil samples were obtained from nine localities in the greater Cape Flats, these localities were as follows Durbanville, Guguletu, Khayelitsha, Kraaifontein, Kuilsriver, Lynedoch, Mitchell's Plain, Philippi and Stellenbosch. Each population was cultured separately on cabbage in a temperature controlled greenhouse (25 ± 2°C). Difference in virulence between the nine populations was investigated on beetroot and cabbage, the root and top weight of the host plants were determined 50 days after planting. Two-week old seedlings of beetroot and cabbage were planted in 14 cm plastic containers, inoculated with 250 juveniles per plant and grown in a greenhouse (25 ± 2 °C) in order to determine root penetration. To determine possible differences between the nine sampled *H. schachtii* populations in the rate of juvenile emergence from the cysts, two-week old cabbage seedlings were planted and inoculated with 500 juveniles per plant.

RESULTS AND DISCUSSION

Virulence: Top and root weight of beetroot and cabbage infected with the Lynedoch and Philippi populations of *H. schachtii* were significantly (P=0.05) lower than those of the other populations. The Philippi population showed significantly (P=0.05) higher Pf/Pi ratios (27) and had the highest number of eggs per cyst.

Root penetration: Significantly (P=0.05) more *H. schachtii* juveniles from the Lynedoch and Philippi populations penetrated the seedling roots of beetroot and cabbage. The Kraaifontein population had the lowest penetration level on beetroot and the Mitchell's Plain population the lowest penetration on cabbage roots.

Juvenile emergence: The number of juveniles emerging from cysts from Lynedoch and Philippi were higher (P=0.05), over a shorter period of time, especially during the first seven days. During the first seven days 67.6% of the total number of juveniles emerged from the Lynedoch population and 65.5% from the Philippi population.

CONCLUSION

The results demonstrated physiological variation in *H. schachtii* populations as far as virulence, root penetration and larval emergence from cysts on hosts were concerned. The results indicate that the Lynedoch and Philippi populations were different from the other populations in their effect on selected hosts. The physiological variation between populations will influence the host-parasite relationship and new management strategies must be considered to control of *H. schachtii* in these areas. Control should be determined in line with the most virulent populations as such populations will eventually spread into the cultivation areas.

Keywords: Heterodera schachtii, juvenile emergence, pathological reactions, root penetration, virulence

THE EFFECT OF SOIL TILLAGE AND CROP ROTATION ON YIELD COMPONENTS OF WHEAT IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

JD Wiese[1], J Labuschagne[2], AG Agenbag[1]

[1]University of Stellenbosch, Department of Agronomy, Private Bag X1, Matieland 7602;
[2]Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607

E-mail: johanl@elsenburg.com

INTRODUCTION

Soil chemical, physical and biological characteristics is influenced by tillage practice and cropping system. The alternation of these characteristics will influence crop development and productivity. The purpose of this study was to quantify the effect of different cropping systems and tillage practices on the establishment, yield components and grain production of wheat.

MATERIALS AND METHODS

This research was conducted during 2010 and 2011 das a component study within a long term crop rotation and soil tillage trial. Three cropping systems, wheat monoculture (WWWW), lupin-wheat-canola-wheat (LWCW) and wheat-medic rotation (McWMcW) were allocated to main plots. Each main plot is subdivided into four sub-plots allocated to four tillage treatments namely, zero-till (ZT) –soil left undisturbed and planted with starwheel planter, no-till (NT) – soil left undisturbed until planting and then planted with a no-till planter, minimum till (MT) – soil scarified March/April and then planted with a no-till planter and conventional tillage (CT) – soil scarified late March/early April, then ploughed and planted with a no-till planter. Ten 1m plant samples were collected and number of ear-bearing tillers.m^{-2} just before harvesting, number of spikelets per ear, number of grains per ear and mass per grain for individual plants recorded.

RESULTS AND DISCUSSION

In both years covered by the study, the McWMcW system resulted in higher (P=0.05) mean numbers of ear bearing tillers (185 and 188 ear bearing tillers.m^{-2} in 2010 and 2011 respectively) compared to 151 and 134 ear bearing tillers.m^{-2} recorded for the WWWW systems in 2010 and 2011 respectively. ZT resulted in less (P=0.05) ear bearing tillers compared to the tillage treatments during both years covered by the study. Mean number of spikelets was only affected by cropping system in 2011 with the McWMcW (17.7 spikelets) outperforming the WWWW (17.2) and LWCW (16.9) systems. CT resulted in the highest (P=0.05) number of spikelets (18.6) in 2010 and 2011 (18.2) although not significantly higher than MT (17.7) in 2011. Cropping system did not influence the number of grains per ear. Increased soil disturbance resulted in increased (P=0.05) number of grains per ear with ZT the lowest (45.6) and CT highest at 54.7 grains.ear^{-1}during 2010. ZT (40.1) resulted in the lowest (P=0.05) numbers of grains.ear^{-1}in 2011, with no differences recorded in number of grains.ear^{-1} in the NT, MT and CT. Individual grain mass was not influenced by cropping system in 2010, however in 2011 differences (P=0.05) were recorded between the WWWW (0.042g), LWCW (0.040g) and McWMcW (0.038g) systems. Grain mass recorded for the ZT in 2010 was lower (P=0.05) than the other three tillage treatments. Contrary to 2010, the highest mean individual grain mass was found in the ZT (0.042g). Mean grain mass did not differ between the NT and MT but CT (0.039g) produced grain of the lowest individual mass.

CONCLUSION

The study showed that no trend exists between cropping system and the number and weight of individual grains produced. The McWMcW system however tends to produce more tillers.m^{-2} as well as more spikelets.ear^{-1} compared to the other systems studied. Tillage treatments that include soil disturbance tend to results in more spikelets- and grains.ear^{-1}.

Keywords: Ear bearing tillers, grains.ear^{-1}, spikelets

THE EFFECT OF INOCULATION AND SEAWEED EXTRACT (KELPAK) ON HOST PLANTS OF SELECTED LEGUMES

JP Zwane[1], C Mathews[2] and FD Dakora[3]

[1]Department of Crop Sciences, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa ; [2]Department of Agriculture, Rural Development and Land Administration, Private Bag X11318, Nelspruit 1200, South Africa; [3]Department of Chemistry, Tshwane University of Technology, Private Bag X680, Pretoria 0001, South Africa

E-mail: jabulile.pinky@gmail.com

INTRODUCTION

Seaweed is a macroscopic marine algae that is found at the bottom of coastal water or float around such environments. Its extract (commercially available as Kelpak) contains macro elements, trace elements and organic compounds and has been used as an ameliorant to promote growth and functioning of various agricultural crops (Cristobel, 2008). No reports were found on Kelpak's role in promoting growth and symbiotic functioning of N_2-fixing legumes in order to improve soil fertility. This study assessed the effect of seaweed extract application with and without inoculation to symbiotic performance and growth of selected legumes. This abstract is on preliminary biomass results.

MATERIALS AND METHODS

Cowpea, Bambara groundnut, mung bean, groundnut, common bean and soybean were sampled at Nelspruit and Mzinti Research Centres in Mpumalanga Province, South Africa. There were four treatments namely; inoculated with Kelpak, Kelpak, inoculated and un-inoculated without Kelpak. 40 ml of Kelpak was diluted to 20 000ml of water. 5000 ml of the diluted Kelpak was applied per plot after germination. Another 5000 ml was applied per plot about 7 days after the first application. A randomized complete block design was used with four replicates. There were 96 plots. Four plants per plot were sampled at physiological maturity, separated into shoots, roots, and nodules, oven- dried, weighed, finely ground and packaged for analysis of ^{13}C and ^{15}N isotopes.

RESULTS AND DISCUSSION

The data ($p=0.05$) revealed increased nodulation as well as greater biomass in nodules, roots and shoots of cowpea, groundnut, common bean and soybean with inoculation and application of Kelpak at the Nelspruit experimental site. At the same site, application of Kelpak without inoculation increased nodulation as well as biomass in nodules, roots and shoots of Bambara groundnut and common bean. Inoculation and application of Kelpak to Bambara groundnut, mung bean, groundnut, common bean and soybean at Mzinti experimental site enhanced nodulation and significantly increased biomass of nodules, roots and shoots of the test legumes.

CONCLUSSIONS

The data showed that Kelpak improved nodulation and enhanced root and shoot growth in both locations.

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Keywords: Inoculation, Kelpak, seaweed extract