

Abstracts: Poster Presentations

ADVANCES IN COWPEA IMPROVEMENT AT THE AGRICULTURAL RESEARCH COUNCIL (ARC)-GRAIN CROPS INSTITUTE, POTCHEFSTROOM, SOUTH AFRICA

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INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the important food security grain legumes in South Africa. It is also a neglected crop despite its contribution to human diet among rural families, soil fertility and use as livestock feed. None availability of adapted high yielding cowpea varieties is a major constraint to cowpea production in South Africa. Therefore, the main breeding objectives were to introduce desirable and specific germplasm accessions with good agronomic characteristics from IITA, Nigeria, and to develop well adapted high-yielding cowpea genotypes with acceptable seed size and maturity. This paper discusses significant achievements made to evaluate introduced breeding lines and develop new cowpea genotypes suitable for the South African environment and market.

MATERIALS AND METHODS

New international breeding lines were introduced in 2005/06 from IITA, Nigeria, to fast track the development of well adapted, high yielding cowpea varieties. The germplasm lines were constituted into four trials (early maturity (27 lines), dual purpose (66), vegetable (10) and fodder (13)) and evaluated at three locations (Taung, Potchefstroom and Limpopo) under supplementary irrigation during 2006, 2007 and 2008/2009 growing seasons. The trials were laid in a randomized complete block design (RCBD) with four replicates. Data were collected on grain and fodder yields, number of days to 50% flowering and maturity, as well as 100 seed weight. In addition, five segregating populations (F2 (7 families), F3 (169), F4 (55) and F5 (21)) developed from crosses made from selections were planted and managed through single plant selections in 2008. At plant maturity promising lines were selected from the breeding lines as well as from segregating populations. Data from breeding lines were analysed using Genstat application and procedure.

RESULTS AND DISCUSSION

Significant progress was attained in germplasm introduction, evaluations and selections. Several promising lines were selected from the different cowpea breeding line trials and segregating populations. These selections formed the breeding stock for the development of new breeding populations (early maturity, dual purpose, vegetable and fodder cowpea).

CONCLUSIONS

Three cowpea varieties ARC-09-001 (dual purpose), ARC-GCI-Cp27 (white seeded) and ARC-GCI-Cp76 (brown seeded) were nominated for release and registration. ARC-GCI-Cp27 and ARC-GCI-Cp76 are early maturing and grain variety. Selections from segregating populations were advanced to the next generation for composition into different cowpea types (early and medium maturity), dual-purpose, vegetable and fodder.

Keywords: Dual-purpose, fodder, germplasm, grain yield, *Vigna unguiculata*

ROOT PRUNING OF MAIZE DUE TO DRYING OUT OF TOP SOIL DURING A VERY WET SEASON

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INTRODUCTION

During a very wet season in Zimbabwe, late planted maize in particular, developed an abnormal leaf symptom. Many leaf samples from farmers were sent in to the central Soil Testing laboratory in Harare, all with very similar symptoms. It was noticed that the occurrence was country wide, on all varieties, on all soil types and within the same time frame. Investigations were carried out to ascertain the cause of the phenomenon.

MATERIALS AND METHODS

Farm visits were made to see firsthand and to take soil and leaf samples. Also at Harare research station, identical symptoms were seen on many hybrid breeding lines – mostly on female and hybrid but not so much on male plants. Soil and leaf samples were taken in triplicate from demonstration plots for some varieties. Seasonal weather patterns for different parts of the country were collated. An attempt was made to examine roots of affected plants after harvest at Harare Research Station.

RESULTS AND DISCUSSION

The leaf symptom occurred on a single pair of leaves towards the middle or top of the nearly mature plants where leaf tips yellowed and edges of leaves were chlorotic or purplish. All plants in a field were affected. The symptom was similar to potassium (K) shortage in some cases. Farmer's soil analyses did not indicate K deficiency or any obvious cause. Similarly, leaf samples of good, bad, and dissected leaves showed shortages of some elements in affected leaves or parts e.g. lower but not always deficient levels of zinc, magnesium and manganese. Analysis of samples from Harare Research Station similarly failed to satisfactorily explain the symptom. The start of the rains was late, so much maize was late planted in December. Throughout the country heavy cloud and rain occurred for the month of December with a short rainless, sunny period in the first 10 days of January after which symptoms were reported. Rainfall in December averaged 375 mm, in January 106 mm and February 253 mm.

CONCLUSIONS

Soil and plant analyses showed that lack of plant nutrients, acidity or excess were not the cause of the unusual symptom. After collating weather data, it was concluded that shallow or adventitious root systems must have developed under continuous rain conditions that were later pruned or desiccated during the January warm spell due to drying out of the surface soil.

REFERENCES

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Keywords: Chlorosis, drying, leaves, maize, roots, topsoil

CONSERVATION AGRICULTURE EFFECTS ON SOIL FERTILITY AFTER FOUR YEARS OF MAIZE-OAT AND MAIZE-GRAZING VETCH ROTATIONS IN A WARM TEMPERATE CLIMATE OF SOUTH AFRICA

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INTRODUCTION

Knowing a cropping system's effects on soil fertility is important, particularly in evaluating and refining management strategies. Soil fertility is influenced by several biological, chemical and physical factors and processes, and is not a distinct property of the soil. There is therefore not yet consensus on the exact parameters for measuring soil fertility and chemical analyses for soil fertility are expensive, especially for resource poor farmers. Planting some indicator plants and measuring their growth is one practical and low cost procedure for measuring soil fertility in an indirect way. It makes intuitive sense that if a soil supports good plant growth and development, then it must be highly fertile. In this experiment, maize is chosen as bio-test indicator plant for evaluating the effects of oat and grazing vetch winter cover crops on soil fertility in a conservation agriculture (CA) system.

MATERIALS AND METHODS

The study is taken from the context of a four year old crop management field trial, originally established to evaluate winter cover crop biomass yield, weed suppression and maize yield response in an irrigated maize-based smallholder CA system of the Eastern Cape (EC). The treatments consisted of maize-oat, maize grazing vetch rotations and a maize-weedy winter fallow control, with and without fertilizer applied to the maize at 60 kg N/ha. This gave a 3 × 2 factorial laid out in a randomized and complete block design. Soil samples were collected during the fourth year of continuous practice, packed into pots and maize planted in a glasshouse. Leaf area development, shoot and root biomass yield, SPAD meter chlorophyll, and plant height were measured 28 days after emergence.

RESULTS AND DISCUSSION

There were significant differences between soils in all parameters, and winter cover crop type × fertilizer interactions were generally not significant ($P > 0.05$). Regardless of fertilization, grazing vetch gave better maize growth responses than either oat or weedy fallow. There was a positive curvilinear response of biomass to levels of soil organic matter, mineral N and Bray 1 P ($r^2 = 0.67, 0.92$ and 0.8). These correlations were stronger than those obtained with maize plants grown in the field, most likely due to the presence of other non experimental variables in the field such as winter cover crop mulch effects on weeds, moisture and temperature.

CONCLUSIONS

In the low fertilizer input maize-based smallholder CA systems as found in the EC, the bio-test can be a reliable and more sensitive indicator of the soil fertility status.

ACKNOWLEDGEMENTS

Funded by the NRF and the Govan Mbeki Research and Development Centre (GMRDC)

Keywords: Bio-test, conservation agriculture, soil fertility, winter cover crops

NEMATODE COMMUNITY ASSEMBLAGES IN POTATO FIELDS AND EFFECT OF COVER CROPS ON ROOT-KNOT NEMATODE POPULATION LEVELS

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INTRODUCTION

Since potato is an integral part of the daily diet of humans, cost-effective and sustainable approaches is crucial to protect the crop against pests and diseases. Plant-parasitic nematodes (PPN), particularly root-knot nematodes (RKN), are an economically important constraint that adversely affects the quality of potato. The removal of red-band Class 1 nematicides forces producers to improve environmental and food safety. Cover crops offer potential for the management of PPN due to their effects of biofumigation and increase in soil-organic material. The aims of this study were to: i) assess the status of PPN and non-parasitic nematodes (NPN) in fields of potato producers and ii) evaluate the effect of cover crops on RKN population levels in a potato-cropping system.

MATERIAL & METHODS

For the survey, root and soil samples were obtained from 31 fields in the Christiana area (Western Free State) where potato is planted. PPN and NPN were extracted using the sugar-flotation method and Prominence Values (PV) calculated. Cultivars Nemat and Calienté (*Brassica* sp.) and Terranova and Doublet (*Raphanus* sp.) were planted on a field where high RKN population prevailed during October 2010. The trial layout was a randomised complete block design (RCBD) with five replicates and six treatments. An untreated control as well as the synthetic nematicide ethylenedibromide (EDB) was included. During flowering of the cover crops, the aerial parts were slashed, chopped and ploughed into the soil. After being left for four weeks, potato was planted on all plots.

RESULTS

Meloidogyne spp. was predominant in soil and root samples, followed by *Pratylenchus* spp. Second-stage juveniles (J2) from an unknown cyst (Heteroderidae) were also identified. NPN present in soil samples mainly consisted of bacteriovores. High RKN population levels were evident in roots/tubers of all four cover crops during the 50% flowering stage. No significant difference in RKN egg and J2 numbers/50g potato roots was evident between the cover crop treatments in the follow-up potato crop. EDB treated plots maintained significantly lower RKN egg and J2 numbers/50g roots compared to other treatments. Population levels were, however, still high in the EDB treatment.

CONCLUSIONS

RKN poses a real problem in fields of potato producers in the Christiana area. Cover crops evaluated, did not result in a reduction of RKN numbers. Changes in terms of the NPN community structure were, however, observed.

ACKNOWLEDGEMENTS

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Keywords: Biofumigation, *Brassica*, cover crops, survey, sustainable

FIRST REPORT OF A NEW LEPIDOPTERAN MAIZE SEEDLING PEST, *Classeya tenuistriga* (HAMPSON)

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INTRODUCTION

Reports of localised outbreaks of an unknown pest on maize seedlings were received from the Kamberg area in KwaZulu-Natal during the 2008/9 growing season. Damage of a similar nature was again reported in 2009/10 resulting in collection and identifying of the pest. The species was identified as *Classeya tenuistriga* (Hampson) (Lepidoptera: Crambidae). This species was described in South Africa during the 1880s (Günther *et al.*, 1898). The original description was made by George F. Hampson as *Crambus (Propexus) tenuistriga* (Lepidoptera: Pyralidae) from specimens collected near Pretoria. The objective of the study was to identify the specie damaging maize seedlings in the Kamberg area.

MATERIALS AND METHODS

Larvae were collected in the Kamberg area during the 2009/10 season and reared on maize seedlings in an incubator at 25°C and 60%RH to identify the species. Moths were identified by Dr. Martin Krüger of the Transvaal Museum, Pretoria. Damage was largely only observed on non-Bt parts of maize fields. This created the opportunity to assess the impact of *C. tenuistriga* on Bt and non-Bt maize. This was done by inspected seedlings for symptoms. Six groups of seedlings, each consisting of 100 maize seedlings were inspected for damage in both the Bt and non-Bt refuge areas of the field. A two-by-two contingency table was used to determine significance of the Chi-square value at $P=0.05$.

RESULTS AND DISCUSSION

Fully grown larvae of *C. tenuistriga* were between 10-15 mm long. Larvae curl up tightly when disturbed. Larvae develop into pupae inside pupal cells in the soil. It is, however, uncommon for Crambidae species to live and pupate in the soil. Larvae emerge from soil and sever seedlings at or just below the soil surface. Neat round holes are chewed into seedling stems. Above ground symptoms are initial wilting of the central whorl leaf which is followed by wilting of the entire plant. Damage differed significantly between the Bt- and non-Bt maize seedlings with less damage recorded in the Bt field (0.7%) compared to the non-Bt refuge area (22.5%, Chi-square = 137.51; $P<0.00001$).

CONCLUSIONS

Although there are several coleopteran species that attack maize seedlings, this is not the case with Lepidoptera. The only other species of Lepidoptera known to attack maize during the seedling stage in South Africa is *Ephysteris promptella* (Staudinger) (Gelechiidae).

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Keywords: *Classeya tenuistriga*, Crambidae, Bt maize, maize seedling pest

POSSIBLE INTERACTIONS BETWEEN NEMATODE AND STEM BORERS WHEN PRESENT ON GENETICALLY MODIFIED MAIZE

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INTRODUCTION

The root-knot nematode *Meloidogyne incognita* and maize stem borer *Busseola fusca* occur throughout the maize production area of South Africa and often at the same site. Genetically-modified (GM) maize has become a popular tool for the management of *B. fusca* (Bt-maize) and weeds (herbicide tolerant maize). There is no information on possible interactions between GM maize, root-knot nematodes and insect pests of this crop. The objective was to assess the comparative population development of *M. incognita* and *B. fusca*, in single and combined infestations on genetically modified maize.

MATERIALS AND METHODS

The maize iso-hybrids tested in a mini field trial at Potchefstroom ARC-GCI were DCK8010 (conventional), DKC8012B (Bt), DKC8030R (Roundup Ready) and DCK8040BR (both Bt and RR). All four cultivars were subjected to the following treatments:

- i) an un-inoculated control,
- ii) inoculated with ± 5000 *M. incognita* eggs and J2 per plant at planting,
- iii) inoculated with 10 neonate *B. fusca* larvae per plant six weeks after emergence and
- iv) inoculated with both *M. incognita* and *B. fusca* at the same rates and times indicated in treatments ii and iii.

Each treatment consisted of 15 plants and was replicated six times. *M. incognita* and *B. fusca* assessments were made nine weeks after planting and the data were subjected to factorial analysis of variance.

RESULTS AND DISCUSSION

DCK8012B controlled *B. fusca* 100% when *M. incognita* was not present. However, in the presence of *M. incognita* a small percentage of *B. fusca* larvae survived on DCK8012B. *B. fusca* survival differed significantly between DKC8010 and DKC8030R if only *B. fusca* larvae were present on maize plants, but no significant difference was observed between these two hybrids if *B. fusca* and *M. incognita* were both present. *B. fusca* showed a significantly higher survival rate on DKC8030R in the presence of *M. incognita*. *M. incognita* numbers increased significantly on DKC8012B and DCK8040BR compared to DCK8010 and DKC8030R. In the presence of *B. fusca*, however, *M. incognita* numbers decreased significantly on DKC8012B but remained significantly higher than those on DCK8010. Although *M. incognita* numbers on DCK8040BR remained significantly higher than on the other iso-hybrids in the presence of *B. fusca*, there was no significant increase compared to those on the same iso-hybrid inoculated only with *M. incognita*.

CONCLUSIONS

M. incognita numbers increased significantly on maize hybrids that contained the Bt gene, while its numbers decreased significantly on the Bt hybrid in the presence of *B. fusca*. *B. fusca* numbers were significantly higher in cultivars that did not contain the Bt gene. *B. fusca* survival was higher on the iso-hybrid that contained the herbicide tolerance gene in the presence of nematodes. The interaction between nematodes and *B. fusca* on GM hybrids deserves further investigation.

Keywords: *Busseola fusca*, genetically modified maize, interaction, *Meloidogyne incognita*

RESEARCH AND TRAINING INTERVENTIONS TO ADDRESS ROOT-NEMATODE PROBLEMS IN SUBSISTENCE AGRICULTURE

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INTRODUCTION

Plant-parasitic nematodes (PPN), particularly root-knot nematodes (RKN) cause significant damage to a variety of crops in intensified cropping systems of local subsistence farmers. The presence of weeds further aggravates nematode problems since a wide variety of species of the latter acts as host for PPN. In addition, local producers do not perceive PPN as a constraint to crop production or ultimately to food security. The aims of this research were to i) assess the PPN problem associated with crops and weeds grown in fields of subsistence farmers, ii) investigate management strategies to reduce PPN population levels and iii) disseminate information about the importance and impact of PPN to members of relevant communities and extension officers.

MATERIAL & METHODS

Nematode samples were obtained from crop and weed plants in fields of small-scale farmers across South Africa since 2005. On-farm trials were subsequently conducted to evaluate the effect of various environment-friendly management strategies on PPN. Treatments included soil solarisation, manures, compost, *Tagetes* spp. mulches and intercropping, use of *Brassica* spp. as well as certain biological control agents. Knowledge gained during research activities was disseminated to extension officers and community members by means of interactive farmers' and information days.

RESULTS

RKN were identified as the predominant spp., infecting crops as well as weeds. Inclusion of *Brassica* spp., as well as solarisation resulted in superior control (> 90 %) of RKN. Solarisation combined with either cow manure or compost also resulted in substantial reduction in RKN population levels. *Tagetes minuta* mulch reduced RKN population levels by 71 % and intercropping with *T. erecta* by 30-90 %. Cow and chicken manure amendments reduced RKN significantly compared to the untreated control treatments in the respective trials.

CONCLUSIONS

An increased awareness of members of remote, resource-poor communities with regard to the importance and impact of PPN was evident as a result of these research activities. As a prime example, crop production at a village in the Morokweng area (North West Province) improved from self-sufficiency in terms of local vegetable consumption to supporting a feeding scheme for scholars.

ACKNOWLEDGEMENTS

ARC-GCI, NWU, VLIR and GDARD for financial support.

Keywords: Biofumigation, *Brassica*, environment-friendly management strategies, nematode

QUALITY OF ACTIVE INGREDIENTS IN AGRO-CHEMICALS REGISTERED ON MAIZE IN SOUTH AFRICA

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INTRODUCTION

When registered concentrations of active ingredients (*a.i.*) in agro-chemicals as specified on product labels deviate, huge economic losses could be experienced by users of these products and irreparable damage could be done to the integrity of those products and the manufacturing company. The aim of this study is to monitor the compliance of agro-chemical formulations. The ARC-Grain Crops Institute, in collaboration with Grain SA and CropLife SA (AVCASA and ACDASA), compiled a protocol with regard to the annual sampling of agro-chemical products and the reporting of these analyses.

MATERIALS AND METHODS

Annually Grain SA nominates a number of agro-chemical products to be sampled for quality control analysis. Products of all the agro-chemical companies in South Africa can be nominated by the relevant parties involved, in collaboration with commercial farmers as members of Grain SA. Act 36 of 1947 prescribes permissible deviations in the active ingredient contents for all agro-chemical product formulations. Products sampled included *a.i.* of herbicides and insecticides. Three accredited laboratories were identified to do the analysis of the products handed in by manufacturers. The choice of laboratory depended on the preference of each manufacturing company. Only products with a manufacturing date of two years or less were sampled. Results covered in this study included agro-chemicals tested from 2008 – 2011.

RESULTS AND DISCUSSION

2008/2009: In total an amount of 31 products representing 36 active ingredients were analysed of which eight did not comply with acceptable registered deviations. Where mixtures were analysed, only one of the active ingredients did not comply. Four of the agro-chemicals analysed were underformulated and four were overformulated.

2009/2010: Twenty six products representing 36 active ingredients were analysed of which one did not comply with acceptable registered deviations. This agro-chemical was underformulated and none were overformulated.

2010/2011: A total of 11 products were tested, representing 17 active ingredients. All the agro-chemicals tested complied with standard deviation specifics.

CONCLUSION

The monitoring of agro-chemicals has proven to be worth the effort taking into account that during 1999, 75% of active ingredients deviated from the product label. Only 42% did not comply in 2008/2009 season and improved to 2% during the 2009/2010 season. All the products tested the previous season (2010/2011) complied with the relevant product labels.

Keywords: agro-chemicals, deviation, label formulation, monitoring

SOIL INFORMATION SYSTEMS OF THE ARC-ISCW

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INTRODUCTION

Over a period of almost 100 years, the ARC Institute for Soil, Climate and Water has collected soil information in the form of soil maps, reports, soil profile information and chemical soil analysis. Much of the data was collected after 1970 when present soil classifications and soil analysis procedures used today were operational and old soil maps still show accurate distribution of natural soil units that can easily be converted to the present soil classification systems.

MATERIALS AND METHODS

More than 13 000 soil maps, soil profile descriptions and analytical data have been archived and metadata has been stored in several databases. A process is followed to digitise soil maps and many important soil surveys and related maps and is now available as an electronic image or in digital format, being either geo-referenced or fully digitised.

RESULTS AND DISCUSSION

Because much of the information is now in digital format, it is possible to access, distribute and use the data much more easily than in the old formats of paper maps and hard copy reports.

Soil map information can now be used in geo-graphical information systems like ArcGis. Land Type information on soil, terrain and climate is available in hardcopy and digital format in order to process it for many land use applications.

The physical and chemical characteristics of over 19000 soil profiles can be accessed, queried and made available in digital format.

Climate information of over 3000 zones in the country can be produced and used in agricultural orientated applications.

Almost 500 soil surveys including over 2400 soil maps are available in digital format of which a considerable part has been geo-referenced or fully digitised.

More than 4600 soil-related reports can be accessed and used for research and land use planning purposes.

Over the years, valuable information has been obtained from other departmental institutes and the private sector and more external partners are invited to contribute their soil information in the forms of reports, maps and analytical data to the ARC-ISCW databases to improve access to data and prevent loss of valuable soil information.

CONCLUSIONS

The aim of the exercise is to make soil information available for research projects, land use, environmental and conservation planning. The process of collecting and digitising soil information is ongoing and new addition of spatial and point data takes place on a daily basis. Requests for soil information and contributions to the databases of the ARC-ISCW databases can be made by contacting E O Jacobs at 012-310 2668 or ernst@arc.agric.za.

Keywords: Soil Information, Data Base

PRE-TREATMENT OF CAROB SEED AFFECTS GERMINATION RATE

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INTRODUCTION

The carob tree (*Ceratonia siliqua*) originates from the Mediterranean region, thus well adapted to winter rainfall climatic conditions of the Western Cape. This crop is drought tolerant, needing only 500mm per year to produce a commercially viable crop. The crop can be grown as an animal fodder in winter rainfall areas where water is scarce and the soil is marginal. The yield can be increased by adding additional irrigation and by using higher potential soils. Carob tree is known in South Africa as a horticultural crop, however, it is not yet commercially grown in the country. Its pods' nutritional value is only being exploited by a few farmers as sheep fodder. Carob powder is used in making health treats for human consumption and is solely imported from Spain. The limiting factor in the commercial production of the crop is the scarcity of good quality female clonal material. Viable seeds are produced by female tree and are thus commercially important for propagation. The objective of this study was to determine seed germination capacity with a view to understand the production potential of the crop (Tous, 1995).

MATERIALS AND METHODS

Seeds were collected during 2009 season and stored in a cold room at 6 °C until 2011. Seeds were surface-sterilised, and pre-treated with acid for 30 minutes and hot water (80°C for 10 minutes). Seed germination capacity was determined at 25°C. Seed germination was evaluated every second day over a period of 56 days. The experiment was replicated four times.

RESULTS AND DISCUSSION

It was found that seeds treated with acid for 30 minutes and hot water (80°C for 10 minutes) showed the highest germination rate. Both treatments significantly enhanced seed germination by reducing mean germination time.

CONCLUSIONS

Pre-treatment of carob seeds improves seed germination and may be necessary for successful stand establishment and crop production.

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Keywords: acid, germination rate, hot water

PHOSPHORUS RETENTION CHARACTERISTICS OF SELECTED SOUTH AFRICAN BENCHMARK SOILS UNDER MAIZE CULTIVATION

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INTRODUCTION

Proper phosphorus (P) testing is a critical step in developing sustainable agricultural systems as well as determining the amount needed to reach and maintain optimum levels in any given cropping system. This study was undertaken to (i) determine the P retention capacity of different South African soils following P application; and (ii) establish the relationship between Bray-1 and Ambic-1 extraction methods.

MATERIAL AND METHODS

Fifty two surface soils that varied greatly in clay content (3 to 48%) and chemical characteristics were used for laboratory incubation study over 48 weeks. Phosphorus-containing solution ($1.645 \text{ mg P ml}^{-1}$) was prepared and added to 1 kg of each soil at different rates (0, 10, 20, 40 and 80 mg P kg^{-1}) representing 0, 20, 40, 80 and 160 kg P ha^{-1} , respectively. Soils were thoroughly mixed and incubated at room temperature. Distilled water was added to each soil at 2-weekly intervals to maintain the moisture content at nearly 85% field capacity. Sampling for P determination was done at 6, 12, 24 and 48 weeks after incubation. Prior to soil sampling, each soil was thoroughly mixed and approximately 200 g scooped, air-dried and analysed for P using Bray-1 (Bray & Kurtz, 1945) and Ambic-1 (van der Merwe et al., 1984) methods. Data generated were subjected to analysis of variance using Stat Graphics® Plus version 5.0.

RESULTS AND DISCUSSION

Results showed that these soils had variable P retention capacities, with those containing a higher clay content exhibiting quantitatively and significantly higher retention. The mean values of retained P represent 0.9 to 51.4% (Bray-1) and 3.7 to 51.4% (Ambic-1) depending on the application rate. Though a generally high P retention was obtained at lower rates, there seems not to be a uniform trend in relation to increase clay content and P rates. About 42% (Bray-1) and 23% (Ambic-1) of the soils showed net negative P retention values at different sampling dates. Such net negative P retention values in soils with less than 20% clay content suggest poor retention characteristics and possible mineralization following P addition. There was a generally significant ($P < 0.001$) relationship between Bray-1 and Ambic-1 P retained at the different sampling dates. Also, significant linear relationships between extractable Bray-1 and Ambic-1 P concentrations (correlation coefficient ranged from 0.64 to 0.98) were established that can be used in other studies and situations to extrapolate one from another.

CONCLUSIONS

The result of this study showed that high P rate in some of the soils is uneconomical due to high retention. Appropriate P management programme in these soils will involve the determination of the optimum rate for specific crop so as to guarantee sustainable crop production and environmental safety.

Keywords: Benchmark soils, clay content, maize production, P availability, P retention

SOIL NITROGEN MINERALISATION POTENTIAL IN THREE CROPPING SYSTEMS AND NITROGEN RECOVERY BY WHEAT IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

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INTRODUCTION

Seasonal variation in nitrogen supply (quantity and timing of the N mineralised) may affect the fertiliser N requirements of the wheat crop. The aim of this study was to quantify N mineralisation as influenced by previous crops and to evaluate the availability of soil N (mineralised and fertiliser N) during the growing season of the wheat crop.

MATERIALS AND METHODS

A trial was laid out at the Langgewens Research Farm near Moorreesburg to evaluate the effect of previous crops and differential nitrogen applications on soil mineral N levels and availability for crop uptake during the 2008 – 2010 production seasons. Previous crops (wheat, canola or medic) were allocated to main plots and N treatments to sub-plots. Nitrogen fertiliser 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 60 days after emergence. Fallow plots were included to monitor nitrogen mineralisation. Soil and plant samples were collected at two weekly intervals during the growing season.

RESULTS AND DISCUSSION

Nitrogen mineralisation in the fallow plots varied between years. Soil mineral N levels tended to decrease between planting and July and remained relatively constant during the rest of the growing season. Nitrogen mineralisation during 2008 in the wheat after medic and wheat after canola rotations tended to result in higher levels of mineral N compared to the wheat monoculture system during the first 4 to 6 weeks after planting. During 2009, nitrogen mineralisation in the wheat after medic and wheat after canola rotations tended to result in lower levels of mineral nitrogen compared to the wheat monoculture system during the entire production season, an observation that needs further investigation. The wheat after medic system resulted in a marginally higher mineral N content during the 2010 season. Nitrogen recovered by an unfertilised (0 kg N ha⁻¹) wheat crop differed ($P=0.05$) with mean values of 84.4, 68.5 and 49.9 kg N ha⁻¹ recovered by wheat after medic, wheat after canola and wheat monoculture systems, respectively.

CONCLUSIONS

Soil mineral N content as a result of mineralisation differed between cropping systems and years, a situation that made it difficult to predict soil nitrogen mineralisation during the growing season. Mean recovery of mineralised nitrogen was highest for the wheat after medic system and lowest for the wheat monoculture system.

Keywords: nitrogen mineralisation, nitrogen recovery, wheat

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

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INTRODUCTION

Tillage practices and crop rotation systems that ensure high biomass production and high percentages of soil coverage by crop residues can be regarded as important factors that promote 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

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, 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. Data were recorded immediately after planting the crops during May 2011, using the line-transect method to estimate residue cover. The 2011 season represented the first year of the second cycle (the 5th year of the study).

RESULTS AND DISCUSSION

Residue cover was at similar levels for both sites with Tygerhoek and Langgewens recording mean residue cover values of 43 and 41 percent respectively. The percentage residue cover recorded at Tygerhoek for the zero, no-, minimum and conventional till treatments were 67, 46, 36 and 21 percent respectively. At Langgewens the zero, no-, minimum and conventional till treatments resulted in 69, 48, 34 and 13 percent residue cover, respectively. At both sites, wheat as previous crop resulted in higher residue cover in the canola and lupin crop compared to wheat drilled in canola or lupin stubble. 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.

CONCLUSIONS

The study showed that cultivation of the soil will reduce residue cover on both sites. The use of conventional tillage practices is questionable as the residue cover was reduced to levels much lower than the minimum recommendation of 30 percent. In terms of residue cover wheat as previous crop was superior to medic, lupin and canola.

Keywords: crop rotation, residue cover, soil tillage, wheat

NUTRIENTS AND NUTRITIONAL CONTENTS OF THREE JUTE ACCESSIONS GROWN UNDER GLASSHOUSE CONDITION AS AFFECTED BY GRADED FERTILIZER RATES

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INTRODUCTION

Indigenous wild leafy vegetables such as jute are often consumed by rural people for its nutritional and medicinal benefits. In some instances, such consumption is considered as a coping strategy for poverty alleviation and livelihood stress. Nevertheless, the importance of leafy vegetable consumption in human nutrition cannot be over-emphasized. Maintaining increase and sustainable availability of this importance food crop is a major challenge in the face of increasing human population, land degradation and climate change. This study aims to develop an appropriate fertilization strategy that will promote increase availability of jute as a nutrient-rich and medicinal leafy-vegetable alternative for many resource-poor households.

MATERIALS AND METHODS

A 6 m x 3 m factorial experiment was conducted under glasshouse conditions at the University of Limpopo Horticultural Skill Centre during November 2010 to March 2011. Treatments consisted of five combinations of graded NPK fertilizer rates (0-80-60, 100-0-60, 100-80-0, 100-80-60 and 50-40-30 kg/ha) on three jute accessions. Unfertilized control treatment was included as a standard check. The experiment was carried out using 10 kg soil filled polybags that were arranged in a RCBD with four replications. The trial was terminated after 23 weeks and above ground leafy biomass harvested and oven-dried at 65°C. Laboratory determinations were done using conventional analytical techniques prescribed by the Association of Analytical Chemists, AOAC.

RESULTS AND DISCUSSION

The results showed that mean fresh biomass of 24.7, 22.7 and 21.2 g/pot across the various fertilizer rates, respectively for Kenya, Tanzania and Uganda jute accessions did not differ significantly from one another. Application of NPK fertilizer resulted in increased protein content but decreased the fat content of the three jute accessions. The different fertilizer rates exerted variable effects on the ADF and NDF percentage. Percent mean fat content of 3.04, 2.52 and 2.50 and crude protein of 27.5, 26.2 and 24.2 were obtained, respectively for Kenya, Uganda and Tanzania Jute accessions across the six fertilizer levels. The content of micronutrients (Fe, Zn and Mn) and Ca in the dried biomass was highest in the Tanzania accession while the percent P and K concentrations (0.76% and 5.59%, respectively) were highest in Uganda accession.

CONCLUSION

The low fat, high protein and mineral constituents of these jute accessions represent good food quality attributes for the crop species. Therefore, they could serve as a good mineral supplement source for resource-poor families.

Keywords: Indigenous vegetables, fertilizer rates, nutrient composition, nutritional value

EFFECT OF PLANT POPULATION ON DRY BEAN YIELD IN THE LIMPOPO PROVINCE

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INTRODUCTION

Plant population is one of the factors that affect growth and yield. According to Dahmarder *et al.* (2010) "Plant density is an important agent that affect yield and yield components in legumes". The maximum plant density of beans varies with growth habit. The total density also depends on environmental resources available. Knowledge of the effect of plant populations on the seed yield components of beans (*Phaseolus vulgaris* L.) is needed to design management systems utilizing the genetic potential of different cultivars and to aid in the development of higher seed-yielding cultivars (Westermann & Crothers, 1977).

MATERIALS AND METHODS

The trial was planted at Palmaryville irrigation scheme in Vhembe District (Lat 22°58'S, Long 30°26'E) in Limpopo Province during 2011 season. The layout was a 3x3 factorial experiment involving three plant populations (150 000, 110 000 and 70 000 plants ha⁻¹) and three varieties of dry bean (Kranskop, DBS 310 and Jenny) in a split-plot design with three replications. The recommended population is 150 000 plants ha⁻¹. All the varieties used have indeterminate growth pattern. The spacing between the rows was 90 cm. The plot consisted of 4x4 m rows. Data was collected from the middle 2 rows, sampling 10 randomly selected plants per plot. The following data were collected at harvest: plant height, seed yield, 100 seed mass, seeds per pod, with yield expressed at 10% moisture. Harvesting was done by hand. Data was subjected to Analysis of Variance using General linear Model procedure of SAS to determine the response of dry beans under different plant populations. Means were compared using Least Significant Difference test at 5 % level (LSD = 0.05).

RESULTS AND DISCUSSION

Plant population influenced the yield of dry bean varieties where the lowest plant population had the lowest yield and the highest had the highest grain yield. Varieties performed significantly different but the difference was not influenced by plant population where the highest performer was Kranskop with a mean yield of 1.84 tha⁻¹ and the lowest being Jenny with the mean yield of 1.61 tha⁻¹. The results are in line with the findings by Hosseini *et al.* (2001).

CONCLUSIONS

The results indicated that the higher the plant population the more the yield. There is also a need to add a higher level of plant population. These are preliminary results, in follow up experiments determinate and indeterminate varieties will be included.

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Keywords: grain yield, pods, *Phaseolus vulgaris*

PLANT GROWTH, MINERAL LEVELS AND N₂ FIXATION OF HONEYBUSH (*Cyclopia longifolia* VOGEL L.) FERTILISED WITH MINERAL ELEMENTS IN FIELD CONDITIONS

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INTRODUCTION

Honeybush (*Cyclopia longifolia* Vogel L.) is mainly grown for the production of a herbal infusion (Kokotkiewicz & Luczkiewicz, 2009), and has economic potential in the cosmetic and nutraceutical industries. Although Honeybush tea contributes greatly to the South African economy, its production is constrained by high acidic soils and low nutrients and farmers' harvesting practices which lead to huge nutrient mining. Yet, mineral nutrition is an important biological process regulating plant growth and productivity (Mengel & Kirkby, 1987). The aim of this study was to assess plant growth, the concentrations and amounts of major nutrients and symbiotic performance in Honeybush tea plants supplemented with different levels of P, Mg and Ca.

MATERIALS AND METHODS

A rainfed field experiment in 2008 at Kanetberg, Western Cape was conducted using a completely randomized design where K₂HPO₄, MgCl₂·6H₂O and CaCl₂·2H₂O (0mM, 5mM, 25mM and 50 mM) were split-applied as liquid nutrients over a nine month period (November 2008, March 2009 and July 2009). Harvesting of shoots was done 300 days after last fertilisation, and processed for the determination of mineral nutrient concentration and symbiotic performance using ICP-MS and mass spectrometry, respectively. Data was analysed using Statistica 2007 (Statsoft Inc., Tulsa, OK, USA).

RESULTS AND DISCUSSION

The application of P, Mg, Ca significantly ($p \leq 0.05$) increased plant growth, uptake and accumulation of macro elements in *Cyclopia* shoots. However, as compared to lower application rates, 50 mM application tended to enhance mineral nutrient levels in the shoots of *Cyclopia*. Higher application rate decreased %Ndfa value because of higher $\delta^{15}\text{N}$ value. The actual amounts of N-fixed and soil mineral N uptake also increased with greater fertiliser supplementation.

CONCLUSIONS

In conclusion, the application of P, Mg and Ca increased growth, the uptake and accumulation of macro elements, just as symbiotic performance was much enhanced in *C. longifolia* shoots.

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Keywords: Honeybush, mineral nutrition, uptake, accumulation, symbiotic performance

ELECTROSCOPY ANALYSIS OF BAMBARA SEED QUALITY

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INTRODUCTION

Crop physiology allows description and prediction of crop performance (Modi & Greenfield, 2010). Physical characteristics of healthy normal seeds are important indicators of seed quality. In landraces, these differences can provide an important initial step in identification of crop improvement characters. The seed industry seeks quick and reliable methods to determine seed quality and predict seed performance. Hence, the objective of this study was to determine the relationship between seed coat colour and mineral content in terms of seed performance during germination and seedling establishment.

MATERIALS AND METHODS

Seeds of Bambara groundnut (*Vigna subterranea* L. Verdc.) were collected in 2009 from Jozini (27° 26' S, 32° 4' E), KwaZulu-Natal, and used to produce fresh seed lots during the 2010 growing season in Pietermaritzburg (29° 35' S, 30° 25' E), KwaZulu-Natal. Seeds were separated in terms of seed coat colour: 'Red', 'Brown' and 'White', respectively. Environmental scanning electron microscopy (ESEM) was used to perform an energy-dispersive X-ray (EDX) analysis (Modi and Asanzi, 2008) to determine mineral elements in the seed parts during seed germination (Modi & McDonald, 1999). Germinated seeds were used to produce seedlings (Sinefu, 2011). Data were analysed using analysis of variance (ANOVA) (GenStat® Version 14, VSN International Ltd, UK).

RESULTS AND DISCUSSION

There were significant differences between landraces, with respect to germination capacity ($P < 0.05$), mineral content in seed parts ($P < 0.01$) and seedling establishment ($P < 0.05$). There was also a significant correlation between seed mineral content and seed performance, however, the correlation was significantly more associated with carbon and calcium contents in cotyledons than in embryonic axes. Carbon content changes are linked to soluble carbohydrate changes during seed germination (Modi & McDonald, 1999). Calcium has been shown to play a significant role in legume seed quality (Mazibuko & Modi, 2005).

CONCLUSIONS

The findings of this study suggest that seed coat colour is an important attribute of seed quality in Bambara groundnut. Energy-dispersive X-ray analysis has a good potential as a seed industry tool for rapid physiological seed quality test.

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Keywords: Germination, seedling, Seed coat, seed quality, X-ray analysis.

PERFORMANCE EVALUATION OF SWEET SORGHUM LANDRACES AS SOURCE OF SUGAR IN LIMPOPO PROVINCE, SOUTH AFRICA

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INTRODUCTION

Sweet Sorghum (*Sorghum bicolor* (L) Moench) also referred to as sugar sorghum belong to the Poaceae family. The crop can be used as fodder crop, for biofuel or sugar production which can play an important role in the future. However, sweet sorghum is rated a minor sugar crop, and as a result the crop has been neglected with insufficient research on commercialization and juice utilisation. It is also an essential source for ethanol production due to its high biomass yield, and high sugar content in the stalk (Curt *et al.*, 1995). Because of shortage of germplasm for the crop in the rural areas, the aim of the study was to evaluate various landraces of sweet sorghum collected in the province for their productivity under dry-land conditions.

MATERIALS AND METHODS

Fifteen landraces of sweet sorghum were planted at Towoomba Research Station of the Limpopo Department of Agriculture during December 2010 under dryland conditions. The experiment was carried out in a RCBD with three replications. Each landrace was planted in 4 rows, each 4 m in length with an intra-row spacing of 12 cm, resulting in 123 148 plants ha⁻¹. Planting as well as weeding was done manually. Stalk length, diameter, grain yield, %brix (using a hand refractometer) and biomass were the parameters measured at harvest. SAS 9.2 was used to analyse the data and differences between means were determined using t-test at P=0.05.

RESULTS AND DISCUSSION

There were significant differences for stalk height, grain yield and brix percentage among landraces. There is lots of variation between and within landraces resulting in a wide gene pool that will be of importance for breeding for improved varieties. The results further indicated that increased number of internodes resulted in increased stalk height and diameter (correlation=0.86 and 0.65). Increased grain yield in the panicle resulted in decreased sugar in the stalk although the correlation was weak (-0.25).

CONCLUSIONS

Three of the landraces (G10 (31), L5 (35) and F2 (62)) performed better than other landraces on all production parameters measured. However, definite conclusions could not be drawn from only one year results.

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Keywords: Grain yield, landraces, sugar content, sweet sorghum

EVALUATION OF SYMBIOTIC N₂ FIXATION IN 15 FIELD GROWN MUNG BEAN (*Vigna radiata* L. WILCZEK) GENOTYPES AT NELSPRUIT, SOUTH AFRICA

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INTRODUCTION

Mung bean is a grain legume originally from India. It was introduced into Central and East Africa in the 17th Century (Tateishi, 1996). Nutritionally, it provides protein, vitamins and minerals when eaten raw, sprouted or cooked (Anon, 2002). Although some studies have quantified symbiotically fixed N by mung bean (Rafat *et al.*, 2008), little is known about its growth and dependency on symbiotic N₂ fixation for its N nutrition in Southern Africa. This study evaluated plant growth, symbiotic N₂ fixation in 15 mung bean genotypes grown in the field at Nelspruit in Mpumalanga Province.

MATERIALS AND METHODS

Field experiment was conducted at the Department of Agriculture Research Station, Nelspruit Mpumalanga Province, South Africa in 2010 and 2011. A randomized complete block design with three replicates was used. Samples (the whole plant) were collected at flowering, oven-dried at 60°C, weighed to determine dry matter yield and ground (0.85 mm sieve) for δ¹⁵N isotope analysis using mass spectrometry. The data was subjected to analysis of variance using STATISTICA package.

RESULTS AND DISCUSSION

There were significant differences in plant growth, δ¹⁵N, %Ndfa (Nitrogen derived from atmosphere) and amount of N-fixed. Year 2011 for example, showed enhanced plant growth relative to year 2010. Plant growth in 2010 could have been affected by water logging. Mung bean grown in 2011 exhibited lower δ¹⁵N values, higher %Ndfa and greater amount of N-fixed. Symbiotic dependency was therefore, greater in 2011 cropping season than the 2010 season. Genotypes VC6486-10-S1 and VC6493-44-1 accumulated the highest N fixed as compared to when they were planted in 2010.

CONCLUSIONS

The generally low amount of N-fixed in 2010 was due to poor growth of the species (i.e. low biomass) rather than poor N-fixing ability. Incorporating mung bean into traditional cropping systems can offer a biological solution to overcoming low soil N fertility.

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Keywords: nutritionally, mung bean, N-fixed, N nutrition

YIELD AND QUALITY RESPONSE OF HEMP CULTIVARS (*Cannabis sativa* L) TO DIFFERENT N LEVELS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

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INTRODUCTION

Hemp (*Cannabis sativa* L.) better known as Marijuana or dagga has been cultivated illegally in Southern Africa for centuries. However, this plant species also produce good quality fibre which can be used in the making of clothes. Its high fibre content warrants more research efforts for the latter purpose. The objective of the study was to determine effect of N - application rates on yield and quality of hemp cultivars in South Africa.

MATERIALS AND METHOD

Trials were conducted under irrigation on a sandy clay loam soil, during 2006/2007 and 2007/2008 seasons at Addo in the Eastern Cape Province. The trial was laid out in a randomized complete block design replicated four times. The treatments were four N-rates (0, 50, 100 and 150 kg N ha⁻¹) and two hemp cultivars (Kompolti and Felina 35) established at a plant population of 160 000 plants ha⁻¹. During the 2007/2008 season Novosadska replaced Felina 35. Each trial plot consisted out of six rows per plot 4 m in length, 1.5 m apart and with an inter row spacing of 0.25 m. The four middle rows of each plot were harvested at full maturity (120 days after planting) to determine biomass, plant height, stem diameter, fibre % and fibre yield.

RESULTS AND DISCUSSION

Fertilized treatments gave significantly higher yields than the control. The highest biomass yield and plant height were obtained with 100 and 150 kg N ha⁻¹ application in both seasons. Of the three cultivars, Kompolti performed better than Felina 35 and Novosadska. For stem diameter, only the cultivar effect was significant. Generally, application of N improved fibre quality and quantity. Highest percentages of fibre yield were obtained with 100 and 150 kg N ha⁻¹ applied in 2007/2008 season on Kompolti. Kompolti showed better response to N in fibre quality parameters (fineness, length, strength, colour and length) in both seasons.

CONCLUSIONS

Nitrogen application rates had a positive effect on yield and quality on most traits studied. Of the three cultivars Kompolti had higher potential to be commercialized. However, more research is needed with more trials and sites using more cultivar combinations. N rates at 100 and 150 kg N ha⁻¹ were best in increasing fibre yield.

Keywords: cultivars, nitrogen fertilization, yield, quality

RAINFALL OVER THE EASTERN CAPE PROVINCE ASSOCIATED WITH CUT-OFF LOWS

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INTRODUCTION

Cut-off low (COL) pressure systems are regarded as important synoptic scale weather systems that occur over the sub-tropics of southern Africa, and are normally associated with widespread rainfall with about one out of five systems that result in flood events, especially along the southern and eastern coastal belts and adjacent interior of South Africa. The Eastern Cape Province makes an important contribution to the agricultural economic sector in South Africa but is known for having high rainfall variability. It also experiences flood events due to the occurrence of cut-off lows. In this study we investigate the COL which is one of the temperate mid-latitude disturbances associated with the westerly airflow, and is associated with heavy rainfall over the Eastern Cape Province.

MATERIAL AND METHODS

In this study, COL events over South Africa were identified by visual inspection of the geopotential height fields of the 1000 hPa and 500 hPa pressure levels from the National Center for Environmental Prediction (NCEP) reanalysis data for the period of 1979 – 2009. Daily rainfall data from 22 weather stations in the Eastern Cape was utilized to identify the COL events that are associated with rainfall over this province. This was done for various rainfall categories (0-10 mm, 0-20 mm, 0-30 mm, 0-50 mm and > 50 mm) where at least one station had to report rainfall.

RESULTS AND DISCUSSION

From the total of 353 COL systems that occurred over South Africa during the study period, 255 were associated with rainfall over the Eastern Cape and 95 caused heavy rainfall whereby at least one station reported more than 50mm of rainfall for the period of 1979 to 2009 over the Eastern Cape. Of these, 20% contributed to rainfall amounts of between 0-10 mm, 13% contributed to rainfall amounts of 0-20 mm, 11% contributed to rainfall amounts of 0-30 mm, 19% contributed to rainfall amounts of 0-50 mm and 37% contributed to rainfall amounts of more than 50 mm. The contribution of COL systems to the total annual rainfall varies from one year to the next and also in areas such as along the coast and interior of the province. The highest annual contribution to rainfall by COL systems over this province occurred in 1979, 1981, 1985, 1993 and 1994.

CONCLUSION

Increased occurrences of COL pressure systems are associated with a larger contribution to the total annual rainfall but it also depends on the intensity, duration and the location of the systems.

Keywords: cut-off lows, Eastern Cape, heavy rainfall

SYMBIOTIC N NUTRITION, C ACCUMULATION, AND $\delta^{13}\text{C}$ OF 18 PIGEONPEA RATOONED GENOTYPES AT NELSPRUIT, SOUTH AFRICA

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INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) is grain legume of the semi-tropics. It is a major source of dietary protein. It adapts well to diverse agro ecologies and cropping systems (Ali, 1990). It has been reported to derive greater than 88% of N nutrition can from symbiotic N₂ fixation (Kumar Rao *et al.*, 1987). However, little is known about its growth and dependency on symbiotic N₂ fixation for its N nutrition in Southern Africa. Therefore, the objective of this study was to select locally adapted genotypes with high symbiotic performance, better water use-efficiency and increased grain yield.

MATERIALS AND METHODS

Plants were sampled from the Department of Agriculture Research Station in Nelspruit, South Africa. Samples were oven-dried at 60°C, weight to determine dry matter yield and ground (0.85 mm sieve) for $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ isotope analysis using mass spectrometry.

RESULTS AND DISCUSSION

Dry matter yield, N content, $\delta^{15}\text{N}$, %Ndfa, N-fixed and soil N uptake differed significantly among genotypes. For example, genotype ICEAP 01487/16 accumulated the most biomass. The $\delta^{15}\text{N}$ value was lower in ICEAP 01499/7 -0.10‰ which resulted in higher %Ndfa of 73.75% in ICEAP 01499/7. The amount of N-fixed was higher in ICEAP 01487/16. Carbon concentration and content, and $\delta^{13}\text{C}$ signatures markedly differed among genotypes.

CONCLUSION

Genotypes depended more on symbiotic fixation for their N nutrition. Those genotypes that fixed greater N also produced higher biomass. Also dry matter yield positively correlated with accumulated C. The higher $\delta^{13}\text{C}$ discrimination in some genotypes could indicate greater water use-efficiency in them.

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

DEVELOPING RUST RESISTANT GERMPLASM USING MOLECULAR MARKERS

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INTRODUCTION

Wheat rusts are responsible for causing significant losses to wheat production worldwide. Breeding wheat for rust resistance is the preferred strategy but the formation of new pathotypes with virulence to resistance genes has been a challenge over the years. The use of gene combinations can prolong the resistance of race-specific genes. Our strategy is to use adult plant resistance (APR) or non-race specific resistance in combinations with race-specific genes. We use molecular markers as a tool for pyramiding different rust resistance genes and developing cultivars with durable resistance. This strategy is widely applied and allows for the detection of desired gene combinations in a shorter time period compared to field screenings.

MATERIALS AND METHOD

Two hundred and sixty four F₂ and parental lines were analysed in the molecular laboratory to identify specific genes used in hybrid combinations. DNA samples were extracted from plant material of various cross combinations as well as parental lines and subjected to PCR procedures using Real-Time PCR protocols.

RESULTS AND DISCUSSION

One hundred and sixty eight samples were analysed for the stem rust resistance gene *Sr2* using the *stm598* marker and 116 samples tested positive. However, since this marker is not sensitive enough to discriminate effectively between the genotypes with the desired gene, a new diagnostic marker will be used in future studies to confirm these results. The *cfa2019* marker confirmed that 16 out of 18 samples possessed the *Sr22* gene. From 109 samples which were analysed for *Sr26* using the *sr26#43* marker, 107 samples tested positive. All 16 samples which were analysed for the yellow rust resistance gene *Yr10*, using the marker *xpsp3000* tested positive for the gene. Thirty-six of 96 samples tested positive for the presence of the yellow and leaf rust complex *Yr18/Lr34* with the marker *csLV34*. *Lr19* was validated using the marker *Gb* and 2 out of 21 samples tested positive for the gene.

CONCLUSIONS

Samples that have been validated to contain the gene/s of interest are currently being used as crossing parents and are also incorporated in the backcrossing program to stack resistant gene combinations in good backgrounds.

Keywords: Leaf rust, Marker assisted selections, Stem rust, Stripe rust, *Triticum aestivum*

THE USE OF A LOCALLY DEVELOPED BIOPESTICIDE FOR CONTROL OF *Mylabris oculata* (CMR beetles) IN DRY BEANS IN THE LIMPOPO PROVINCE

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INTRODUCTION

The production of dry beans in Mbahela has been decreasing rapidly in recent years even though there were lots of flowers during the flowering stage of the crop. However; farmers started to observe the Meloidae *Mylabris oculata* (CMR) beetles during flowering stage and realized that the beetles were feeding on the flowers of the dry beans. The CMR beetles are often very abundant in South Africa and do a great deal of harm to crops. At first the farmers used commercial pesticides but it was soon realized that it is not a sustainable system due to the high cost thereof. Hence farmers came up with their own innovation to control the pests in a biological way. The objectives of the study were to determine the effectiveness of a biopesticide mixture on the CMR beetles affecting dry beans and to determine the effect of the mixture on dry bean yield.

MATERIALS AND METHODS

Dry bean seeds were planted manually during March 2011 at Tshiombo Research Station in Thulamela Municipality of Vhembe District. The soil in the area is well drained sandy loamy soil of at least 90 cm depth and irrigated using furrow irrigation. Nitrogen fertilizer 2:3:2 was applied at 30 kg ha⁻¹ at plant. The between row spacing was 90 cm and inter-row spacing was 7.5 cm, resulting in a plant population of 150 000 plants ha⁻¹. A 2x3 factorial experiment in an RCBD, replicated three times with two red speckled dry beans cultivars (Kranskop and OPS-RS1) and three pest treatments namely Control (nothing applied), Mercaptothion and Biopesticide mixture was established. The Biopesticide was prepared from grounded CMR beetles added to 16 l water, stored in a closed container in a dark area for two days and then sieved and poured into a knapsack sprayer for spraying of the beetles. Data was randomly collected from the middle rows. Parameters measured included seedling emergence, climatic conditions on day of treatment, plant height, number of leaves and flowers, root, shoot and pot dry mass as well as pod length and seed yield.

PRELIMINARY RESULTS AND DISCUSSION

The trial is still on-going. The preliminary results indicated that there was no difference between the chemical pesticide and the biopesticide mixture on the drybeans.

CONCLUSIONS

There are lots of data that are not yet analysed and the chemical analysis of the biopesticide as well as the potency of the Biopesticide isn't yet known. However the experiment will be repeated again around March 2012 and all data will be analysed.

ACKNOWLEDGEMENTS

Mbahela Farmers, Madzivhandila ATC and Agricultural Thohoyandou Service Centre

Keywords: Biopesticide, Cape Mounted Rifle (CMR) beetles, Indigenous knowledge systems, pest management, plant protection

SCREENING FIVE RYEGRASS BIOTYPES (*Lolium* spp.) FROM THE WESTERN CAPE FOR RESISTANCE TO AXIAL (PINOXADEN)

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INTRODUCTION

Ryegrass (*Lolium* spp.) is a widespread, troublesome weed that occurs throughout the Western Cape small grain production areas. Herbicides used for weed control in wheat across the Western Cape to address the major challenge from competitive ryegrass are from the ACCase and ALS inhibitor groups. In the past, till 1993 when the first herbicide resistant ryegrass was reported (Heap, 2010), ryegrass control in crop fields was successfully achieved with these herbicides. However, ryegrass is a genetically highly variable, cross-pollinated species and herbicide over-reliance has resulted in the widespread occurrence of herbicide resistant weed populations (Owen, *et al.* 2007) and ALS-inhibiting herbicides (Christopher, *et al.* 1992). Multiple resistance and cross-resistance in ryegrass has also been well documented (Tardif, *et al.* 1997).

Axial[®] is formulated as a 45 g/l pinoxaden emulsifiable concentrate and is used for the control of ryegrass, little seeded canarygrass and wild oats. Axial[®] was introduced to the market after increasing amount of resistance to herbicides from the 'Fops', 'Dims' and SU groups developed. It was not long before producers raised concerns about resistance to Axial[®] ('Den' group) as well. The aim of this study was thus to determine if there is any trace of resistance to Axial[®] in five different ryegrass biotypes collected from the Western Cape.

MATERIAL AND METHODS

Greenhouse trials were conducted at the Agricultural Research Council Small Grain Institute, Bethlehem. Axial[®] was used as herbicide for all trials. Five different ryegrass biotypes collected from the Western Cape were planted for trial purposes. Four Axial[®] rates were applied to all biotypes. These rates were the recommended rate (1x), 2x, 3x and 4x the recommended rate. All experiments were set up as randomized complete block designs. The experiments were evaluated after fourteen days by means of weighing fresh shoot mass and data was analyzed using Genstats 12thed (12.1.0.3338).

RESULTS AND DISCUSSION

According to the results obtained from the trials it is evident that Axial[®] still effectively controls the five biotypes tested. The percentage control at the recommended rate was 76.67%, which is not good, but is a lot higher than the percentage control obtained from both the 'Fop' and the SU groups. Hundred percent weed control was obtained at all three higher rates.

CONCLUSION

Results from this study indicate that Axial[®] can be used for effective weed control in areas where resistance to 'Fops' and Su's was confirmed.

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Keywords: Axial[®], herbicide resistance, *Lolium* spp., pinoxaden, ryegrass

CONFIRMATION OF RESISTANCE TO GLYPHOSATE IN WILD BUCKWHEAT (*Fallopia convolvulus*) IN THE EASTERN FREE STATE

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INTRODUCTION

Fallopia convolvulus (wild buckwheat) is a fast-growing, annual flowering plant in the family Polygonaceae and originates from Europe. During recent years wild buckwheat developed into a widespread weed throughout Southern Africa and became an especially troublesome weed in winter wheat and vegetable crops in the Eastern Free State and the Loskop Irrigation Scheme. Wild buckwheat is a severe competitor when it occurs in dense stands. It climbs/creeps up against other crops to reach the sunlight and competes with the crop to such an extent that the crop may die. Over the past two seasons many concerns were reported that glyphosate is not controlling this weed effectively any more. This study was conducted to determine if the wild buckwheat found in the Eastern Free State is resistant to glyphosate.

MATERIAL AND METHODS

Two greenhouse trials were conducted at the Agricultural Research Council Small Grain Institute, Bethlehem. Roundup Turbo[®] (glyphosate) and 2% ammonium sulphate were sprayed at 12 different rates. These rates were 0.5 l/ha, 1 l/ha, 1.5 l/ha, 2 l/ha, 2.5 l/ha, 3 l/ha, 3.5 l/ha, 4 l/ha, 4.5 l/ha, 5 l/ha, 5.5 l/ha and 6 l/ha Roundup Turbo. The test species were cultivated oats, cv. Sederberg that served as a control and wild buckwheat. Both experiments were set up as randomized complete block designs. Distilled water was used to eliminate the effect of poor water quality since glyphosate is very sensitive to poor water quality (e.g. hard and brackish water). The experiments were evaluated after fourteen days by means of weighing fresh shoot mass and data was analyzed using Genstats 12th ed (12.1.0.3338).

RESULTS AND DISCUSSION

The results clearly indicated that the wild buckwheat biotype from the Eastern Free State is resistant to glyphosate. The percentages control varied from 52.84% at 0.5 l/ha to 100% at 6 l/ha. The concern however, is that only 86.78% of the weed was controlled at 5.5 l/ha. This indicates a high level of resistance to glyphosate if it is kept in mind that until the past two seasons wild buckwheat was effectively controlled with glycine herbicides.

CONCLUSION

With the confirmation of glyphosate resistance in wild buckwheat in the Eastern Free State, producers will have to consider alternative chemical control methods or integrated weed management to prevent the resistance from spreading to other areas.

REFERENCE

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Keywords: *Fallopia convolvulus*, glyphosate, herbicide resistance, Roundup Turbo, wild buckwheat

RAINFASTNESS OF GLYPHOSATE: FACT OR MYTH?

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INTRODUCTION

Glyphosate (glycine) is classified as a non-selective, systemic herbicide that is used for broad spectrum weed control. It can effectively kill all plant types including grasses, perennials and woody plants. Several glyphosate formulations are available for use in South Africa. These include generic formulations. Glyphosate however, is highly water soluble and therefore prone to dilution and removal from plant foliage by rainfall. Glyphosate is particularly vulnerable to wash-off by rainfall from the time of application until a lethal quality of herbicide has penetrated the foliage. Rainfall soon after application may result in partial or complete loss of glyphosate activity. However, some glyphosate labels in South Africa claim that rain or irrigation more than two hours after application will have no impact on the efficacy of glyphosate. This study was conducted to determine whether glyphosate is indeed rainfast after a certain time period.

MATERIAL AND METHODS

Greenhouse trials were conducted at the Agricultural Research Council Small Grain Institute, Bethlehem. Eleven different glyphosate formulations were used for the trials and were applied to cultivated oats, cv. Sederberg at the recommended rate. Each glyphosate formulation was sprayed on 12 pots. The herbicide was then washed off at three different times, 0 hours (not washed), 2 hours and 4 hours after plants have been sprayed. Rain was simulated using a home garden sprayer and 45 sprays were applied to each rain simulated pot. Four pots were used for every time interval. The experiments were set up as randomized complete block designs. Tap water was used for the execution of the trials. The experiments were evaluated after ten days by means of weighing fresh shoot mass and data was analyzed using Genstats12thed (12.1.0.3338).

RESULTS AND DISCUSSION

From the experiment it was clear that the best percentages control were obtained on all the treatments that were not washed off (0 hours) at a certain time after being sprayed. The plants that were washed off 4 hours after being sprayed did second best (in most cases) and the plants that were washed off 2 hours after being sprayed showed the lowest percentage control. These results indicate that glyphosate is certainly not rainfast within 4 hours after being sprayed and caution must therefore be taken to avoid wash-off of these herbicides after spraying.

CONCLUSION

The percentage control at 2h and 4h was significantly less when compared to pots that did not receive simulated rainfall after being sprayed. The glyphosate has NOT been fully absorbed and was therefore still vulnerable to rainfall, even though the rainfall was not excessive.

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Keywords: glycine, glyphosate, percentage control, rainfastness

MAIZE/PIGEONPEA INTERCROP RESPONSE TO PHOSPHORUS APPLICATION UNDER DRYLAND CONDITIONS

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INTRODUCTION

Pigeonpea is tolerant to low phosphorus (P) supply and acid soils as well as having a high capacity for incorporation of external P into organic P (Fujita *et al.*, 2004). However, P fertilizer application improves both the yield and N fixation of pigeonpea. The high demand for P by most leguminous crops, coupled with its complex chemistry in many soils, often result in P management challenges on most croplands. This study investigated the response of pigeonpea to phosphorus application under sole and intercropping systems.

MATERIALS AND METHODS

A field experiment was conducted in the 2010/11 growing season at University of Limpopo Experimental farm. 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 randomized complete block design with 4 replicates. Additional sole maize plots were included in the experiment. Maize variety (ZM526) 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. The yield responses to P rate were subjected to regression analysis.

RESULTS AND DISCUSSION

Phosphorus level had a significant effect on grain yield of pigeonpea only. Optimum P application rates for sole and intercropped pigeonpea were recorded at 60 kg ha⁻¹ and 45 kg ha⁻¹, respectively. Higher pigeonpea and maize grain yield of 160 and 3619 kg ha⁻¹, respectively were recorded under intercropping. Intercropped maize yield increased with increased P up to 60 kg P ha⁻¹.

CONCLUSIONS

Phosphorus rates and cropping system significantly influenced pigeonpea grain yield. The higher yield performance of intercropped pigeonpea over a sole crop requires further investigation.

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ACKNOWLEDGEMENTS

The authors thank the University of Limpopo for funding to attend the conference.

Keywords: Phosphorus, sole cropping, intercropping, pigeonpea, grain yield

EFFECT OF RHIZOBIUM INOCULATION ON GROWTH AND YIELD OF CHICKPEA (*Cicer arietinum* L.) IN SEMI-ARID LIMPOPO PROVINCE

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a valuable source of protein, fibre, carbohydrates and minerals. It improves soil health and fertility by fixing atmospheric nitrogen (N) and is also a drought tolerant legume. Therefore, chickpea may be a legume of choice for smallholder resource poor farmers in Vhembe district of Limpopo province. Incorporation of chickpea into existing cropping systems may lead to better food supply, nutrition and increased family incomes. However, chickpea is a relatively new crop in this region and hence effective native rhizobia may be lacking in these soils. Inoculation with commercial rhizobia may thus increase effective nodulation and N fixation.

OBJECTIVE

To determine the effect of rhizobium inoculation on growth and yield of chickpea in semi-arid Vhembe district.

MATERIALS AND METHODS

The study was conducted in Thohoyandou during the winter season of 2011. Treatments consisted of two desi chickpea cultivars, ICCV5103 and ICCV7116 with or without rhizobium inoculation. Phosphorus (P) and N fertilizers were applied uniformly to all plots at the rate of 50 kg P and 10 kg N ha⁻¹ as SSP and LAN, respectively. Chickpea was planted at a spacing of 40 cm x 15 cm in plots measuring 3 m x 2 m laid out in a RCBD, replicated three times. At 50% flowering, dry matter (DM) yield and nodulation was determined. At harvest maturity, DM, pod and grain yield was determined. Data was analysed using the GLM procedure of SAS.

RESULTS AND DISCUSSION

There was no difference ($P < 0.05$) in DM yield at 50% flowering. Uninoculated cultivars did not develop any nodules thus indicating the possibility that the commercially supplied inoculant used may not have been effective. Nodule numbers ranged from 0 (uninoculated ICCV5103 and ICCV7116) to 3 nodules per plant (inoculated ICCV5103). A similar trend was observed for nodule weight. There was no difference in pod and grain yield among the treatments. Grain yield ranged from 593 kg ha⁻¹ (uninoculated ICCV5103) to 1327 kg ha⁻¹ (inoculated ICCV5103). High coefficients of variation (CV) values were recorded for pod yield (67%) and grain yield (74%). There was no difference in DM at harvest maturity.

CONCLUSIONS

The chickpea cultivars responded poorly to rhizobium inoculation. Damage to seeds by birds prior to harvest may have contributed to the high CV values obtained for pod and grain yield. Despite the poor response, ICCV5103 showed promising results and further field trials should be conducted over several seasons before any recommendations can be made to smallholder farmers.

Keywords: Chickpea, grain yield, inoculation, Limpopo, nodulation, rhizobium

EARLY SOIL MICROBIAL ACTIVITIES AFFECTED BY CONSERVATION AGRICULTURAL MAIZE PRODUCTION SYSTEMS

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INTRODUCTION

The continuous use of conventional farming systems has magnified soil erosion losses causing the steady decline of the soil resource base (Montgomery, 2007). These actions have led to the decline of several soil parameters, especially biological factors. Implementing conservation agricultural (CA) systems may alter the microbiology of soil which may improve soil quality (Andersen, 1999). In South Africa, limited scientific research has been done on soil microbial dynamics in these maize based systems. The aim of this study was to evaluate the impact CA systems have on microbial activity in local maize production systems.

MATERIALS AND METHODS

Soil samples were taken from a field trial comprising of a loamy sandy soil in the North-West Province. Treatments consisted of (1) conventionally cultivated, mono-cropped maize, (2) mono-cropped maize with minimal soil disturbance, (3) a two-year system with maize in rotation with cowpea and sunflower with minimal soil disturbance and (4) a two-year system with maize in rotation with cowpea/sunflower and babala with minimal soil disturbance. Soil samples were taken during the active growing phase at 0-5, 5-15, 15-30 cm depths. Microbial activities were determined using glomalin- and β -glucosidase assays as well as PCR-denaturing gradient gel electrophoresis (DGGE). Results were statistically analysed.

RESULTS AND DISCUSSION

β -glucosidase activity levels were the highest in the 0-5 cm layer and the lowest in the 5-15 and 15-30 cm depths and differed significantly between CA and conventional systems. Higher glomalin activities were detected at deeper depths for CA treatments. DGGE analysis showed changes in DNA banding profiles at various depths between systems.

CONCLUSIONS

β -glucosidase and glomalin levels were affected by cropping systems with increased activity in the CA system. DGGE DNA profiles suggested possible microbial community shifts between cropping systems.

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ACKNOWLEDGEMENTS

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Keywords: conservation agriculture, glomalin, PCR-DGGE, soil enzymes

EMERGENCE OF SUNFLOWER CULTIVARS (*Helianthus annuus* L.) AS AFFECTED BY PLANTING DEPTH AND SOIL TEXTURE AT DIFFERENT PLANTING DATES

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INTRODUCTION

South Africa produces mainly oilseed sunflower, of which 81.4% is produced in the Free State and North West provinces (DAFF, 2010). Both provinces are known for their sandy soils and daily temperatures can frequently exceed the critical level of $\pm 43^{\circ}\text{C}$ during planting in the months of November until January (Nel, 1998). These conditions and a combination of other factors influence seed vigour and emergence and lead to a poor sunflower stand, which requires re-planting with subsequent financial losses. The aim of the study, therefore was to evaluate the effect of planting depth and soil texture on 18 sunflower cultivars at three planting dates.

MATERIAL AND METHODS

A glasshouse experiment, simulating dry land conditions, was conducted during the 2010/11 growing season with 18 commercial South African sunflower cultivars. Treatments consisted of two planting depths (25 and 50 mm) and two soil textures (Bainsvlei – 5% and Tukulu - 14% clay content). Three planting dates (September, November 2010 and February 2011), representing three temperatures (15, 25 and 35°C) at planting depth, were used. A randomised complete block experimental design utilising a split plot layout with four replications was used. Emergence was recorded daily for 21 days after planting. The emergence index, as defined by Nel (1998), was calculated from the daily recorded emergence of each cultivar.

RESULTS AND DISCUSSION

Generally cultivars emerged within seven days of planting, with a higher emergence index on the Bainsvlei than the Tukulu soil. Emergence index of cultivars differed significantly by as much as 50%, proving that cultivar differences exist. The emergence index of the 25 mm planting depth was significantly greater than that of the 50 mm confirming that an increase in planting depth decreased emergence rates. Extremely high anticipated temperatures did not materialise in February as a result of the prevailing cloudy conditions. New temperature simulating emergence containers were therefore developed for the 2011/12 growing seasons' experiments.

CONCLUSIONS

The emergence rate of sunflower varied among cultivars and was higher for shallower planting and the lighter soil with no clear effect from planting date.

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Keywords: Emergence, planting date, planting depth, temperature, soil texture

ASSESSMENT AND MAPPING OF BOREHOLE WATER QUALITY FOR GAME AT MUSINA MUNICIPALITY, VHEMBE DISTRICT IN LIMPOPO PROVINCE

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INTRODUCTION

Game farming is a growing source of income in South Africa. The Limpopo province counts 2300 game ranches, representing approximately 26% of the total area of the province (Van der Waal and Dekker, 2000). During rainy season the game animals drink water from the Limpopo River's catchment area while during dry season surface water supplies are supplemented from local boreholes. Water quality affects the vegetation of a given environment, as well as animal and human health.

MATERIALS AND METHODS

In order to evaluate the quality of water, samples of 14 water quality constituents were taken at 36 boreholes in the municipality of Musina in the extreme northern part of the Limpopo province. During a 4-stage process the ordinary kriging method was applied to predict the contamination level of the 14 water quality constituents in Musina. First, the data were subjected to three important statistical assumptions: the normality assumption, the stationarity assumption and the spatial dependence assumption. Next, the experimental semivariogram was calculated for each constituent and fitted with the spherical, exponential or Gaussian model. In the last stage the fitted model was used in the ordinary kriging process to estimate the expected values of contamination at unmeasured locations in Musina.

RESULTS AND DISCUSSION

For cadmium, at 28 of the 36 boreholes the chronic effect value (CEV), i.e. the concentration above which adverse effects on animals occur, is exceeded. Fluoride and bromine have respectively 5 and 2 sample measurements that exceed their CEV. All the other constituents have values that are expected to be lower than the CEV. It should be noted that since the number of sample measurements per constituent is limited to only 36, conclusions based on the prediction maps should be treated carefully. The spatial dependence test shows for example that for some constituents only a weak spatial dependence exists.

CONCLUSIONS

Subjecting all constituents to the normality assumption shows that for some water quality constituents the data are not normally distributed. Especially the constituents that contain a minimum value of 0 and thus can not be log transformed have a distribution that is far from normal. Since kriging does not require a normal distribution of data, this interpolation technique could be applied on all 14 constituents.

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Keywords: Borehole water quality, Geostatistics, GIS, Kriging

EVALUATING A LOW TECHNOLOGY CLOSED CHAMBER METHOD FOR MEASURING GREENHOUSE GAS EMISSIONS FROM AGRICULTURAL SOIL

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INTRODUCTION

Agriculture is expected to be significantly impacted by climate change and greenhouse gas (GHG) emissions, but at the same time agriculture is also a significant contributor to GHG emissions (IPCC, 2007). Internationally, countries are pressured to quantify, monitor and mitigate their emissions (UNFCCC, 2002). In this study, methods of measuring some GHG emissions from agricultural soil were tested using a low technology closed chamber (LTCC) system and Vaisala CO₂ probes.

MATERIAL AND METHODS

The Zeekoegat conservation agriculture trial was used to deploy the chambers. Low technology closed chambers (Matson & Harriss, 1995) were custom made from 20 L buckets from which the bottoms were removed. The lids were fitted with a fan to circulate the air, and a rubber seal through which a gas sample could be taken with a syringe. The buckets were deployed on 24 plots in the trial. Gas samples were collected monthly during the growing season (2010/2011) and analysed for nitrous oxide (N₂O) and carbon dioxide (CO₂) on a gas chromatograph (GC). Special fittings for Vaisala probes were built-in to some lids in order to correlate Vaisala CO₂ readings with GC analyses. Atmospheric samples were taken as controls.

RESULTS AND DISCUSSION

The average CO₂ emission rate was 5.41 mg/kg/min. No statistical differences were detected between treatments. However, statistical differences occurred between sampling dates. N₂O emissions followed a similar trend. The average emission was 2.584 µg/kg/min, with statistical differences between sampling dates but none due to treatments. A poor correlation was found between the LTCC system and Vaisala probes. No statistical differences were found between the control and the treatments. Low N₂O and CO₂ emissions from the LTCC system could indicate low emission rates, or losses during sampling, transport or analysis.

CONCLUSION

The LTCC method performed poorly compared to Vaisala probes, due to unaccounted gas losses. More appropriate methods to measure CO₂ and especially N₂O must be investigated.

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Keywords: carbon dioxide, closed chamber, greenhouse gas emissions, nitrous oxide

AN EXAMPLE OF A NEW SOIL SERIES: A REVISED PARADIGM

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INTRODUCTION

Objective: The objective of the poster is to present a full text example of a New Soil Series. The New Soil Series represents collective virtual soil information derived from soil analyses of similar soil profiles. Soil form and geology formation are the basis to collective grouping.

The example illustrates a typical modal soil profile description and central property values measured during routine soil sampling and analyses. The table illustrates the mean soil property values of typically similar soil profiles. Their range of soil property values is estimated by the standard error. The estimated distribution of the New Soil Series is derived from soil survey and Land Type information sources supported by tacit expert knowledge. The underlying geology formation and climate (rainfall) provide additional information towards the expected distribution of the New Soil Series. Since the sketch of the expected distribution is supported by published Land Type, geology and climate information, the spatial extent can be readily estimated to farm scale level.

MATERIAL AND METHODS

Materials: The example represents central property values of collection of Avalon and Glencoe soils associated with the Vryheid Formation, Ecca Group geology of KwaZulu-Natal and eastern Mpumalanga. Soil profiles are from the ARC-ISCW Soil Information System.

Methods: Standard methods of soil analysis and profile description were used (LTSS, 1986). Avalon and Glencoe soil profiles were selected per horizon with underlying geology of Vryheid Formation (Pv) (Council for Geosciences, 1998) and a rainfall range of 751 to 850 mm p.a. Plinthic Land Types (Ba, Bb) (LTSS, 1986) with dominant Pv geology give the estimated spatial distribution. Mean and standard error were calculated.

RESULTS

Header Information: Soil form; Geology, Rainfall, List of Land Types, Distribution sketch

Physical Properties: Particle Size Classes (7 fraction), Water Retention, Atterberg Limits

Chemical Properties: Extractable Cations and Acidity, CEC, pH, Phosphorus, Micronutrient

Mineralogy: Semi-quantitative estimate

Estimate of water soluble cations: Estimate is possible where present

Generalized Interpretation Statements: Generalized Land Use Interpretations can be compiled for range of localized agricultural, urban and environmental enterprises.

DISCUSSION AND CONCLUSIONS

The New Soil Series represents new approach to qualitative and quantitative soil property assessment. It places greater emphasis on soil property values, making use of readily available soil classification, geology, and rainfall information with tacit location knowledge. It provides improved opportunities to associate land use applications to soil information, particularly where detailed soil information is not available.

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Keywords: Soil series, soil property values, soil technology transfer

EVALUATION OF PLANT GROWTH AND GRAIN YIELD OF 30 COWPEA (*Vigna unguiculata* (L.) WALP) GENOTYPES GROWN IN MOZAMBIQUE

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INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp.), is an important grain legume in Sub-Saharan Africa. Cowpea grain contains 25 % protein and 64 % carbohydrates (Bressane, 1985), and can potentially alleviate malnutrition among children of resource-poor African households. The current low (i.e. 300 kg.ha⁻¹) grain yield of cowpea in traditional cropping systems is partly due to limited access to improved varieties, crop and soil management practices and a complex of biotic and abiotic factors (Van Ek & Singh, 1997; Singh et al., 1997). This study therefore, assessed plant growth and grain yield of 30 cowpea genotypes grown in the field in Mozambique.

MATERIALS AND METHODS

Field trials were conducted at two sites (i.e. Muriaze and Namialo, Nampula province) in Mozambique during the 2010 and 2011 cropping seasons. The experiment consisted of two planting dates (i.e. third and second weeks, respectively in January and February), thirty cowpea genotypes laid out in a randomized complete block design in two locations and replicated four times. Plot size of 9 m x 3 m with 1.0 m spacing between plots and 2.0 m between blocks were used. Cowpea seeds were planted at 75 cm between rows and 20 cm within rows. Ten (10) cowpea shoots were sampled at 46 days after planting to assess plant growth whilst the grain was harvested at physiological maturity to determine grain yield. The data were then subjected to analysis of variance (ANOVA) using statistical analysis system (SAS) and means separated using Fischer's least significant difference (LSD) at p<0.05.

RESULTS AND DISCUSSION

Plant growth (expressed as biomass yield) was much enhanced in genotype IT04K-217-5 compared to IT00K-835-45. Cowpea genotype IT04K-321-2 attained 50 % flowering at 36 days whilst IT00K-126-3 reached physiological maturity at 65 days after planting. Grain yield was much higher in cowpea genotypes IT04K-321-2, IT04K-227- 4, IT00K-126-3, IT-18 and IT97K-390-2 than in IT06K-108.

CONCLUSIONS

There were significant genotypic variation in dry matter yield, days to physiological maturity and grain yield. However, IT04K-321-2 consistently increased grain yield across the two sites and contrasted with IT06K-108, the least grain producer in all locations. Cowpea planted in the third week of January produced greater grain than those planted in the second week of February.

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Keywords: Cowpea (*Vigna unguiculata* (L) Walp.), genotypes, plant growth, grain yield

LARVAL GROWTH RATE OF THE AFRICAN STEM BORER, *Busseola fusca* (Fuller) AS AFFECTED BY PHOTOPERIOD

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INTRODUCTION

During various evaluations of insect resistant maize genotypes under greenhouse conditions, it was noticed that larvae feeding on the same susceptible standard did not develop at the same rate during various times of the season. This prompted a study into the effect of photoperiod on larval growth rate.

MATERIALS AND METHODS

Maize was planted in the same field from mid-September at one month intervals to a total of six plantings, ending mid-February. All plantings were artificially infested with neonate larvae 35 days after emergence, followed by dissection of plants in one row 21 days after infestation. Larval mass and the incidence of leaf feeding damage were recorded. Further evaluations took place at harvest, including assessment of the incidence of ear and stem damage.

RESULTS AND DISCUSSION

Photoperiod was found to have a pronounced effect on larval developmental rate. A close correlation between day length and larval growth rate was illustrated. Larval mass gain was maximal in the mid-December planting with slower development in either earlier or later plantings. This was reflected in the incidence of leaf feeding damage during the vegetative stages of plant development as well as in the incidence of stem and ear damage at harvest.

CONCLUSIONS

The results explain previous observations on larval injuriousness as affected by planting date. Using artificial infestation of plants, the same infestation level seems to result in less damage occurring in late plantings compared to earlier plantings. Under conditions of natural infestation this relationship is largely masked by the increased infestation levels resulting from the second seasonal moth flight, which is always much larger than the first flight.

Keywords: *Busseola fusca*, larval growth rate, photoperiod

THE EFFECT OF SOIL TILLAGE AND CROP ROTATION ON WHEAT GROWTH FACTORS

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INTRODUCTION

Crop rotation and tillage method influence the chemical, physical and biological properties of a soil, and may therefore influence crop performance. To ensure an optimum sink-to-source relation, plants must have readily access to minerals and moisture. This enables plants to produce enough assimilates and translocate it to the plant tissue where the need derives. Borghi (1999) found that an increase in dry mass is associated with larger leaves that stay green, taller stems and larger numbers of ear bearing tillers. The aim of this study was to investigate the effect of soil tillage and crop rotation on selected plant indicators that ensure high crop productivity.

MATERIALS AND METHODS

Three cropping systems (wheat monoculture, lupin-wheat-canola-wheat, wheat-medic-wheat-medic), combined with four tillage methods (conventional-, minimum-, no- and zero-till), were used to evaluate the effect of tillage and crop rotation on growth components of the wheat crop. Crop rotation system was allocated to main plots, tillage methods to subplots and replicated four times. The leaf area of 20 plants per subplot was taken to determine leaf area and dry mass produced per plant. The following data were recorded at anthesis: ceptometer-readings to determine light interception by the canopy, chlorophyll content to determine the chlorophyll content of the flagleaf and porometer-readings to determine stomatal resistance. Crop development and yield components were also measured in the study.

RESULTS AND DISCUSSION

Although not significant ($p=0.05$), the total number of ears.m⁻² tend to be the highest in the no-till treatment (226) of the wheat-medic-wheat-medic system. The no-till treatment in the wheat monoculture resulted in the highest leaf area index (1.4), whilst in the rotational systems it was highest in the minimum- (1.58) and conventional-till (1.55) treatments. The highest biomass, although not significant, was produced under minimum- and no-till conditions for the rotational systems. Porometer readings indicated that conventional- (4.42 m²s.mol⁻¹) and zero-till (4.40 m²s.mol⁻¹) treatments resulted in the highest levels of water stress. Ceptometer readings showed that crop cover was the lowest in the conventional-till treatments. The highest chlorophyll content was recorded in the minimum (49 SPAD) and conventional-till (50.4 SPAD) treatments.

CONCLUSION

Crop establishment is a very important factor in determining the biomass distribution and finally the yield of a crop. Conservation practices also preserve soil water to a greater degree and therefore the crop tends to grow better and give higher yields. Crop rotation also tends to benefit the establishment and early growth of the following wheat crop, compared to monoculture.

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Keywords: soil tillage, crop rotation, biomass distribution