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Abstracts Poster

ECONOMIC VIABILITY OF FUNGICIDE APPLICATION FOR NORTHERN CORN LEAF BLIGHT ON MAIZE CULTIVARS WITH VARYING RESISTANCE

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Introduction

Northern corn leaf blight (NCLB) is the most widespread leaf disease on maize in South Africa. It commonly occurs in the eastern parts of the country (KwaZulu-Natal and Mpumalanga) as well as under irrigation conditions along the Vaal, Modder and Orange river irrigation schemes. In areas where the disease occurs annually, fungicides are applied prophylactically. The objective of the current study was to establish the economic viability of applying fungicides to cultivars with varying degrees of resistance to NCLB.

Materials and Methods

Two trials were planted at Potchefstroom (mid-November and mid-December 2017). Three cultivars with varying resistance levels to NCLB were included (IMP50-10B - susceptible, BG3292 - moderately susceptible, DKC 61-94BR - resistant). Eight treatments were included to create various levels of NCLB i.e. TMT1 - maximum control (3 fungicide applications); TMT2 - standard control (2 fungicide applications); TMT3 - natural control (not inoculated or sprayed). The remaining treatments were inoculated at various dates with a cocktail consisting of five NCLB races (Race 3, 3N, 23, 23N and 13N): TMT4 (5 weeks after planting -WAP); TMT5 (5+6 WAP); TMT6 (5+6+7 WAP); TMT7 (6+7 WAP); TMT8 (7 WAP). The trials were planted in a split plot design with treatment as the main plot and cultivar as the sub-plot (three replicates). Fifteen randomly selected plants were screened for NCLB development at dent stage. Disease was quantified as the percentage infected leaf material per plant per plot using a modified scale of 0.0, 0.5, 1.0, 5.0 10.0, 25.0, 50, 70 and $\geq 85\%$. Yield was calculated at 12.5% moisture (t/ha).

Results and Discussion

The application of fungicides three times during the season (TMT1) did not result in significantly higher yields compared to two applications during the season (TMT2) in any of the cultivars. Even though up to 55% disease severity was recorded in the resistant cultivar (DKC61-64BR) in the first planting, yield was not significantly lower compared with those where fungicides (TMT1 and TMT2) were applied. The absence of fungicides during the season, resulted in up to 18 and 36% (BG3292) and 28 and 22% (IMP50-10B) yield loss in the first and second planting date trials, respectively.

Conclusions

Even though very high levels of disease severity were observed in the resistant cultivar, the application of fungicides were not economically viable.

References

A COMPARISON OF VISUAL DISEASE RATINGS AND FUNGAL TARGET DNA CONCENTRATIONS OF NINE COMMON ROOT ROT PATHOGENS

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Introduction

Root and crown rot are complex diseases that can be caused by fungi, bacteria and nematodes, or a combination of all three organisms. Real-time quantitative PCR (qPCR) are often implemented towards the identification and quantification of fungal pathogens because it is unbiased and less time consuming than visual disease ratings. The aim of this study was to compare visual disease ratings with results of qPCR analysis.

Materials and Methods

Three hundred maize plants (DKC 77-77BR) were randomly sampled, 112 days after planting, from a maize production site in the Wesselsbron area. Conventional tillage practices were implemented on the site under dryland conditions. The roots and crowns of the sampled plants were categorized into eight severity classes i.e. 10%, 20%, 30% 40%, 50% 60%, 70% and >75 % based on visual root and crown rot disease ratings (visual discoloration), with twelve plants per severity class. The twelve plants of each severity class were sub-divided into three replicates, from which DNA was extracted using the CTAB method. qPCR analysis was performed to quantify *Exserohilum pedicellatum*, *Macrophomina phaseolina*, *Fusarium oxysporum*, *Phoma* spp., *Curvularia eragostidis*, *F. graminearum*, *Pythium* spp., *Rhizoctonia solani* and *Trichoderma* spp.

Results and Discussion

Regression analysis was used to determine the relationship between visual disease severity classes and qPCR data. The only significant relationship was observed in the crowns for *F. oxysporum* and *F. graminearum*. Higher fungal target DNA concentrations were observed at higher percentage visual damage, with a similar relationship observed for the combined crown fungal target DNA concentrations (combination of nine tested fungi). No relationships were observed between the fungi tested in the roots (individually or combined) and the root disease severity classes.

Conclusions

Few significant visual disease ratings and target DNA concentration relationships existed in the crowns but none in the roots. Further investigation is required to establish why there is a lack of association between visual disease severity and target DNA concentrations.

References

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AN INVESTIGATION INTO THE EFFECT OF PLANT STRESS INDUCED BY NORTHERN CORN LEAF BLIGHT ON ROOT AND CROWN ROT DEVELOPMENT IN MAIZE

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Introduction

Stalk rot has, in the past, been shown to be more severe when co-occurring with leaf diseases. Root rot and crown rot infections often results in stalk rot and thus Northern Corn Leaf Blight (NCLB) might influence root and crown rot severity. The objective of this study was to determine the effect of NCLB disease incidence- and severity-levels on root and crown rots in maize cultivars with varying resistance levels to NCLB.

Materials and Methods

Three cultivars were planted in Potchefstroom during the 2016/17 season, with varying resistance levels to NCLB (IMP50-10B - susceptible, BG3292 - moderately susceptible, DKC 61-94BR - resistant). Eight treatments were included to create various levels of NCLB i.e. TMT1 - maximum control (3 fungicide applications); TMT2 - standard control (2 fungicide applications); TMT3 - natural control (not inoculated or sprayed). The remaining treatments were inoculated at various dates with a cocktail consisting of five NCLB races (Race 3, 3N, 23, 23N and 13N); TMT4 (5 weeks after planting -WAP); TMT5 (5+6 WAP); TMT6 (5+6+7 WAP); TMT7 (6+7 WAP); TMT8 (7 WAP). Plants were sampled at dent stage and screened for NCLB development as well as root and crown rot. NCLB disease severity was quantified as the percentage infected leaf material per plant per plot using a modified scale of 0, 0.5, 1, 5, 10, 25, 50, 70 and $\geq 85\%$. Root and crown rot severity was determined visually using a modified scale of 0-4. DNA was extracted and qPCR analysis was performed to quantify *Exserohilum pedicellatum*, *Macrophomina phaseolina*, *Fusarium oxysporum*, *Phoma spp.*, *Curvularia eragostidis*, *F. graminearum*, *F.verticillioides*, *Pythium spp.*, *Rhizoctonia solani* and *Trichoderma spp.* Regression analysis was conducted to establish the relationship between NCLB, root and crown rot for the three cultivars.

Results and Discussion

A significant relationship existed between NCLB and crown rot for cultivar IMP50-10B ($R^2 = 0.93$) only, with none of the other cultivars' root or crown rot severity being affected by the degree of NCLB. Likewise, a significant relationship was also observed between *F. oxysporum* target DNA concentrations in the crowns and the visual crown rot severity for IMP50-10B ($R^2 = 0.79$) indicating that *F. oxysporum* might have been the dominant soil-borne pathogen.

Conclusions

Root rot were not affected by the degree of NCLB infection in any of the three cultivars included. Crown rot was affected by NCLB in only one cultivar. Additional trials must be conducted to verify the stress impact of NCLB on maize roots and crowns.

References

NORTHERN CORN LEAF BLIGHT SEVERITY AND FUNGICIDE APPLICATION EFFECTS ON *F. verticillioides* AND FUMONISINS IN MAIZE GRAIN

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Introduction

Northern corn leaf blight (NCLB) is an economically important leaf disease of maize in South Africa and fungicides are applied prophylactically where NCLB occurs annually. Fumonisin is a secondary, carcinogenic metabolite produced by *Fusarium verticillioides*. The effect of induced plant stress by NCLB on *F. verticillioides* ear rot and resultant fumonisin production is unknown. Elevated fumonisin levels have been documented with the use of prophylactic fungicides containing strobilurins and/or triazoles. The objective of this study was to determine the effect of NCLB severity and fungicide applications respectively on *F. verticillioides* infection and fumonisin production in maize grain.

Materials and Methods

Two field trials were planted at Potchefstroom (mid-November and mid-December 2016) including susceptible (IMP50-10B), moderately susceptible (BG3292) and resistant (DKC 61-94BR) NCLB cultivars in a split plot design with treatment as the main plot and cultivar as the sub-plot (three replicates). Treatments included a control and two- and three- fungicide applications. The five remaining treatments were inoculated with five NCLB races (Race 3, 3N, 23, 23N and 13N) at different time intervals (5, 6 and 7 weeks, respectively) after planting. Fifteen randomly selected plants were screened for NCLB development at dent stage and disease was quantified as the percentage infected leaf material per plant per plot using a modified scale. Cob rot severity was determined for each plot after harvest and yield calculated (t/ha; 12.5% moisture). Individual maize samples were milled and total fumonisins (B1+B2+B3) quantified through LC/MS analysis.

Results and Discussion

Analysis of variance indicated that the treatments had no effect on *F. verticillioides* ear rot incidence and severity in either of the two trials. Significantly higher levels of ear rot incidence and severity was recorded in cultivar BG3292 compared to cultivars IMP50-10B and DKC 61-94BR. In trial one, treatment one (three fungicide applications) and eight (inoculated seven WAP) had a significant effect on total fumonisins, with a highest average concentration of 5.22 ppm and 4.05 ppm, respectively. In trial one, mean total fumonisins was significantly higher ($P=0.002$) in cultivar BG3292 (3.84 ppm). Treatments had no effect on fumonisins in trial two and mean total fumonisins was significantly higher ($P=0.001$) in cultivars BG3292 (2.92 ppm) and IMP50-10B (2.62 ppm).

Conclusions

NCLB severity did not influence *F. verticillioides* incidence and severity or fumonisin contamination in maize grain. The effect of fungicides on fumonisin production should be further investigated.

References

The Influenced of plant density and nitrogen fertilizer rates on growth of Water Efficient Maize (WEMA)

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Introduction

Nitrogen is considered as the most important and limiting nutrient for profitable maize production in most African soils. The majority of South African soils are widely deficient in nitrogen and this is a most challenge to world. Hence, this study aimed at evaluating the effect of plant density and nitrogen fertilizer rates on growth of Water Efficient Maize variety.

Materials and Methods

Field experiments were conducted at two sites of North-West Province, South Africa during 2015/16 and 2016/17-summer planting seasons namely the North-West University Research Farm (NUWRF) and the North - West Provincial Department of Agriculture Research station in Taung (NDAFS). The experiment at each site was laid out in split plot arrangement fitted into a randomized complete block design (RCBD) with four replications. The main and subplot were plant density (44444, 55555 and 33333 plants/ha) and nitrogen rates (0, 60, 120, 180 and 240 kg N /ha), respectively. Inorganic NPK fertilizer 20:7:3 was applied as basal dressing (half of each rates) while lime ammonium nitrate (LAN, 28%) was used for top dressing. At tasseling and physiological maturity stages, five maize plants were tagged from middle in each plot and used for data collection. Data collected included chlorophyll content index (CCI) and plant height using CCM-200 Chlorophyll content meter and measuring tape, respectively; the number of leaves was physical counted, leaf area was determined as described by Otegui et al (1996) and stem diameter with aid of Vernier caliper. Data were analyzed using analysis of variance and treatments means separated with LSD $p < 0.05$.

Results and Discussion

The interaction treatment between sites, plant density and nitrogen rates fertilizer were significant ($P \leq 0.05$). During both seasons, plant height of (235.63cm) was obtained at NUWF with 60 kg N/ha under 33,333 plants/ha. Highest plant height of (309.95 cm) was recorded at 240 kg N/ha with 55,555 plants/ha during physiological maturing in both seasons at NUWF. During tasseling stage, highest leaf area (724.0 cm² and 874 cm²) respectively was obtained with application of 60 kg N/ha under 55,555 plants/ha during both seasons at NUMF. During 2016/17 season, NUWF had highest leaf area (758.4 cm²) with application of 180 kg N/ha under 55,555 plants/ha. Plot with 44.444 plants/ha when applied with 60 kg N/ha gave highest leaf area (888.36 cm²) during physiological maturing at NUWF in 2016/17.

Conclusions

Both high plant density and nitrogen fertilizer rates had positive influence on the WEMA variety growth parameters.

References

PREDICTION OF RUNOFF ON THE GLEN/BONHEIM ECOTOPE

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Introduction

Prediction of runoff (R) with models enables researchers to quantify the benefits of water harvesting techniques in terms of crop yield for different ecotopes. It is however not easy to accurately predict R since R is controlled by various factors (soil type, surface cover, cultivation practices and rainfall characteristics).

Materials and Methods

The ability of a number of empirical statistical R models and two dynamic R models, area under the rainfall intensity curve (AUC) method and the Morin & Cluff (M&C), for predicting R on the Glen/Bonheim ecotope were tested against measured data over seven rain seasons. The tests were conducted for different kinds of soil surfaces: a) a bare, crusted conventional tilled surface (CON); b) a bare, flat, crusted in-field rainwater harvesting (IRWH) surface; c) surfaces covered with either organic or stone mulch. Willmott (1982) statistical parameters (r^2 , d and $RMSEu/RMSE$) were used for the evaluation of models' performance.

Results and Discussion

Application of the M&C runoff model showed that the key factors influencing R are rainfall intensity (P_i); final infiltration rate of the soil (I_f); surface storage (SD_m), which depends on the surface roughness; and the speed and degree of crust formation (γ). The measured R values from the IRWH, CON, mulch and stone surface treatments were 35, 11, 6 and 23% of the rainfall, respectively. The M&C model gave the best overall performance. Appropriate values for the M&C model on the Glen/Bonheim ecotope are: $I_f = 6 \text{ mm hr}^{-1}$; $\gamma = 0.02 \text{ mm}^{-1}$; $SD_m = 3, 0.05, 6 \text{ and } 0.2 \text{ mm}$ for a CON, IRWH, mulch and stone surface treatment, respectively. The Willmott statistical test parameters for the IRWH surface gave the following acceptable results: $d = 0.88$; $r^2 = 0.63$; $RMSEu/RMSE = 0.83$. The AUC method and two empirical equations also gave acceptable R predictions for the IRWH surface. One empirical equation gave acceptable predictions for the CON surface.

Conclusions

The M&C model can be used with confidence to predict R from flat, bare, crusted IRWH soil surfaces on the Glen/Bonheim and similar semi-arid ecotopes. It can also predict R from CON surfaces in a reliable way.

References

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COMBINING ABILITY AND HETEROSIS OF EXTRA-EARLY MATURING PROVITAMIN A INBREDS AND PERFORMANCE OF DERIVED HYBRIDS UNDER MULTIPLE ENVIRONMENTS

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Introduction

Breeding of maize hybrids with high pro-vitamin A (PVA) could prevent PVA deficiency diseases including night blindness and depressed immune system. Objectives of this study were to determine the combining abilities and heterotic groups of IITA extra-early PVA inbreds, identify testers and assess yield and stability of hybrids across environments.

Materials and Methods

One hundred and ninety F1 hybrids derived from diallel crosses involving 20 extra-early PVA inbreds plus six checks were evaluated using 14 x 14 lattice design with two replications under Striga infestation at Mokwa, drought stress at Ikenne and optimal environments at Mokwa and Ikenne, 2015-2017. General combining ability (GCA) and specific combining ability (SCA) effects were computed. Inbred lines were classified into heterotic groups across environments using heterotic groups' SCA and GCA of grain yield (HSGCA) method. Inbred and single-cross testers were identified and AMMI analysis was used to determine the yield and stability of hybrids across environments.

Results and Discussion

The GCA and SCA effects were significant for grain yield and most other traits indicating that both additive and non-additive gene actions governed the inheritance of measured traits of the inbreds. However, the over-dominating effect of the GCA over the SCA effects of the traits suggested that additive gene action was more important than the non-additive in the expression of the traits. The inbreds TZEEIOR 202 and TZEEIOR 205 had PVA levels of 16.09 and 12.39 $\mu\text{g/g}$, respectively. The HSGCA method classified the inbred lines into three heterotic groups. The inbreds TZEEIOR 197 and TZEEIOR 205 were identified as testers for heterotic groups 2 and 3 while no inbred satisfied the requirements of a tester in heterotic group 1. Single cross testers TZEEIOR 109 x TZEEIOR 197 and TZEEIOR 205 x TZEEIOR 250 were identified for heterotic groups 2 and 3. The hybrids TZEEIOR 24 x TZEEIOR 109, TZEEIOR 30 x TZEEIOR 209, TZEEIOR 41 x TZEEIOR 142, TZEEIOR 197 x TZEEIOR 251, TZEEIOR 142 x TZEEIOR 197 and TZEEIOR 30 x TZEEIOR 205 were high yielding and stable across environments and should be tested extensively and commercialized to contribute to food and nutrition security in sub-Saharan Africa (SSA).

Conclusions

Inbred lines with high levels of PVA could serve as sources of beneficial alleles for improvement of PVA levels of tropical breeding populations. Inbred and single cross testers could be used for classifying PVA inbreds in SSA. High yielding and stable hybrids could contribute to food security in the sub-region.

References

The relationship between minerals and phenolic acids in selected South African wheat genotypes

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Introduction

The wheat (*Triticum aestivum* L.) grain houses a wide range of nutritional components such as macronutrients and micronutrients, including phenolic compounds that are important for human health. Outer layers of the grain were reported to have more phenolic acids and mineral than the endosperm region. Regular consumption of wholegrains is said to improve health and prevents the occurrence of illnesses such as cancer, diabetes and cardiovascular diseases. Biofortification can be utilized as a tool to enhance the bioavailability of desirable nutrients in a sustainable manner. The genetic variation of a desirable trait of interest needs to have been established prior to carrying out biofortification. However, little or no information is available on the genetic variation of minerals and phenolic acids amongst South African wheat genotypes. In this study, the relationship between minerals and phenolic acids between selected wheat genotypes is discussed to guide attempts to improve nutritional quality.

Materials and Methods

The mineral and phenolic compound composition of more than 360 samples of white and wholemeal flour was determined using the ICP-OES and ThermoFischer TSQ 8000 MS quadrupole Gas Chromatography-Mass Spectrometry (GC-MS/MS) instrument operated in single reaction monitoring (SRM) mode; BSTFA with 1% TCMS was used for derivitization. Statistical tests were analysed using the Genstat ® 18th edition software.

Results and Discussion

More than five minerals were detected at varying concentrations including 10 phenolic acid derivatives (hydroxybenzoic acid, ferulic acid, caffeic acid, p-coumaric acid, gallic acid, syringic acid, m-coumaric acid, protocatechuic acid and syringaldehyde) were detected in varying concentrations in white and wholemeal flour. The major phenolic acid derivative detected was p-coumaric acid and the least phenolic acid derivative detected was hydroxybenzoic acid across the genotypes. The correlation between the major phenolic acid derivatives and essential mineral elements amongst the different wheat genotypes was explored.

Conclusions

South African wheat genotypes contain a wide range of minerals and phenolic acid derivatives at varying levels. The relationship between these components will provide a guidelines to pre-breeding programs when targeting the development of germplasm with improved nutritional quality.

References

Water stress development of glasshouse grown malting barley under water-limited conditions

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Introduction

Malt barley is typically grown in dryland conditions in South Africa. It is an important cereal grain after wheat, but little is known about its water requirements and most importantly how it responds to water stress. Determining when water stress sets in and how malt barley responds to water deficit during its growing season is crucial for improved management of crop water requirements. The objectives of this study were to evaluate the response of plant available water (PAW) content, transpiration (T), stomatal conductance (SC) and leaf water potential (LWP) to water stress for different growth stages of malting barley. These indicators were used to identify onset and different levels of water stress (mild, moderate and severe).

Materials and Methods

This was achieved by monitoring the water stress indicators under greenhouse conditions in well-watered and water stressed lysimeters over two years. The crop was grown for two seasons on lysimeters, and was subjected to water stress at different growth stages (Late tillering, Flag leaf, Anthesis and Milk/Dough) from the beginning until the end of each growth stage.

Results and Discussion

Results show that inducing water stress resulted in a high variability of PAW, T, SC and LWP during the growing season. T was found to be the most sensitive indicator in detecting the onset of water stress for malt barley across all the crop growth stages of Late tillering, Flag leaf, Anthesis, except the Milk/Dough stage, while PAW was better at differentiating water stress into mild, moderate, severe levels.

Conclusions

Soil-based measures of T and PAW would be useful for irrigation management of malt barley.

References

SOCIO-ECONOMIC IMPACT OF COCONUT LETHAL YELLOWING DISEASE IN MOZAMBIQUE

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Introduction

Coconut palm (*Cocos nucifera* L.) is an important cash crop, widely cultivated in tropical and coastal regions of the world. In Mozambique, succession of coconut lethal yellowing disease (CLYD) epidemics, caused losses of millions of coconut trees, threatening the livelihood and subsistence of a significant part of the Mozambican population. In this study, the socio-economic impact of CLYD in Mozambique has been investigated.

Materials and Methods

To assess how CLYD affects the coconut farmers' income, descriptive followed by multivariate linear regression (MLR) analysis was used, where several income variables are used as dependent variables. In contrast to the dependent variables that are measured on a numerical scale, the explanatory variables were both categorical and numerical, for which MLR is better suited. The target population for this study was households currently involved in coconut production. The data was collected in 2012 and covered 499 randomly selected coconut farmers of Zambezia and Nampula provinces. The income variable was chosen due to its linkage with different socio-economic parameters.

Results and Discussion

In northern and central Mozambique where CLYD is now endemic, 100% coconut production losses can be observed in several production sites. As result, the private's companies associated with production, processing, and export of coconut are closing, and thousands of workers were fired, with direct impact on their livelihood. For small scale farmers, the income from non-agricultural activities has the highest mean value of 4248 metical/year, while coconut and other farming income were 2204 and 2230 metical/year respectively, which suggested that it was more profitable to be engaged in non-agricultural rather than any farming activities. However, beside coconut and other farming activates, the majority of the households didn't have any other source of income. This study failed to quantify the money saved by the household for self uses of the different coconut parts and its derivates, which is not a negligible figure. The coconut losses due to CLYD will limit the community for its endless uses, such as stable food, timber, material for building houses, fences, furniture, boat, fuel, etc.

Conclusions

CLYD has negative impact on both income from coconut and its derivate as well as from other farming activities. The income from coconut palm is highly depended on the availability of actively producing trees which in turn is affected by CLYD prevalence. The disease is currently threatening the ongoing and even the incoming investors in the coconut sector, with disastrous socio-economic impact on the population of the study area.

References

Evaluation of well-composted pine bark as an alternative to peat moss in a standard rooting medium for *Leucospermum*

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Introduction

The Fynbos nursery at Agricultural Research Council (ARC) Infruitec-Nietvoorbij in Stellenbosch, South Africa (33°55'28.1"S; 18°52'26.1"E), maintains the national Proteaceae genebank and supports related research. The maintenance protocol requires the rooting of various genotypes. A sufficiently aerated rooting mixture is essential in rooting Proteaceae cuttings. The rooting medium used in the ARC's protocol comprises of peat moss, coarse sterilised sand and polystyrene granules. This mixture has the ability to absorb and retain irrigation water, but still allows aeration. The aim of these trials was to evaluate alternative rooting mediums on three genetically diverse *Leucospermum* cultivars: 'Jyoti' (*L. cuneiforme* × *L. conocarpodendron*), 'Raziya' (*L. patersonii* × *L. cordifolium*) and 'Rigoletto Gold' (*L. glabrum* × *L. cordifolium*).

Materials and Methods

The trial was performed in March 2016 and repeated in May of the same year. The standard rooting medium was compared with two mediums composed of well-composted, fine pine bark and coarse sterilised sand. Root length and weight was determined after 13 and 29 weeks respectively, and rooting success was evaluated according to a standard scale ranging from callused to well-rooted.

Results and Discussion

It was found that, overall, cultivar differences had a more significant effect on rooting than variations in rooting media composition. 'Raziya' produced well-rooted cuttings with the longest roots independent of rooting medium used. However, the root length of 'Rigoletto Gold' was significantly influenced by the medium used, with the best results on pine bark and sand in a 1:1 v/v ratio. During the May trial a cultivar-treatment interaction was revealed on the category "well-rooted". Rooting success increased with longer exposure to the rooting environment. Pine bark can, therefore, be considered as an alternative to peat moss, since rooting is not significantly influenced by replacing the peat moss and polystyrene granules with pine bark in the growth medium.

Conclusions

The following conclusions can be drawn from the study: Rooting success increased with longer exposure to the rooting environment and precaution should be taken not to remove cuttings too soon. Cultivar or genetic composition of the cultivars revealed a more significant effect on success of rooting than the rooting medium. Alternative rooting mediums which are more cost effective can be utilized for successful rooting of *Leucospermum*.

References

EVALUATING VARIOUS LARGE-SCALE RAINWATER HARVESTING AND CONSERVATION TECHNIQUES ON THE FORT COX/VALSRIVIER ECOTOPE

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Introduction

Less than 15% of South Africa's land area is arable. This implies very limited scope for conventional food production. In addition, South Africa is a semi-arid, water-scarce country with an average rainfall of less than 500 mm per annum (Schulze et al., 1997). Rainwater harvesting and conservation (RWH&C) practices have demonstrated to increase agricultural production in semi-arid areas. This study seeks to assess RWH&C techniques for improved cropland productivity under large-scale conditions.

Materials and Methods

Statistically laid out cropland field experiments were carried out over five growing seasons (2008/09 - 2012/13) on the Fort Cox/Valsrivier ecotope in the Eastern Cape Province of South Africa to compare RWH&C techniques with conventional tillage (CON) under commercial conditions. Five treatments, viz. CON (control), in-field rainwater harvesting (IRWH 2.4-m runoff area), Daling plough (DAL), mechanized basins (MB) and minimum (MIN), replicated four times, were laid out in a randomized block design. Maize (PAN 6Q-708BR) with a plant population of 18000 plants ha⁻¹ was used as the indicator crop. The indicators used were grain yield, above-ground biomass, plant available water (PAW), soil water content (SWC) and rainwater productivity (RWP).

Results and Discussion

Comparing the results of all parameters (grain yield, biomass, PAW, SWC and RWP) indicate: a) a trend of IRWH2.4m > MB > DAL > MIN > CON; b) that all the RWH&C treatments were superior to CON; c) IRWH2.4m was the best technique overall; and d) that the RWH treatments (IRWH2.4m & DAL) performed slightly better than the conservation treatments (MB & MIN). The results indicate that all the RWH and conservation treatments were on average 22 and 18%, respectively, more effective than CON in converting rainwater into grain yield.

Conclusions

RWH&C techniques induced higher yields, PAW and RWP values than CON with IRWH2.4m being the most effective under large-scale conditions.

References

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THE INFIELD EVALUATION OF THE SEED TREATMENT FLUQUINCONAZOLE ON PGPR EFFICIENCY ON PROMOTING WHEAT HEALTH AND YIELD.

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Introduction

Wheat is one of the most important grain crops in South Africa but soil fertility is a major constraint as fertilizer cost can amount to 30% of the production inputs. Research findings support the use of rhizobacteria as a potential agrochemical replacement. In this study the effect of Fluquinconazole a fungicidal seed treatment was evaluated on the efficiency of various rhizobacteria to promote wheat health and yield.

Materials and Methods

The trial was planted on Huttons ecotype found on Tlokoeng ADC in a CRD (complete randomized design) design. Each treatment was replicated three times and each replicated consisted of a 4m x 4m block with a 1.5m buffer. Fertiliser was applied at planting to 75% of the standard wheat production recommendations and 0.77 kg of seed (Duzi® Klein Karoo, P.o. Box 159, Oudshoorn, 6620, South Africa) was used as per planting population recommendations. The treatments comprised Fluquinconazole treated and untreated wheat seed inoculated with the PGPR, B-RUS or UP-mix in a liquid or powder form. Two controls were introduced that comprised of untreated/uninoculated or Fluquinconazole treated seed. All treatment dosages were applied to factory specifications. The trial was irrigated for one hour, twice a week until harvesting at grain maturity. Bi-monthly growth rate (soil surface to apical leaf) was collected from the second to the fourth row while yield data was collected by harvesting the whole plot at a 12% grain moisture content. All the collected data was analysed using Genstat 14.1 at a 95% confidence level and the means separated using Fishers protected LSD.

Results and Discussion

The yield results indicated that all the treatments increased wheat yield compared to their respective controls except the Fluquinconazole & Brus® liquid treatment that decreased yield by 47.02% compared to its respective control yield of 4.11tha⁻¹. The best performing treatment was the UP-mix seed treatment closely followed by the Brus® liquid treatment with a yield increase of 63.92% and 63.52% over that of the control yield 3.29tha⁻¹.

Conclusions

The current study and complementary studies such as Kifle & Laing (2011) and Miller & Bassler (2001) clearly indicates the sensitivity of the technology to biotic and abiotic factors. However considering these limitations the studies show the potential of biofertilizers to increase the economic viability of farming through increased yields.

References

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STERILIZATION OF PECAN [*CARYA ILLINOENSIS* (WANGENH.) K. KOCH] BUDS FOR IN VITRO CULTURING

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Introduction

One of the major problems in micro propagation is the sterilization of plant material from field grown trees, especially the buds (Altaf, 2006). In the present study, the aim was to compare two chemical sterilization agents namely: sodium hypochlorite (NaOCl) and hydrogen peroxide (H₂O₂) and their effect on the survival rate of in vitro cultivated buds.

Materials and Methods

Pecan buds (cv. Ukulinga) with scales removed were subjected to two different sterilization methods: 1) soaking buds in 70% ethanol for 2 min and then dipping in sodium hypochlorite (NaOCl 5.25% v/v) for 2 min followed by rinsing 5 times with sterile deionized water; 2) soaking buds in 70% ethanol for 2 min and then dipping in hydrogen peroxide (H₂O₂ 30% v/v) for 3 min followed by rinsing 5 times with sterile deionized water. Buds were cultivated on Murashige and Skoog (MS) medium supplemented with 30 g L⁻¹ sucrose, 2 mg L⁻¹ glycine, 1 mg L⁻¹ BAP, 40 mg L⁻¹ adenine sulfate, 500 mg L⁻¹ ascorbic acid, 100 mg L⁻¹ CaCl₂, 1 mg L⁻¹ calcium pantothenate, 556 mg L⁻¹ CaNO₃ and solidified with 0.4% phytigel. The pH was adjusted to 5.7 before autoclaving. Two buds per container were incubated in the dark at 26°C for 1 week followed by a 16/8 hour day/night photoperiod and each treatment replicated 9 times. Data were collected after 5 weeks of incubation and the following parameters were recorded: survival (%), shoot number and shoot length (cm).

Results and Discussion

Browning of the buds occurred at the end of the third week of incubation. The percentage survival rate of buds was low for both methods (<50%). However, survival of buds treated with sodium hypochlorite (38.8%) was significantly higher than buds treated with hydrogen peroxide (13.3%). No significant differences between the methods were observed for shoot number and length.

Conclusions

The survival rate of buds was low so further studies are required to refine the protocol to increase the survival rate.

References

Altaf N. 2006. In vitro bud culture of kinnow tree. Pakistan Journal of Botany 38(3): 597-601.

IN VITRO PROPAGATION OF CACTUS PEAR (*OPUNTIA FICUS-INDICA*) AND GLASSHOUSE ESTABLISHMENT

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Introduction

Cactus pear (*Opuntia ficus-indica*) belongs to the Cactaceae family and is native to Mexico. It has huge potential as an alternative energy source for the production of biogas as well as a biofertilizer in South Africa (Varnero, 2001). For this reason mass multiplication of plant material is needed. The aim of this study was to propagate cactus pear in vitro and then establish it in a greenhouse.

Materials and Methods

Ten axillary buds of in vitro propagated 'Morado' explants were cultured on Murashige and Skoog (MS) medium supplemented with 30 g L⁻¹ sucrose, 2 mg L⁻¹ IBA, solidified with 0.8% agar and the pH adjusted to 5.8 prior to autoclaving. Buds were incubated for 4 weeks at 26°C and 16/8 hours of light/dark photoperiod. Rooting percentage and survival rate were recorded after 28 days. Five plantlets were transplanted in pots filled with Hygromix growth medium and kept under room conditions for 30 days where after it was transferred to a greenhouse (24±2°C/15±2°C day/night temperatures).

Results and Discussion

A one hundred percent survival rate and rooting was observed for the ten buds propagated in vitro on the MS medium. The in vitro rooted 'Morado' plantlets were successfully transplanted in pots and established in the greenhouse for a period of 12 weeks.

Conclusions

This preliminary work showed that 'Morado' can be propagated in vitro and laid the basis for future research for mass and rapid multiplication of cactus pear.

References

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THE INFLUENCE OF COVER CROP TYPE AND MANAGEMENT ON THE WEED SEEDBANK UNDER CONSERVATION AGRICULTURE

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Introduction

Introduction of cover crops to improve soil health can affect the weed seedbank in terms of weed density as well as a possible shift in certain weed species, better adapted to the changed environment. The aim of this study is to determine the weed seedbank dynamics in terms of specie composition and density.

Materials and Methods

The study is in progress at the Langgewens Research Farm near Moorreesburg, Western Cape. The treatment design is a split-plot design with two cover crop mixtures (70%/30% combination) as allocated to the main plots, predominantly grass or predominantly legume and methods of cover crop termination to sub plots. Termination methods include (1) rolling crop towards end of the growing season and left as mulch, (2) biomass removed as hay and (3) mob grazed by sheep. A composite soil sample consisting of 12 soil cores were taken in each subplot to a depth of 5 cm at the end of March 2017, placed in trays and irrigated regularly to stimulate germination. Weed seedlings were identified, counted, noted and removed at monthly intervals over a period of 6 months.

Results and Discussion

The two dominant weed species were *Lolium* and *Conyza*. *Lolium* seedling numbers were higher following the predominantly grass cover (18 seedlings.m⁻²) compared to the predominantly legume cover (5 seedlings.m⁻²). *Conyza* seedling numbers were also lower in the legume cover (54) compared to the grass cover (80). The effect of the different termination method showed that hay production resulted in more *Lolium* seedlings.m⁻² (21) compared to mulch (8) and grazed (5), whereas the *Conyza* seedling number was higher in the grazed (74) than in the much (62) and hay (65).

Conclusions

Preliminary results show that type of cover crop may influence the number of weeds germinating during the following season and that the method of termination may also play a role. Management recommendations will only be finalised after completion of the study after at least 3 years of data capturing.

References

YIELD PROBABILITIES AS A TOOL TO DETERMINE THE MOST SUITABLE SOYBEAN CULTIVARS DURING CULTIVAR SELECTION

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Introduction

The correct cultivar selection for soybeans under different environmental conditions is important to ensure optimum yield and profitability. The best-adapted cultivar is therefore the one that will, in the long term, give the best yield and quality for a specific locality within a specific geographical area. A selection can be made of cultivars with high yield and above average yield probability under comparable environmental conditions as well as production practices.

Materials and Methods

Thirty-two (32) commercial cultivars were evaluated, during the 2016/17 season in 21 field trials representing the cool-, moderate- and warm areas. These cultivars were evaluated for seed yield and some agronomical characteristics, and response to environmental factors. Only GMO cultivars were included in the trials and Roundup applications were used during the execution of the trials. A randomised complete-block design with three replicates was used for all field trials. Each trial plot consisted of four, 5 m rows. Four metres were harvested from each of the middle two rows, in order to avoid border effects. Soil form, fertilization and weed control together with row spacing as well as rainfall and irrigation were also recorded. All seeds were inoculated with *Bradyrhizobium japonicum* bacteria at planting. The regression line technique, calculated for each cultivar over localities, are based on the least square method with mean locality yield as the independent and cultivar yield as the dependable variable. From this analysis yield probabilities can be calculated for different yield potentials (Thiebaut 2015). This technique is chosen due to the expression of cultivar performance by taking the cultivar environment interaction and stability into account.

Results and Discussion

The 2016/17 production season's results indicated that the mean yield of the best four cultivars (3656 kg ha⁻¹) was approximately 933 kg ha⁻¹ higher than the mean yield of the poorest four cultivars (2723 kg ha⁻¹) in the cool area. This relates to R4 198.50 ha⁻¹ at a price of R4 500 t⁻¹ and indicated the advantage of the correct cultivar choice. Although the yield can be high for a cultivar, (NS 5909 R - 3320 kg ha⁻¹) the yield probability can be below average for the lower yield potential (18, 26 and 35 % respectively for the 1, 1.5 and 2 t ha⁻¹ yield potential).

Conclusions

The yield of a cultivar in combination of the yield probability gives a more reliable estimate of the potential of that specific cultivar.

References

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INFLUENCE OF NITROGEN SOURCES ON YIELD AND QUALITY OF CANOLA IN CONSERVATION AGRICULTURE SYSTEMS IN THE WESTERN CAPE OF SOUTH AFRICA

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Introduction

Environmental conditions will influence nitrogen use efficiency. Leaching and volatilisation are two of the most important parameters influencing N use efficiency. Different N formulations were developed to be used under specific ranges of soil, climatic and management conditions. For the producers it is important to use the most efficient N source for their specific conditions to ensure cost-effective production. The aim of this study was to evaluate the efficiency of different N sources topdressed on seed yield and quality of canola.

Materials and Methods

Four research sites namely Riversdale, Riviersonderend, Moorreesburg and Darling were included in the study. Five N sources, ammoniumsulphate, urea, urea plus urease inhibitor, limestone ammoniumnitrate and limestone ammoniumnitrate plus S were used. Trial was laid out as a randomised block design replicated 4 times. Topdress N rate was cropping system and site specific, based on the general recommendations for the different systems and areas. Application rates were 53, 70, 68 and 45 kg N ha⁻¹ for canola after wheat at Darling, Moorreesburg, Riviersonderend and Riversdale respectively. Seed yield and oil content were recorded.

Results and Discussion

Except for Moorreesburg where urea plus urease inhibitor caused significantly ($P=0.05$) lower oil content compared to the other sources, no significant differences in yield and oil content were recorded between the different N sources evaluated.

Conclusions

Preliminary results show that application of different N sources at rates recommended did not influence canola yield and quality. The current study shows that the cost of N could be the deciding factor when a decision on N source must be made. Recommendations will only be finalised after at least 3 years of data capturing.

References

SOIL MINERAL NITROGEN IN RESPONSE TO NITROGEN RATE TOPDRESSED ON CANOLA UNDER CONSERVATION AGRICULTURE IN THE WESTERN CAPE

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Introduction

The use of soil N test values to determine topdressed N application requirement can be regarded as a useful and important management tool. To ensure successful implementation of this tool, accurate predictions of the response of soil test N value to applied fertiliser N is essential. The aim of this study was to determine the relation between top-dressed fertiliser N application rate and the resultant increase in soil mineral N test value.

Materials and Methods

Canola (Hyola 575) was planted at five different locations in the grain producing areas of the Western Cape. The trial was laid out as a randomised block with four replications. The N treatments comprised of planting with 25 kg N ha⁻¹ and 0, 25, 50, 75, 105, 135 and 165 kg N ha⁻¹ topdressed. A control treatment was included that did not received any fertiliser N. Soil samples were taken to a depth of 300 mm and NO₃⁻-N and NH₄⁺-N determined colorimetrically on a SEAL AutoAnalyzer 3. For the purpose of this presentation total mineral N was calculated as the sum of NO₃⁻-N and NH₄⁺-N.

Results and Discussion

The soil mineral N content was plotted against total N applied for all sites included in the study. Increases in N fertiliser application rate resulted in an increase in soil mineral N content. R² values differed between localities and years. R² values were in general lower in 2017 compared to 2016.

Conclusions

Preliminary results show that the response of soil mineral N test value in response to fertiliser N applied is highly variable, possibly as a result of climatic conditions immediately after topdressed N application. Prediction models will only be finalised on completion of the study after at least 3 years of data capturing.

References

DEVELOPING MINIMUM INHIBITION CONCENTRATION OF CUCURBITACIN A ON MELOIDOGYNE INCOGNITA USING A COMPUTER-BASED MODEL

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Introduction

Minimum inhibition concentration (MIC) is the lowest concentration of a chemical that brings about significant inhibition of the target organism. The conventional method for establishing the MIC for phytonematicides is tedious. The objective of this study was to use the Curve-fitting Allelochemical Response Data (CARD) to determine the MIC for pure cucurbitacin A on *Meloidogyne incognita* second-stage juveniles (J2) hatch, immobility and mortality.

Materials and Methods

Meloidogyne incognita eggs and freshly hatched J2 were separately exposed to a series of pure cucurbitacin A concentrations of 0.00, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25 and 2.50 $\mu\text{g}\cdot\text{mL}^{-1}$ for 12, 24, 48 and 72 h in an incubator set at $25 \pm 2^\circ\text{C}$. *Meloidogyne incognita* J2 hatch, immobility and mortality counts were determined using a stereomicroscope and the significant means were subjected to the CARD model.

Results and Discussion

The model exhibited density-dependent growth (DDG) patterns of J2 hatch, immobility and mortality to increasing concentrations of cucurbitacin A. The average MIC for cucurbitacin A on *M. incognita* J2 hatch, immobility and mortality were 2.2, 0.58 and 0.63 $\mu\text{g}\cdot\text{mL}^{-1}$, respectively. *Meloidogyne incognita* J2 hatch had the highest average MIC value followed by mortality and immobility had the least. Low MIC values indicates high level of compound toxicity to J2. Pure carvacrol, linalool, thymol, menthone and glucosinolate degradation products were found to be toxic on *Meloidogyne incognita* J2 at concentrations of between 1 and 4 $\text{mg}\cdot\text{L}^{-1}$ (Ibrahim et al. 2006), which are higher than those observed in this study. The minimum J2 inhibition concentrations observed in this study were lower than those of *H. schachtii* and *M. javanica* J2 exposed to aldicarb at 1 to 5 $\mu\text{g}\cdot\text{mL}^{-1}$ water (Hough and Thomason 1975).

Conclusions

The CARD model was able to generate MIC for cucurbitacin A, hence it could serve as a valuable tool in the chemical-nematode bioassay studies.

References

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HIGH BIOMASS PRODUCING COVER CROP MIXTURES SUPPRESS HERBICIDE RESISTANT RYEGRASS

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Introduction

Herbicide-resistant weeds, environmental concerns and cost containment, has prompted interest in new weed control measures. By broadening the array of weed management options available, producers may manage these pressures more effectively. Therefore, the objective was to study the effects of cover crop mixtures on herbicide resistant ryegrass.

Materials and Methods

Cover crop mixtures comprised of white mustard-lupine, rye-serradella, and black oats-vetch, were each planted annually over a five year period at two localities, namely Langgewens and Tygerhoek. Wheat was cultivated as standard treatment. Apart from wheat, no agricultural chemicals were applied to cover crop mixtures. Plots were laid out in a randomised block design with four replicates. The control was an untreated plot to allow natural weed growth. Student's t-least significant difference was calculated at the 5% level to compare treatment means.

Results and Discussion

All cover crop mixtures effectively suppressed weeds at above 80% and produced more than 7 t ha⁻¹ of dry biomass at Tygerhoek. At Langgewens, weed suppression was above 70%, except for the black oats-vetch treatment which achieved more than 80%. At this locality, biomass production by cover crop mixtures was more than 4 t ha⁻¹. The lower biomass production at Langgewens in all probability resulted in lower weed suppression. In addition, a very high ryegrass seed bank, lower soil depth and shorter rainfall period, prevented cover crops from producing greater amounts of biomass. Nevertheless, all treatments at both localities provided moderate to excellent weed suppression which skipped herbicide use in that particular year, thus preserving its efficacy for longer.

Conclusions

The adoption of cover cropping in conservation agriculture may form part of an integrated weed management system in crop rotation, thereby benefitting sustainability by suppressing herbicide resistant ryegrass.

References

STRATEGIES FOR SUPPRESSING NUTSEdge DURING TRANSITION TO ORGANIC PRODUCTION

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Introduction

Herbicide resistance, production costs, sustainable production and environmental and human health concerns necessitates the development of new weed control strategies. Cover cropping, flail mowing and plant mulching are non-chemical techniques. These practices, in combination with limited herbicide application in the early stages, were tested in an integrated way to evaluate its effectiveness for nutsedge management during the transitional phase to organic vegetable production.

Materials and Methods

Field treatments for cover cropping and mulching were arranged in a randomised block design with four replicates in a field trial conducted over three years at George, Western Cape. Winter cover crops consisted of grass crops in mixtures with legumes. Treatments also included pure stands of grass crops. All winter and summer treatments were cut at 18 weeks after planting to form mulches. Tef grass was planted as a summer cover crop. Student's t-least significant difference was calculated at the 5% level to compare treatment means.

Results and Discussion

Weeds numbers were suppressed significantly by over 80% by black oats, black oats-lupine, rye-vetch and rye-serradella treatments. In summer, tef grass suppressed nutsedge and all weeds effectively at 86%. Dry mass production of all treatments was above 5 t ha⁻¹. After cutting and flail mowing all treatments at 18 weeks after planting to form plant mulches, effective weed suppression was extended by an additional 6 weeks. Therefore, the period of weed suppression was extended with thick plant mulches until planting of the summer or winter cover crop.

Conclusions

By integrating winter and summer cover cropping, cutting, flail mowing and mulching and using it in tandem to constantly cover the soil, nutsedge may be suppressed effectively with less herbicide, benefitting and promoting sustainable agriculture.

References

Effect of cover crops and soil management on Nata red-top (*Rhynchelytrum Repens*)

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Introduction

This perennial spreading grass grows mainly in summer and, therefore, competes with the grapevine for water and nutrients. The objective of the study was to determine the effect of different weed management treatments on the stand of Natal red-top, a group of species which had a significant stand in the experiment vineyard.

Materials and Methods

Twelve treatments were applied in a full-bearing, seven-year-old drip irrigated Shiraz/101-14 Mgt vineyard established on a sandy to sandy clay loam soil (33°58'S, 18°50'E) near Stellenbosch. Five cover crop species and a treatment in which no winter growing cover crop was established (Weeds) were evaluated. Two management practices were applied to each of these winter treatments, namely full surface, post-emergence weed control (CC) or slashing of cover crops/weeds which was immediately mechanically incorporated in the soil (MC) during grapevine bud break. The dry matter production (DMP) of Natal red-top were determined at the end of August (winter growth), end of November (grapevine berry set) and beginning of April (post-harvest).

Results and Discussion

Natal red-top was prominent pre-treatment in all the treatments plots, but absent in Nemat (*Eruca sativa* cv, Nemat) (MC). The pre-treatment results indicate that this perennial grass seemed well adapted to the permanent sward system applied in the vineyards. Natal red-top appeared in Nemat (MC) for the first time in April 2010. Natal red-top was totally controlled from grapevine bud break to berry set in all the treatments during the 2009/10, 2010/11 and 2011/12 seasons, except in Pallinup (MC) in November 2009. Pallinup oats (CC) gave total control of Natal red-top during the 2012/13 grapevine growing season. This level of control was achieved during the wettest summer recorded during the trial. All the treatments, except Nemat (MC), reduced the stand of Natal red-top in April 2013 compared to the pre-treatment stand in April 2009. Pallinup oats was the only cover crop treatment that improved the level of control in the medium term compared to the treatments in which no cover crops were sown.

Conclusions

All the treatments, except where Nemat (MC) reduced the stand of Natal red-top. Cover crops did not improve the level of control. However, Pallinup oats (CC) gave total control in the fourth season.

References

SOIL MICROBIAL COMMUNITY DYNAMICS AND NEMATODE SUCCESSION IN MEDIC-WHEAT ROTATIONAL SEQUENCES UNDER VARYING SOIL DISTURBANCE DURING A FOUR-YEAR CROPPING CYCLE

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Introduction

Terrestrial nematode and soil microbial communities are sensitive indicators of sustainable crop production as influenced by cropping sequence and tillage. The aim of this study was to quantify the effects of agricultural management practices on soil microbial functional diversity and enzymatic activity, and nematode trophic levels in crop production systems in the Western Cape.

Materials and Methods

This study was conducted at the Tygerhoek Research Farm near Riviersonderend, Western Cape. Soil samples, to a depth of 150mm, were aseptically collected over four consecutive years (2012-2015) from two cropping systems: wheat monoculture (WWWW) and wheat-medic (McWMcW) rotations under conventional tillage (CT -soil scarified late March/early April, then ploughed and planted with a no-till tine planter) and zero tillage (ZT - soil left undisturbed and planted with double disc planter). Nematode functional groups from soil and root samples, and soil microbial activity and functional diversity were determined. Data was subjected to non-parametric statistical analyses using Canoco for Windows 4.5. Carbon source utilisation profiles, enzymatic activity and nematode trophic levels were analysed by means of Principal Component Analysis (PCA).

Results and Discussion

Cropping sequences and tillage changed temporal shifts in terrestrial nematode and soil microbial functioning and activity. Cropping sequences influenced microbial functioning more than microbial activity. The ratio of free-living to plant-parasitic nematodes was similar under WWWW, but was much higher with medic as the initial crop, compared with wheat as the initial crop. Soil microbial functioning and activity increased more under ZT compared with CT, whereas the percentage of free-living nematodes present in the soils under ZT was similar but varied greatly under CT.

Conclusions

This study suggests that agricultural management practices could be adjusted to enhance soil biodiversity and soil fertility.

References

Acknowledgements

Western Cape Agricultural Research Trust is acknowledged for partial funding of this study.

POST-EMERGENT APPLICATION EFFECTS OF NEMAFRIC-BG PHYTONEMATICIDE ON GROWTH OF POTATO CULTIVAR 'MONDIAL G3' AND SUPPRESSION OF MELOIDOGYNE JAVANICA

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Introduction

Potato (*Solanum tuberosum*) is among the top commodities produced in South Africa. However, it is highly susceptible to root-knot nematodes, without any identifiable nematode resistant genotypes (García et al., 2014). Nemafric-BG phytonematicide, is being researched and developed as an alternative to synthetic nematicides at the University of Limpopo. However, since active ingredients in phytonematicides are allelochemicals, this phytonematicide has the potential of inducing phytotoxicity on crops protected against nematode damage (Mashela et al., 2015). The objective of the study, therefore, was to establish whether post-emergent application of Nemafric-BG phytonematicide would have effect on potato growth and suppression of *M. javanica*.

Materials and Methods

Potato seed tubers were planted inside 30 cm plastic pots at an inter- and intra-row spacing of 0.6 m, in autumn 2017, under micro-plot conditions. After emergence, each plant was inoculated with 5000 eggs and second-stage juveniles of *M. javanica*. Seven days after inoculation, treatments, namely, 0, 2, 4, 8 and 16 g Nemafric-BG phytonematicide were arranged in a randomised complete block design, with fourteen replicates.

Results and Discussion

At 56 days after initiation of treatments, treatments significantly affected plant height, contributing 55 % to total treatment variation. The fact that stem diameter, tuber mass, chlorophyll content, dry shoot mass and fresh root mass were not affected by increasing levels of the phytonematicide, suggest that the organs were at saturation concentration by harvest (Mashela et al., 2015).

Conclusions

In conclusion, Nemafric-BG phytonematicide could be applied at a concentration of 2 g per plant where it was shown to be effective in stimulating plant growth and suppressing population densities of *M. javanica* without inducing phytotoxicity.

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Improving the vermicomposting of igneous rock phosphate enriched pig manure through inoculation with phosphate solubilizing bacteria

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Introduction

Vermicomposting has been shown to improve nutrient bio-availability from rock phosphate (RP). There is, however, a paucity of information on the potential of efficient P solubilizing bacteria (PSB) like the *Pseudomonas* spp, combined with earthworms, to further enhance vermi-degradation and nutrient release from igneous RP amended composts.

Materials and Methods

Pig manure enriched with 0.88 % P as RP was inoculated with *E. fetida* or PSB alone and in combination, and composted for 10 weeks. The treatments were, therefore, T1=0.88 % P as RP + pig manure (PMRP) (control), T2= PMRPM+ *E. fetida*, T3= PMRP + PSB, T4= PMRP + *E. fetida*+ PSB. Samples were collected at two-week intervals and analysed for Olsen P, ammonium and nitrates, alkaline P, FDA, C: N, EC and pH. Worm biomass and germination index (GI) were also determined.

Results and Discussion

Inoculation with with *E. fetida* (T2) and PSB alone (T3) significantly increased the Olsen extractable P relative to the control. Olsen extractable P results followed the order T2 > T3>T1>T4. These results show that the addition of both *E. fetida* and *Pseudomonas fluorescences* enhanced the release of P from RP enriched pig manure. The pH of the vermicompost mixtures decreased from 8.2 to 7.5 for the treatment with *E. fetida* and from 7.88 to 7.59 and 7.64 for treatments with PSB (T3) and *E. fetida* and PSB (T4). The final vermicompost pH ranged from 5.5 to 8 which is favourable for nutrient availability and microbial activity. Inoculation with PSB had a positive effect on earth worm biomass. The C: N ratio, an indicator of compost maturity, decreased steadily during vermicomposting from an initial value of 30 in all treatment combinations until the experiment was terminated. The PSB treatment (T3) resulted in the lowest C: N ratio of 20.2 indicating its positive impact on vermidegradation. The GI, a plant parameter for compost maturity, was more than 50% in all test crops. At 133%, radish had the highest GI followed by Spinach (104%) and tomato (70.5%) in the T4 vermicompost. Lower GI values were obtained with T3 vermicompost where PSB was applied alone indicating the superiority of inoculating with the combination of *E. fetida* and PSB in vermicomposting.

Conclusions

It is concluded that the combination of *E. fetida* and *Pseudomonas fluorescences* positively influences vermi-degradation and P release from phosphate rock enriched pig manure .

References

GENETIC VARIABILITY AMONG PRESUMED CLONALLY DERIVED ISOLATES OF PUCCINIA GRAMINIS F. SP. TRITICI IN AUSTRALIA BASED ON SIMPLE SEQUENCE REPEAT (SSR) MARKERS

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Introduction

Evolution of aggressiveness and high virulence of stem rust pathotypes against important resistance genes constitutes a major threat to the global wheat production, and consequently food security. Fungi pathogenicity and environmental adaptation have resulted in serious epidemics and total crop loss. Understanding current pathotype evolution and pathogenic dynamics against resistance genes is priority. This study examined the genetic variability among 157 Australian *Puccinia graminis* f. sp. *tritici* (Pgt) isolates derived from founding pathotypes 326-1,2,3,5,6 (Lineage 3), and 194-1,2,3,5,6 (Lineage 4) collected over 39 years.

Materials and Methods

Pathotype urediniospores were purified and increased on cultivar Morocco in greenhouses. The 35 standard differential genotypes with known resistance genes were used to verify isolate purity and identity based on avirulence/virulence patterns. Genomic DNA was amplified via PCRs using 13 SSR markers, and electrophoresis. Genotypic data were analysed using Peak Scanner v1.0 to determine actual allele sizes. Polymorphic information content per microsatellite locus was calculated, and cluster analysis carried out using MEGA v6 through UPGMA with bootstrap. Analysis of molecular variance (AMOVA) determined the genetic variations based on Wright's F-statistics.

Results and Discussion

Application of molecular markers continues to increase the understanding of genetic diversity that exists in rust pathogen populations worldwide. In view of this, pathogenicity assessments found general consistency with previous determinations, indicating that pathotypes in Lineage 3 and Lineage 4 generally displayed similar avirulence and virulence patterns. Cluster analysis of 111 Pgt isolates based on phenotypic data collected 99 derivatives of 326-1,2,3,5,6 and 194-1,2,3,5,6 into one group comprising multiple subgroups. The principal coordinate analysis (PCoA); pairwise population Nei genetic distance, UPGMA and AMOVA derived Wright's F-statistics (FST) analyses using six markers detected moderate to high genetic variations among the five lineages, but no variations were detected among Lineage 3 and Lineage 4 isolates. A further analysis of 142 isolates from Lineage 3 and Lineage 4 using seven highly polymorphic SSRs detected 34 genotypes. Even with 34 genotypes, the level of genetic similarity (FST = 0.042) remained high supporting step-wise mutation as the major mechanism for new pathotype evolution contributing to Pgt genetic diversity in Australia.

Conclusions

Pathogenicity is subjected to intense selection by resistance genes in common hosts, leading rapid mutations that facilitate adaptation of the pathogen to hosts carrying specific resistance genes. This results in significant allelic variation within loci leading to genetic diversity in clonal pathogen populations. Understanding mutations and actual nucleotide changes via whole genome sequencing, would provide detailed knowledge about Pgt diversity.

References

PARTITIONING OF ESSENTIAL HEAVY METALS IN ONION PLANTS (*ALLIUM CEPA*) IRRIGATED WITH TREATED WASTEWATER UNDER FIELD CONDITIONS

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Introduction

Due to increasing incidents of irrigation water in Limpopo Province, treated wastewater is being used as alternative source of irrigation water in other parts of the province. However, treated wastewater could result in accumulation of essential heavy metals to high levels in the plant systems and the related edible organs. The objective of the study was to determine the partitioning of heavy metals in onion (*Allium cepa*) cv. 'Star 5516' plants, that were irrigated with treated wastewater under field conditions.

Materials and Methods

The study was conducted at Polokwane Wastewater Treatment Plant (PWTP) exit pond 16, where water flows into the furrow that conveys water to the night-dam at ULEF, then at the entry and exit sites of the night-dam and the adjacent borehole. The study comprised a 4 × 5 factorial, with water samples collected from 4 points once a month for five months. Water samples were collected in 500 mL sterile glass bottles and analysed for *E. coli* counts. Data were transformed using $\log_{10}(\chi + 1)$, prior to factorial analysis of variance using Stata 12.0 software (StataCorp, 2011).

Results and Discussion

In Experiment 1, treatment effects were significant on Zn, Fe, Cu and Mn, contributing 78, 86, 95 and 84 in total treatment variation (TTV). In Experiment 2, treatments increased by 37 and 75% in leaf tissues, but reduced by 31 and 32% in bulb tissues, respectively. The partitioning of Fe and Mn in root and leaf tissues was not significant. Relative to root tissues, Fe and Mn were reduced by 50 and 64% in bulb tissues, respectively. Relative to root tissues in Experiment 2, Zn and Cu were increased by 50 and 83% in leaf tissues, respectively. In Experiment 2, the partitioning of Zn in root and bulb tissues was not significant. However, Mn was reduced by 72% in the bulb tissues. Iron and Mn were reduced in both leaf and bulb tissues. Zinc was reduced by 19 and 32%, whereas Mn was reduced by 32 and 72% in leaf and bulb tissues, respectively.

Conclusions

Generally, cv 'Star 5516' accumulated much less heavy metals in the bulb tissue compared to leaves and roots. Consequently, the use of treated wastewater did not constitute a health hazard to consumers in terms of heavy metals in the test onion cultivar.

References

Evaluating pre-harvest sprouting tolerance and yield traits in doubled haploid wheat populations

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Introduction

Pre-harvest sprouting (PHS), which is the germination of intact kernels on the plant ear upon humid conditions between maturity and harvest, greatly reduces grain quality and value (Andreoli et al., 2006). This leads to huge economic losses for both producers and end-users. Significant progress was made in managing PHS through breeding for tolerance or increased seed dormancy in South Africa (Barnard et al., 1997; Barnard & Smith, 2009). This strategy has proven to be most effective (Zhang et al., 2014), especially under the current climatic conditions. However, the challenge is to release cultivars exhibiting both increased PHS tolerance and good yield characteristics. Therefore, this study aimed to select for DH lines with PHS tolerance and good yield characteristics for the ARC – Small Grain germplasm collection.

Materials and Methods

Two doubled haploid (DH) mapping populations (Tugela-Dn/Elands and Elands/Flamink) were planted in four environments (Bethlehem, Clarens, Harrismith and Arlington) to evaluate PHS tolerance. Individual ears of these populations were harvested at maturity, air-dried, subjected to simulated rainfall for 72 hours and scored for PHS tolerance according to a scale of 1 – 8 (Barnard et al., 1997). For thousand kernel weight (TKW), 100 seeds of each line were counted in multiples of 10 using the elmor seed counter, weighed and the average weight recorded. The GY was recorded as the total weight of seeds produced.

Results and Discussion

Both the mapping populations evaluated exhibited varying levels of PHS tolerance with Elands/Flamink population being more tolerant than Tugela-Dn/Elands. The PHS response could be categorised into three main groups, namely a tolerant group (scores 1 – 3), a moderate group (scores 3,1 – 4,5), and a susceptible group (scores 4,6 – 8). For both populations, the majority of lines tested were moderately tolerant/susceptible with 55% and 43% for Tugela-Dn/Elands and Elands/Flamink, respectively. This is in agreement with the observation of Smit et al. (2010) whilst reviewing the South African situation of PHS tolerance in wheat. Thirty-one% of the Tugela-Dn/Elands lines showed good tolerance and 14% poor tolerance whilst 11% and 46% corresponded to poor and good PHS tolerance in the Elands/Flamink population, respectively. Furthermore, a strong environmental effect was observed both on PHS response, TKW and GY. Most of high yielding lines were also found to exhibit good PHS tolerance, which is a desirable combination.

Conclusions

The desirable combination of good PHS tolerance and high yield was observed in the studied populations, complementing them as potential material for breeding purposes.

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COMPARING THE EFFECTS OF CONTOUR BUNDS AND TRADITIONAL FARMING PRACTICES ON SOIL PHYSICO-CHEMICAL PROPERTIES AND CROP YIELDS

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Introduction

Most communal farmers in South Africa rely on rain-fed agriculture. However, the country is faced with high rainfall variability as well as low soil fertility. These are major limiting factors to food production, since South Africa is dominated by semi-arid climatic conditions. It is for this reason that rural communities need to optimize the use of their limited water resources for crop production. Rainwater harvesting (RWH) technologies are amongst possible alternatives to maximise agricultural crop production. The aim of this study was to assess the effect of contour bunds as a form of RWH on selected soil physico-chemical properties and crop yields in comparison with the traditional farmer's practice.

Materials and Methods

The study was conducted in homestead gardens in the Eastern Cape Province (EC), under Tsolo local municipality. The study was set up as five homestead gardens namely Madosini, Beya, Mjali, Quvile and Sokhombe in the Eastern Cape. It was designed as randomised complete block design with three replications, that compared contour bunds with the traditional farmer's practice (control) over two summer growing seasons (2013/14 and 2014/15). Data was collected for soil chemical and physical properties as well as for maize grain and dry matter yield. Soil samples were collected at 0 - 10, 10 - 20 and 20 - 30 cm depths for analysis of soil pH, exchangeable bases, micro-nutrients and aggregate stability, and for analysis of bulk density at 0 - 10 cm. These samples were collected at planting (2013) and at harvesting (2015). Gravimetric soil moisture content was periodically monitored at different stages of maize growth (planting, vegetative growth, tasselling and harvesting) in 2015. Maize dry-matter and grain yields were determined at harvest in 2015.

Results and Discussion

Results indicated that contour bunds improved soil moisture content, aggregate stability, bulk density (12%), grain yields (19%) and dry matter yields (3%). No clear trend was observed on the effect of contour bunds on exchangeable bases, soil pH and micro-nutrients across all study sites.

Conclusions

It is therefore recommended that contour bunds be used by resource constrained rural farmers who are experiencing unfavorable precipitations to improve crop yields and soil productivity.

References

FIRST COMPLETE GENOME SEQUENCE OF A SOUTH AFRICAN TOMATO SPOTTED WILT VIRUS ISOLATE INFECTING TOMATO FIELD CROPS AND AMARANTHUS THUNBERGII

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Introduction

Tomato spotted wilt virus (TSWV) is a genetically diverse and complex viral pathogen. It is one of the most economically important plant viruses with an extensive host range, infecting more than 1000 species belonging to over 100 plant families. Considering the widespread distribution of TSWV, only a few isolates have been fully sequenced to date. The aim of this study was to elucidate the full genome of a South African TSWV isolate infecting tomato crops in South Africa.

Materials and Methods

The genome of TSWV was sequenced using next-generation sequencing (NGS) technology. The generated complete genome, as well as the genome organization of the TSWV LK-1 isolate, was subjected to phylogenetic, reassortment and recombination analysis.

Results and Discussion

The LK-1 isolate genome organization was found to be consistent with a non-resistance breaking strain of TSWV. Phylogenetic analysis showed geographically diverse relationships for the individual open reading frames of TSWV LK-1 and other isolates of TSWV. Recombination analysis revealed one recombination event on the S segment that showed apparent regional preference. This study provides the first complete genome sequence of a South African TSWV isolate

Conclusions

The complete genome sequence of a South African TSWV isolate will contribute to the understanding of the emergence and evolution of TSWV and its adaptation to new hosts. The phylogenetic analyses on TSWV isolates worldwide suggest possible intraspecific reassortment of the L, M and S segments. The findings of this study are essential in the development of effective management strategies of TSWV. Sources of natural TSWV resistance from wild or native plants should be evaluated. In addition, early warning systems and monitoring programs of thrips may assist in reducing potential outbreaks and the emergence of TSWV resistance breaking isolates in South Africa and other parts of the world.

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Leaf cutting production potential of different *Lachenalia* species

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Introduction

Lachenalia is a genus in the Asparagaceae (previously Hyacinthaceae) family. Cultivars developed by the Agricultural Research Council (ARC) are sold internationally as dry bulbs and flowering pot plants. To maintain market interest, new cultivars have to be developed on a continuous basis from the genepool available. Plant production of commercial cultivars is carried out in South Africa using leaf cuttings. Leaf cutting production potential is essential for the successful marketing of new cultivars. Identifying species from the genebank with a natural better leaf cutting potential will thus assist breeders in selecting breeding material. The aim of the study was thus to investigate the leaf cutting potential of four *Lachenalia* species.

Materials and Methods

Leaf cuttings from *Lachenalia unifolia*, *L. longibracteata*, *L. aloides* and *L. pallida* were obtained from the ARC and planted in six-pack trays containing composted bark medium in the greenhouse at TUT. The experimental design was a 4x4 Latin square with 4 cuttings per replicate as experimental unit. Survival was monitored weekly and the number of bulblets formed as well as size of bulblets was recorded at harvesting.

Results and Discussion

All cuttings survived but *L. unifolia* produced significantly more bulblets than the other three species. All four species, however produced more than 8 bulblets per leaf cutting, which is commercially acceptable. Furthermore, *L. unifolia* also produced more bulblets in the bigger size (>1cm circumference) category compared with the other species, although not significantly different. Bulblets harvested from leaf cuttings are grown to flowering size, before they are sold in the year following leaf cutting production. Larger bulblets from leaf cuttings are thus preferred as they grow to flowering size within one year, whilst smaller bulblets can take two years to grow to flowering size with a resulting increase in production cost.

Conclusions

All four species used had acceptable multiplication rates and can be used for breeding. *L. unifolia* however, outperformed the other species in terms of number of bulblets produced per leaf cutting. *L. unifolia* also produced more bulblets of larger size making it the preferred species (of the four tested) in terms of leaf cutting production. Only specific accessions were used in this study and including different accessions of each species can add further value towards understanding the production potential of specific species.

References

Genetic diversity analysis of soybean (*Glycine max*) genotypes using SSR markers

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Introduction

Soybean [*Glycine max* (L.) Merr.] is one of the most frequently cultivated leguminous crops worldwide. It is used for both human and animal consumption as a source of vegetable oil and protein meal, as well as industrial purposes. Knowledge of genetic diversity is essential for effective breeding and conservation. The objective of the study was to determine the presence of genetic diversity among soybean genotypes using simple sequence repeat (SSR) markers.

Materials and Methods

A total of 30 soybean genotypes were genotyped using 20 SSR primers. DNA was extracted using the standard CTAB method (Saghai-Marooft et al, 1984). DNA was amplified by Polymerase Chain Reaction and the amplified products were electrophoresed on 3.5 % agarose gel and detected by ethidium bromide staining. The alleles were scored quantitatively as present or absent. Allele sizes were estimated in comparison with 100 bp DNA ladder. The assay efficiency index referred to as polymorphic information content (PIC) was calculated according to Anderson et al. (1993) as $PIC = 1 - \sum f_i^2$, where f_i is the frequency of the i th allele (Smith et al., 1997). GGT 2 software (Van Berloo, 2007) was used to generate the dendrogram and matrix.

Results and Discussion

A total of 196 alleles with an average of 7.3 alleles per locus were detected. The allele sizes ranged between 2 to 33bp, having an average of 18.7 bp. The polymorphic information content among genotypes varied from 0.85 (Satt001) to 0.75 (Satt43) with an average of 0.716. The heterozygosity ranged from 0.87 to 0.78 with an average of 0.7485. The most diverse genotypes were B66S31, 69S7, and R5-4-2M showing the efficiency of the SSR markers for detecting genetic diversity.

Conclusions

The study revealed the presence of genetic diversity among the genotypes, which will aid breeders with the selection of parents for effective breeding and conservation strategies.

References

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WATER DEFICIENCY IN SWEET POTATO: A STUDY OF POSSIBLE CONSEQUENCES

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Introduction

Sweet potato is the seventh most important crop in the world. Although the crop is drought tolerant, water scarcity severely influences proper growth and yield. The study aimed to determine the effect of drought on the various traits of a number of sweet potato cultivars in the field. An understanding of the physiological factors ruling growth and water use efficiency in sweet potato varieties subjected to drought stress, is needed to develop selection criteria for improved water use efficiency and optimum yield.

Materials and Methods

Eight sweet potato varieties were grown in the rain out shelter in control and drought stress conditions. Soil water for the control plants were kept at field capacity, while the soil in control conditions were irrigated such that 30% of the soil water depletion was recorded. Agronomical measurement and leaf sampling were done twice during the growth period after which leaf samples were freeze dried and stored at -80 degrees. Various physiological traits were determined on leaf samples.

Results and Discussion

Water deficiency had a negative effect on the nitrate reductase activities in the sweet potato leaves in severe stress conditions which correlated with the findings of FERRARIO-MÉRY, VALADIER and FOYER (1998). Proline concentrations, however, increased during the drought stress periods leading to significant genotypic differences and possibly leading to adjustment of the osmotic balance. Both glutathione and ascorbate peroxidase levels increased in all eight varieties indicating that the plant is reacting to radicals possibly harming the photosynthetic system. The decline in the values of yield and stomatal conductance correlated well with each other, since stomata regulates the uptake of carbon dioxide and in stress conditions values were lower in the stressed plants. This is slightly in contrast to canopy cover where it was expected yield would have a linear relationship to the size of leaf coverage. It is therefore seen that other processes also played a role in upholding production of roots. Strong correlations were found between yield, stomatal conductance, carbon (13) discrimination, proline, ascorbate peroxidase and glutathione reductase.

Conclusions

The strong correlations found between the mentioned parameters indicated that such parameters could be used to identify promising genotypes for drought tolerance in a breeding programme.

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YIELD AND YIELD COMPONENTS OF FOUR CHICKPEA GENOTYPES: RESPONSE TO PLANTING DENSITY

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Introduction

Chickpea (*C. arietinum* L.) is an important food legume globally but is a fairly new crop in South Africa. However, its adoption into the smallholder cropping systems may contribute to increased crop diversification and food security (Miller et al., 2002). Manipulation of planting density (PD) is an important agronomic practice for increased chickpea productivity. A preliminary study, though inconclusive, found that PD affected chickpea grain yield in summer but not in winter sowing (Thangwana and Ogola 2012). Therefore this study assessed the effect of PD on yield and yield components of chickpea.

Materials and Methods

An experiment was conducted in winter 2015 and 2016 at the University of Venda, Thohoyandou. A factorial combination of four chickpea genotypes (ACC1, ACC3, ACC4 and ACC7) and three PD (20, 25 and 33 plants m⁻²) was laid out in a randomized complete block design replicated three times. Aboveground biomass, number of pods per plant (NP/P), grain yield, 100 seed weight (100-SW) and harvest index (HI) were determined at harvest maturity.

Results and Discussion

Planting density did not affect NP/P, 100-SW and HI in 2015 and 2016. Similarly, aboveground biomass and grain yield did not vary with PD in 2015. In contrast, aboveground biomass and grain yield, respectively were greater at 33 (3477 and 1724 kg ha⁻¹) compared to 25 (1953 and 982 kg ha⁻¹) and 20 (1500 and 680 kg ha⁻¹) plants m⁻² in 2016. The greater grain yield at high PD was associated with greater aboveground biomass (Thangwana and Ogola 2012).

Conclusions

Clearly manipulation of PD may affect chickpea productivity but this effect may vary with seasons. Therefore we recommend further studies over several seasons before definite conclusions can be drawn.

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IMPROVING NUTRITIONAL QUALITY OF WHEAT: WHAT IS IMPORTANT IN THE SOUTH AFRICAN CONTEXT?

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Introduction

Wheat (*Triticum aestivum* L.) is widely consumed by humans, hence making it one of the important crops in South Africa. It contains a wide range of nutritional components such as iron, zinc, vitamins and phenolic acids, which are important for plant metabolism and human health. However, the bioavailability of these minerals is low due to their interaction with other constituents and relatively low quantity in the endosperm. In South Africa, malnutrition still remains a persistent problem as more children are still stunted and also suffering from micronutrient deficiencies (Schönfeldt et al., 2016). Currently, increasing the concentration of bioavailable micronutrients in the edible parts of the wheat grain (biofortification) has become a promising technique. Conventional agricultural systems can partially improve the nutritional value of crops, but the progresses in the 'omics' technologies are quickly being utilized to produce crops with improved essential nutrients. This review discusses the advantages and potentials of using the 'omics' technologies to improve nutritional bioavailability.

Materials and Methods

Omics offers the possibility to exploit the natural genetic variation for grain minerals and hence improve the nutritional value of wheat. It is a multidisciplinary study that refers to studies in applied biology that end with -omics, such as genomics, transcriptomics, proteomics, metabolomics, etc. Discovering genes that control translocation, remobilization and biosynthesis in wheat has been one of the key research goals for decades and has increasingly gained importance. Reviewing and concisely summarising currently available genetic and genomic resources for improved nutritional quality and the progress made so far towards introgressing known genes in elite germplasm is vital to guide future research.

Results and Discussion

Wheat endosperm is the main portion of the grain consumed by humans. The major challenge with improving nutritional quality is enhancing the bioavailability and levels of nutritional components in the wheat endosperm. Advancements in studying the genetic control of nutritional quality will be achieved if selected omics technologies are integrated to obtain a holistic overview and manipulate key biological processes involved in the remobilization and biosynthesis of nutritional components into the wheat endosperm.

Conclusions

The era of the omics has largely contributed to our current understanding of various biological and physiological processes in wheat in a faster way through the provision of high-throughput data that have made a provision for researchers to understand and manipulate some complex traits in wheat. The omics technologies are much needed in these years where many people and especially children are suffering from malnutrition.

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THE EFFECT OF ONCE-OFF TILLAGE ON THE SOIL WATER BALANCE OF A SHALE DERIVED SOIL UNDER NO-TILL IN THE SWARTLAND SUB-REGION OF THE WESTERN CAPE

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Introduction

The positive effects of CA are well known, although some negative effects may develop over time. Nutrient stratification, increased bulk density and increased crop residue cover may result in problematic effects in the soil. These effects may be addressed through, amongst others, the cultivation of soil. The cultivation of soil may effect soil water relations. The objective of this study was to determine the effect once-off tillage of no-till land has on the soil water balance and therefore the resultant crop response.

Materials and Methods

The study was conducted as a short term study during 2014 to 2015 at the Langgewens Research Farm near Moorreesburg (33°16'42.33" S; 18°42'11.62" E; 191 m). The experimental design was a randomised complete block with a split-plot treatment design with four replications. Canola after wheat in a wheat/lupine/wheat/canola (WLWC) sequence was allocated to main plots. Main plots were subdivided into three sub-plots and allocated to tillage treatments, namely: continuous no-till (NT), soil left undisturbed until planting and then planted with a tined no-till planter, non-inversion tillage (NIT), deep tine to a depth of 400 mm and inversion tillage (IT), soil inverted using mouldboard plough to a depth of 250 mm. The Diviner 2000 was used to monitor soil water content at weekly intervals to a depth of 800 mm using access tubes. Soil water content (SWC) was determined in 100 mm increments which was used to determine the cumulative evapotranspiration (Σ ET).

Results and Discussion

Tillage did not influence ($P=0.05$) SWC or Σ ET during the canola sequences in both 2014 and 2015. A total of 294 and 144 mm were evapotranspired from the NT treatments during the 2014 and 2015 growing seasons respectively. Total evapotranspiration from the NIT treatment was 310 and 159 mm and from the IT treatment 278 and 134 mm was evapotranspired during 2014 and 2015 respectively.

Conclusions

Tillage had no significant effect on the soil water content or total evapotranspiration. It is therefore concluded that the use of a once-off strategic NIT or IT (or variations thereof) can be considered as management option to address some of the constraints caused by conservation agriculture.

References

The Western Cape Agricultural Research Trust for financial assistance.

Comparing seed yield of conventional and Triazine tolerant canola in the rain fed environment of the Western Cape.

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Introduction

Canola (*Brassica napus*) is divided into variety groups (genotypes) according to their resistance to herbicides: conventional (no resistance), Triazine Tolerant (TT) and Imidazolinone Tolerant (CI). In Western Australia, TT cultivars have a 5% to 10% lower yield potential (Oilseed Western Australia, 2006). Beversdorf et al. (1988) reported that in the early varieties in Canada the yield difference between conventional and TT genotypes were 21-25%.

Materials and Methods

The combined data from the cultivar evaluation programme for the Swartland and southern Cape for 2011 to 2016 were used. Yield performance was compared on a percentage basis. Conventional yield was taken as the control.

Results and Discussion

The seed yield of both the conventional as well as CI groups was higher in both the Swartland and southern Cape for all the growing seasons. The variety group with the highest yield in the Swartland was the conventional group (100%) followed by the CI (96.1%) and TT group (83.6%). The yield of the conventional group was significantly higher than the TT group for all six seasons. In the southern Cape the seed yield of the CI group was 2.4% better than the conventional group. The yield of the TT group was 12.5% lower than the conventional group. The yield of the CI group was significantly better than the TT group for all six seasons. The yield of the conventional and TT group did not differ significantly in 2011.

Conclusions

The seed yield of the conventional and CI groups did not differ significantly. There was a yield penalty of 12.5% and 16.4% at average for the Swartland and southern Cape when compared to the conventional group. The TT cultivars have genes for tolerance to the Thiazine group of herbicides, this trait make these cultivars useful in a weed control programme.

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Interactive effect of NPK applications on young rooibos (*Aspalathus linearis*) and fertilizer leaching under Clanwilliam field conditions

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Introduction

Currently no macronutrient fertilizer recommendations have been established for rooibos plants under field conditions. The aim of this study was to examine the interactive effect of NPK on young rooibos plants' growth and survival, and soil chemistry and fertilizer leaching under Clanwilliam, field with an aim to establishing soil and foliar nutrient norms for optimum rooibos production.

Materials and Methods

A field trial was established at Vaalkrans Farm, Clanwilliam district in June 2016. Rooibos seedlings were fertilised at planting as a completely randomised design in combinations of various levels of N (0, 20, 40, 60 mg/kg) as NBPT-coated urea, P (0, 15, 30, 45, 60 mg/kg) as double superphosphate and K (0, 20, 40, 60, 80 mg/kg) as KCl. The N and K applications were split, 50% at planting and the remainder top-dressed after 2 months. The fertilizers and application rates were selected based on previous seedling greenhouse trials. Parameters measured during the trial included: soil pH, total C and N, mineral N, Bray II P, exchangeable cations, micronutrients, plant height, mortality, biomass, and foliar nutrient content. The movement of the applied fertilizer was also determined on selected treatments.

Results and Discussion

Initially, during the wet winter months, the application of P at 15 and 30 mg/kg stimulated biomass production. However, after the dry summer it was observed that all P applications suppressed plant growth and enhanced mortality, and this effect was more pronounced as P application rate increased. Foliar P and shoot biomass were negatively correlated ($R^2=0.64$). The highest plant survival and highest above-ground biomass yields were recorded in treatments in which either N (20 mg/kg) or K (40-60 mg/kg) was applied. Due to the low intensity rainfall experienced in Clanwilliam, the fertilizer had not leached significantly in the soil profile, and the majority remained where it was initially placed at planting (20-30 cm) and on surface (0-20 cm).

Conclusions

This study shows the importance of field trials, as opposed to short term greenhouse trials as the effect of nutrients combined with climate can have deleterious effects. It is recommended that young rooibos plants do not receive any P fertilizers at planting, but receive up to 20 mg/kg of N and between 40-60 mg/kg of K (soil background K was 80 mg/kg). Due to the low intensity rainfall experienced in June-September 2016, limited fertilizer leaching took place.

References

Effects of biochars produced from different feedstocks on soil bulk density, nodulation and growth of chickpea grown in different soil types

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Introduction

The alternative approach to use incomplete charring of biomass “biochar” could be a significant way in improving soil fertility and crop production. This study evaluated the effect of biochars produced from different feedstocks of poultry litter and acacia on soil bulk density, nodulation and growth of chickpea grown in different soil types.

Materials and Methods

A pot experiment was conducted at the University of Venda, experimental farm from May to August 2017. Treatments consisted of two biochars produced from acacia (*Acacia mearnsii*) and poultry litter feedstocks, four rates (0, 10, 20, and 40 t ha⁻¹), and three soil types (sand, clay loam and clay), laid out in a split-split plot design, with soil types as the main treatment, biochars as the sub-treatments, and biochar rates as sub-sub treatments, replicated four times. Poultry litter biochar was produced by heating poultry litter at 550-600 °C in a kiln furnace at the University of Venda, while acacia biochar was produced at 550-600 °C by Lanstar Company. Chickpea, desi cultivar was used a test crop. Bulk density, biomass, nodule number and nodule dry weight were determined at podding stage at 65 days after emergence. Data was subjected to ANOVA using GenStat software and means were compared using the LSD test at $P < 0.05$

Results and Discussion

Poultry litter (PL) biochar application at 20 t ha⁻¹ significantly ($P < 0.001$) decreased bulk density in the clay loam soil compared to the acacia (AC) biochar. The addition of PL biochar at 10 t ha⁻¹ increased biomass, while AC biochar increased biomass at 40 t ha⁻¹ in the clay loam soil. Nodule number and nodule dry weight increased in the sandy soil when 10 t ha⁻¹ PL biochar and 40 t ha⁻¹ AC biochar were applied. In contrast, in the clay loam soil, PL and AC biochar addition had no effect on nodule number and dry weight, but AC biochar application at 20 t ha⁻¹ increased nodule number and dry weight in the clay soil. The results suggest that biochar application either from animal or plant feedstock have the potential to enhance soil structure, and nutrient availability to alleviate low nutrient agricultural soils thus improve plant growth depending on the soil type and application rate.

Conclusions

Poultry litter biochar application had a significant effect on soil bulk density in the clay loam soil, but both PL and AC biochar increased growth and nodulation of chickpea in the sandy and clay soil.

References

EFFECT OF PLANTING DENSITY ON SEED YIELD AND OIL CONTENT OF *Moringa oleifera* GROWN UNDER DRYLAND IN LIMPOPO PROVINCE, SOUTH AFRICA

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Introduction

Moringa oleifera Lam is a highly nutritional valued plant, distributed in many countries under tropical and subtropical regions (Makkar and Becker, 1996). Farmers in Limpopo province grow moringa mainly for processing of leaf powder. Moringa seeds concentrates 35-45% oil that which can be used for various industrial purposes (Lalas and Tsaknis, 2002; Ayerza, 2012). Following oil extraction, the seed cake can be used for water purification (Makkar and Becker, 1996) and as organic fertilizer to improve agricultural productivity (Leone et al, 2016). This study was aimed at determining the effect of planting density on seed yield and oil content under marginal conditions of Limpopo Province.

Materials and Methods

The study was conducted over two consecutive years (2014/15- 2015/16) at NBef Organics Farm (Eiland). Four planting densities of Moringa, at a total population of 1 250; 1 667; 2 500 & 5 000 plants/ha, were used as treatments. The treatments were arranged in a RCBD and replicated eight times. Mature pods were manually harvested from a net plot of 12m². Pods were threshed and determined for seed yield (kg/ha), number of seeds/pod and 100 seed weight (g) were determined. Seeds from the four treatments were analysed to determine the oil content (%). Data were analysed using Statistix 10.0.

Results and Discussion

Planting densities showed significant difference on seed yield ranging between 157.60 and 435.53 kg/ha during growing period. Seed yield increased with an increase in plant density. The highest seed yield was obtained at a planting density of 5 000 plants/ha during year 2, irrespective of the low rainfall received during the growing season. The increase in seed yield production during year 2 might have been influenced by pruning during the first harvest which encouraged development of lateral branches. No significant differences were observed on yield components and oil content (%) of moringa from both harvests. The oil % ranged between 25.5 and 28.15% in all densities during both harvests. Oil % of moringa was very low compared to other studies which reported oil content of more than 30%. This might be due to drought that occurred during the growing seasons.

Conclusions

Moringa can be produced successfully in the Limpopo province of South Africa with a planting density of 5000 plants/ha. Future studies should be conducted under irrigation and fertilizer application to evaluate the potential of yield improvement.

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INTERACTIVE EFFECTS OF BIOCONTROL AGENTS AND A PHYTONEMATOCIDE ON MELOIDOGYNE SPECIES AND TOMATO PLANTS

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Introduction

Biological control with *Steinernema feltiae*, *Trichoderma harzianum* and cucurbitacin-containing Nemafric-BL phytonematicide, had separately, been successful in managing different pests in crop production (Kenney and Eleftherianos 2017; Mashela et al. 2017). However, it had also been hypothesized that biological control had lower efficacies and could yield satisfactory results in combinations of two or more biologicals compared to synthetic nematicides. The objective of this study was to determine the interactive effects of *S. feltiae*, *T. harzianum* and Nemafric-BL phytonematicide in the management of root-knot (*Meloidogyne* spp.) nematodes and growth of tomato (*Solanum lycopersicum*) plants.

Materials and Methods

A 2 × 2 × 2 factorial experiment, with first, second and third factors being *S. feltiae*, *T. harzianum* and Nemafric-BL phytonematicide, respectively, was conducted on tomato plants. Eight treatments comprising various permutations were arranged in randomised complete block design, with 10 replications. One-month old tomato seedlings were transplanted on nematode infested fields. Treatments were applied once at transplanting for biocontrol agents, and Nemafric-BL phytonematicide at 17-day intervals, starting at 7 days after transplanting. Plant and nematode variables were collected after 56 days. Data were log-transformed and subjected to ANOVA using STATISTIX 10.0 software.

Results and Discussion

Significant first and second-order interactions occurred in most plant variables. Since tomato plant growth was improved, the biocontrol agents and Nemafric-BL phytonematicide were compatible. Both combinations and individual treatments had no significant effects on nematode suppression, possibly due to antagonism. Generally, under field conditions biocontrol agents may take some time prior to successfully suppressing nematode numbers (Mashela et al. 2017).

Conclusions

Results suggested that Nemafric-BL phytonematicide and biocontrol agents could be combined in tomato crop production. However, their combination would not be a good strategy in managing root-knot nematodes in the short term.

References

Kenney E, Eleftherianos I. 2017. Entomopathogenic and plant pathogenic nematodes as opposing forces in agriculture. *International Journal of Parasitology* 46:13–19. Mashela PW, De Waele D, Dube Z, Khosa MC, Pofu KM, Tefu G, Daneel MS, Fourie H. 2017. Alternative nematode management strategies. In: Fourie H, Daneel MS, De Waele D (ed.), *Nematology in South Africa: A view from the 21st century*. Heidelberg: Springer International Publishing.

INTERACTIVE EFFECTS OF BIOCONTROL AGENTS AND A PHYTONEMATOCIDE ON MELOIDOGYNE SPECIES AND TOMATO PLANTS

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Introduction

Biological control with *Steinernema feltiae*, *Trichoderma harzianum* and cucurbitacin-containing Nemafric-BL phytonematicide had separately been successful in managing different pests in crop production (Kenney and Eleftherianos, 2017; Mashela et al., 2017). However, it had also been hypothesized that biological control had lower efficacies and could yield satisfactory results in combinations of two or more biologicals compared to synthetic nematicides. The objective of this study was to determine the interactive effects of *S. feltiae*, *T. harzianum* and Nemafric-BL phytonematicide in the management of root-knot (*Meloidogyne* spp.) nematodes and growth of tomato (*Solanum lycopersicum*) plants.

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Conclusions

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References

Kenney E, Eleftherianos I. 2017. Entomopathogenic and plant pathogenic nematodes as opposing forces in agriculture. *International Journal of Parasitology* 46:13–19. Mashela PW, De Waele D, Dube Z, Khosa MC, Pofu KM, Tefu G, Daneel MS, Fourie H. 2017. Alternative nematode management strategies. In: Fourie H, Daneel MS, De Waele D (ed.), *Nematology in South Africa: A view from the 21st century*. Heidelberg: Springer International Publishing.

Growth response of four chickpea (*Cicer aritenum* L.) genotypes to phosphorus fertilizer and rhizobium inoculation.

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Introduction

Crop productivity in the semi-arid regions of Limpopo Province is limited largely by the physical constraints of inadequate water, high temperatures and poor soils. The use of drought tolerant legume crops such as chickpea may be beneficial in sustaining cropping system productivity in this region. Although chickpea shows huge potential in South Africa (Thangwana and Ogola, 2012), poor nodulation attributed partly to lack of infective and/or effective native rhizobial strains has been reported (Ogola, 2015). This study assessed the effect of phosphorus (P) fertilizer application and rhizobial inoculation on growth and nodulation of four chickpea genotypes.

Materials and Methods

A field experiment was undertaken in winter 2016 at the University of Venda, Thohoyandou, using a factorial combination of two P rates (0 and 90 kg P ha⁻¹), four desi chickpea genotypes (ACC#1, ACC#2, ACC#3 and ACC#5) and two rhizobial inoculation levels (with and without *Rhizobium*) laid out in a randomized complete block design with three replications. Nodulation was determined at flowering, and plant height and number of primary and secondary branches were determined weekly between 14 days after emergence (DAE) and physiological maturity. However, only data collected at flowering is presented.

Results and Discussion

Inoculation and P application increased nodulation and number of primary and secondary branches but only P application affected plant height. Number of nodules per plant and nodule dry weight were reduced without inoculation, in contrast to inoculated plots (7.7 and 16, respectively). P application increased number of nodules and nodule dry weight by 49% and 36%, respectively. It is likely that the positive effect of rhizobial inoculation and P application was due to the corresponding effect on nodulation. Similarly, Ogola (2015) associated greater interception of radiation in inoculated chickpea with increased nodulation.

Conclusions

Our findings show that inoculation and P application may improve chickpea productivity by increasing nodulation.

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Acknowledgements

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PERFORMANCE OF TINE AND DISC OPENERS, SOIL QUALITY, AND RESIDUE MANAGEMENT FOR WHEAT PRODUCTION

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Introduction

Conservation agriculture (CA) has been widely adopted by many farmers in the wheat production areas of the Western Cape during the past decade. Wheat producers of the Western Cape following CA practices, rely mostly on tine openers. However, disc opener is new technology which has not yet been scientifically vindicated under Western Cape conditions. The aim of the study was to evaluate tine and disc openers for wheat production in soils of different qualities and through various levels of residue.

Materials and Methods

The study was conducted on the Langgewens research farm of the Western Cape Department of Agriculture near Moorreesburg. The trial was laid out as a split-plot design with three factors. The whole plot comprised two soils (high and low quality) in close approximation to one another. The split-plot comprised of openers, and the residues (high, medium, low) were randomly allocated within the split-plots. Soil disturbance was determined using the pin profiler immediately after planting. Wheat plant population was determined at 30 days after planting. Ten plants were sampled per plot at 30, 60, 90 days after planting and at physiological maturity to determine above-ground biomass production. The number of wheat ear bearing tillers (m^{-2}) was determined. At the end of the season the grain was harvested with a combine harvester

Results and Discussion

The tine openers caused more ($P < 0.05$) soil disturbance than the disc openers. The interaction effects of soil quality, opener, and residue level were not significant ($P > 0.05$) for any of the parameters. Tine openers resulted in the highest plant population, ranging from 125 to 179 plants m^{-2} compared to disc openers with plant populations ranging between 122 and 142 plants m^{-2} . Residue and soil quality had no effect ($P > 0.05$) on plant population. However, tine openers resulted in a higher biomass production compared to disc openers. Tine openers had the highest ($P < 0.05$) number of ear bearing tillers (ranging from 460 to 640 m^{-2}) compared to disc openers (360 m^{-2} to 550 m^{-2}).

Conclusions

Although no conclusion can be drawn at this stage from these preliminary results, the study showed good establishment with tine openers compared to disc openers

References

PROANTHOCYANIDIN CONCENTRATION IN CLEOME GYNANDRA AS AFFECTED BY HARVESTING AND PROCESSING TIME

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Introduction

Cleome gynandra is harvested for consumption from early shoot development to flowering without empirical knowledge of the period of proanthocyanidins (PAs) concentration accumulation in the plant. Proanthocyanidins in *C. gynandra* is responsible for bitterness. Processing time (PT) that had been used to reduce bitterness also affects its nutritional value (Rotich, 2004). The objective of this study was to determine the effect of harvesting and processing time in *C. gynandra* PAs concentration.

Materials and Methods

The study was a 5x7 factorial arranged in CRD. Cleome gynandra plants harvested at 4, 6, 8, 10 and 12 weeks were subjected to 0, 30, 60, 90, 120, 150 and 180 min PT (boiling). Boiled samples were oven dried for 24 hrs and grinded to fine powder prior to chemical analysis. Proanthocyanidins were determined using the Butanol-HCl method (Makkar, 2000) prior to ANOVA through statistix 10.0.

Results and Discussion

Harvesting x processing interaction had significant ($P \leq 0.01$) effect on PAs concentration, contributing 28%, 43% and 27% of the total treatment variation. Relative to the control, at 4 weeks, interaction reduced PAs by 63% and 51% when boiled for 30 and 60 min, respectively. Interestingly, PAs increased by 5%, 22%, 36% and 72% when boiled for 90, 120, 150 and 180 min at 4 weeks. At week 6, 8, 10 and 12, PT reduced PAs by 67-81%, 25-90%, 7-62% and 30-74%, respectively. Generally, it was observed that *C. gynandra* PAs reduces highly when the tender shoots and leaves could be harvested at 6, 10 and 12 weeks and boiled for 60 min. However, for harvesting week 8, PAs could be reduced highly when boiled for 60 min, suggesting that around week 8, PAs accumulates.

Conclusions

In conclusion, *C. gynandra* can be harvested at any stage and processed for 30-60 min to reduce PAs concentration.

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EVALUATION OF AGRONOMIC POTENTIAL OF FINGER MILLET (*Eleusine coracana*) AT A SEMI-ARID LOCATION IN SOUTH AFRICA.

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Introduction

Finger millet (*Eleusine coracana*) is a highly nutritious, drought tolerant small grain cereal crop, primarily grown for human consumption (Bitew and Asargew, 2014). The agronomic performance of finger millet varieties depends on environmental factors prevailing in a production area. In South Africa, there is no commercial production of finger millet. Therefore, there is no sufficient information regarding the agronomic potential of the crop in target production areas. This study examined the agronomic performance of 24 experimental lines of finger millet including one local check at a semi-arid location.

Materials and Methods

A field trial was conducted using a rectangular lattice experimental design replicated three times at Thohoyandou (22° 35' S and 30° 15' E) and Potchefstroom (26° 42' S; 27° 06' E). Agronomic attributes including plant height (PH), panicle length (PL), duration to 50% flowering (50% DF), number of primary tillers (NPT), number of spikes per panicle and number of productive tillers (NPDT) were measured.

Results and Discussion

The results showed that there were significant differences ($P < 0.05$) among the experimental lines in 50, NPT, NPDT and PL indicating that there was variation that could be exploited for finger millet breeding. The highest NPDT (9) was three-fold higher than that for the check. At least the experimental lines attained grain yield > 1.25 t/ha which was significantly ($P < 0.05$) higher than that for the check. The results indicated the adaptation of the crop to the prevailing agro-ecological conditions at the test location.

Conclusions

The results showed that agro ecological condition influenced agronomic attributes of the plant that resulted in variations in the grain yield. However, there is a need to increase the test locations and seasons in order to determine most stable lines that produce optimum grain yield in the area.

References

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SUSCEPTIBILITY TO MELOIDOGYNE INCOGNITA IN SWEET POTATO CULTIVAR 'BOPHELO'

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Introduction

A previous host-status screening trial of 12 sweet potato (*Ipomea batatas*) cultivars in South Africa suggested that cultivar 'Bophelo' was a non-host to the root-knot nematode, *Meloidogyne incognita* race 2 (Pofu et al., 2016), with limited information on its degree of nematode resistance to this nematode species. The objective of this study was to confirm the host-status and determine the host-sensitivity of cv. 'Bophelo' to *M. incognita* race 2 under greenhouse conditions.

Materials and Methods

Cuttings were planted in 20-cm diameter plastic pots containing pasteurized loam soil and Hygromix-T at a 3:1 (v/v) ratio. Cuttings were irrigated every other day using 250 ml water. Treatments comprised 0; 25; 50; 125; 250; 625; 1250 and 3125 eggs and second-stage juveniles (J2) of *M. incognita* race 2. These were arranged in a randomised complete block design, with five replicates. The nematode-susceptible cv. 'Beauregard' served as a standard for inoculum infectivity. The final nematode population densities (Pf) and plant growth variables were collected 56 days after inoculation, prepared and subjected to analysis of variance.

Results and Discussion

In plant-parasitic nematodes, nematode resistance is described using two concepts, namely, host-status and host-sensitivity. Host-status is described using the concept of a reproductive factor ($RF = Pf/Pi$). Generally RF values below one suggest that the nematodes failed to feed and reproduce on a given plant host, whereas values above one as observed in cv. 'Bophelo' suggest that the nematode established a feeding site and reproduced. Host-sensitivity describes the degree of plant response to nematode infection which could, in the context of density-dependent growth (DDG) patterns, be stimulated, neutral and inhibited plant growth. In the current study, there was a decrease in stem diameter and dry root mass with increase in inoculum levels which suggested that infection of *M. incognita* race 2 at various inoculation levels had inhibited the growth of cv. 'Bophelo'.

Conclusions

Cultivar 'Bophelo' was susceptible to *M. incognita* race 2 and therefore, is not suitable for use in crop rotations intended to manage population densities of this nematode race.

References

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COMPARISON OF DIRECT TO INDIRECT METHODS FOR ESTIMATING LUCERNE (MEDICAGO SATIVA) HERBAGE YIELD

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Introduction

Lucerne is an important fodder crop used for grazing and haymaking. Currently in South Africa there is no uniform data collection method for lucerne. The standard method for determining lucerne yield is the cut-and-dry method. It is labour intensive, costly and time consuming. There is a need to identify if use of non-destructive methods can be used to accurately estimate yield in a time-efficient manner. The aim of this study was to calibrate a rising plate meter (RPM), ceptometer and plant height to estimate lucerne herbage yield.

Materials and Methods

The trial was laid out as a randomised block design at Elsenburg Research Farm. Fifteen lucerne cultivars were used as treatments, replicated three times. A ceptometer was used to determine light interception by taking ten readings per plot. Ten plant height readings per plot were taken using a meter stick. Twenty RPM readings per plot were taken as indicator of plant height and density. Three rings (0.0985 m²) were cut to 50 mm above ground level and dried. A sickle bar mower was subsequently used to cut each plot. Fresh weight was taken using a platform scale and the herbage yield (kg DM ha⁻¹) was determined from the dry matter content from the rings. Pearson correlations were used to calculate linear regressions between the non-destructive methods and herbage yield.

Results and Discussion

The herbage yield ranged from 554.79 to 2219.44 kg DM ha⁻¹ with the mean yield at 1334.10 kg DM ha⁻¹. Variation was caused by cultivar effect. Regressions between actual yield and indirect methods to estimate yield is shown in Table 1. Table 1: Method, regression and coefficient of variation (r-value) for estimating lucerne yield. Method Regression r Ceptometer Yield = 1.81(ceptometer) + 101.23 51% Plant height Yield = 49.26(Plant height) - 465 76% RPM Yield = 2.30(RPM) + 322.97 84%

Conclusions

The RPM provided the most accurate results with the r value at 84% accuracy compared to the other two yield estimations. These are preliminary results as data is limited to only two cuttings (end of winter and early spring). One would expect seasonal variation in yield estimation and the study needs to be repeated over several months for accurate results.

References

Biodiversity of Carabidae and Coccinellidae in wheat agroecosystems and their role as bioindicators

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Introduction

Predatory insects provide a valuable ecosystem service in the control of agricultural pests. Carabidae and Coccinellidae beetles in the order Coleoptera are considered important predators of arthropod pests, especially of cereal aphids. These beetles are important from both an economic perspective in their use as biological control agents and ecological perspective in their diversity and adaptation to varied environments. Their biodiversity is, therefore, a key resource to improve sustainability and productivity in agroecosystems. Despite their economic importance little is documented on the diversity of these predators and how they respond to agricultural management (organic vs. conventional). The objectives of the present study is to document the biodiversity of predatory Ground beetle and Ladybeetle predator species in wheat agroecosystems and to estimate their role as bioindicators.

Materials and Methods

The study is being conducted at Lower-land Farm, Prieska, Northern Cape (S29.50161°E23.00156) in irrigated organic and conventional wheat systems. Sampling commenced from August 2017 and still in progress. Predatory beetles are being sampled using pitfall traps, yellow sticky traps and sweeping. Traps are arranged in a diagonal transect design with 12 sampling points in each agroecosystem and are monitored monthly. Predatory insects collected from each wheat system will be preserved in 200gr plastic jars in 70% ethanol and identified to species level. Shannon-Wiener diversity index (H'), Margalef's species richness index (d), and Pielou's evenness (J') will be calculated to determine the diversity of predators in the organic and conventional wheat agroecosystems.

Results and Discussion

The trial is still in progress, and preliminary results will be presented. The aim of this study is to determine whether an organic wheat ecosystem will provide a more suitable habitat than a conventional wheat agroecosystem to sustain the diversity of Carabidae and Coccinellidae.

Conclusions

The abundance and diversity of Carabids and Coccinellids can be used as an indication that reflects the sustainability of wheat agroecosystems. To practice sustainable wheat production, the diversity of indicator species, such as beneficial predators, and their role and interaction within the ecosystem should be understood.

References

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SURVEY ON FARMERS' DECISION PROCESSES AND ADOPTION OF CONSERVATION AGRICULTURE (WATERBERG STUDY)

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Introduction

Conservation tillage (CA) is being promoted as a means of overcoming agricultural production constraints, reversing soil degradation, and mitigating the impacts of climate change in southern and eastern Africa. Conservation agriculture provides many ecosystem services instrumental in improving agricultural productivity: reducing moisture deficits, breaking up pest and disease cycles, minimizing weeds, enhancing nutrient cycling and soil fertility, reducing soil erosion, and increasing carbon sequestration. Survey was conducted to determine factors affecting farmer's adoption of CA

Materials and Methods

Structured questionnaires was used to conduct the study. It involved the administration of structured interviews with farmers around Waterberg district, Limpopo province.

Results and Discussion

About 69% of farmers surveyed were male and most farmers were between ages of 51 to 65 years. Results show high level of land ownership were recorded (56%), 25% were leasing and 19% were farming on communal land where farms were less than 3 ha each. The education level is low: 31.25% had only attended primary school, 50% attended secondary school and only 12.5% have gone to university. There is high level of non adoption of CA with 81.25% and this could be due to farmers having limited knowledge of CA, 87.5% of farmers surveyed mentioned that they have never heard about it and only a small percentage of farmers heard about it and adopted the technique. We asked adopting farmers to tell us what motivates them to practice CA. Farmers cited higher yields, labor saving, potential increase on soil fertility and soil moisture conservation as major motivations of CA adoption. About 66.7% mentioned that CA is simple and easy to execute while 33.3% saying its moderate, and consequently most farmers with 66.7% mentioned that they have sufficient management skills while only 33.3% say their management skills are insufficient.

Conclusions

This study finds that most farmers are not aware of CA and its benefits, only small proportion have realized the benefit of CA, improved knowledge and awareness of CA and continued farmer support could be the most cost effective way to increase CA adoption.

References

Discrimination of soil aggregate microstructure and stability under continuous tillage and fallow using micro-focus X-ray computer tomography

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Introduction

Soil is a complex multi-component system with a hierarchical organization that can be explained by studying each component at a spatial configuration (Taina et al., 2008). Studying soil microstructure at a spatial configuration, can for instance, reveal the effect of different land-use practices on soil behavior. The non-destructive technique of x-ray computer tomography is an excellent tool for studying the nature of soil components at a spatial configuration (Kumi et al., 2015). It was hypothesized that no-tillage natural fallow (NTNF) affects soil aggregation thereby altering soil microstructure and porosity. The objective of the study was to determine the effect of continuous cultivation (CCI) and NTNF on aggregate stability and the resulting soil microstructure and porosity using X-ray μ CT and image analysis.

Materials and Methods

Five samples were collected from a five-year-old NTNF and CCI. Aggregate stability was estimated by calculating mean weight diameter (MWD) using the fast wetting method described by Le Bissonnais (1996). The aggregate microstructure was determined with X-ray μ CT on aggregates ~ 10 mm diameter and image analysis was done using VGstudio MAX 3.0.

Results and Discussion

Aggregate stability and soil organic carbon (SOC) were 5.66% and 18.55% higher under NTNF than under CCI. Higher aggregate stability observed under NTNF was possibly due to the higher amount of SOC than in CCI. SOC acts as an aggregate binding agent (Six et al., 2004) and is positively correlated to MWD (Spohn and Giani, 2011). In addition, No-till practice was reported to improve aggregate stability (Thierfelder and Wall, 2012). Porosity was 7.71% higher under NTNF than CCI. Soil porosity is an important parameter associated with transport and storage of water and nutrients in the soil and its increase enhances infiltration and reduces soil erosion (Kumar et al., 2010). Thus, NTNF has potential to enhance soil water status and hence reduce soil erosion. Microstructural pore properties (pore distribution, pore shape proportion) and visualization were similar in NTNF and CCI. Despite the similarities, aggregates under NTNF had higher total number of pores. The study shows link between aggregate stability and aggregate microstructure. This study agrees with previous results by Zhou et al. (2012), who reported an association between aggregate stability and microstructure.

Conclusions

NTNF management can improve soil aggregation, altering soil microstructure and increasing porosity.

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Comparison of soil macrofauna diversity and abundance between organic and conventional wheat ecosystems

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Introduction

Soil macrofauna diversity contributes to the processes within the soil ecosystem, particularly the decomposition of soil organic matter, cycling of nutrients and the amendment of the soil's physical properties. The influences of conventional agricultural practices including the physical disturbances of soil by the means of tillage and chemical intensification are detrimental to the diversity of soil macrofauna and hence the essential ecosystem services they provide. In order to promote soil biodiversity in agricultural environments, ensuring sustainable functioning and resilience, it is important to understand the influence of agricultural management on soil community structure. The study aims to evaluate the influence of agricultural management systems on soil biodiversity by comparing the diversity and abundance of the soil macrofauna assemblages between organic and conventional wheat ecosystems.

Materials and Methods

The current study was carried out in the Prieska area of the Northern Cape, from August to December 2017. Soil macrofauna assemblages were sampled using pitfall traps and soil monoliths in irrigated organic and conventional wheat fields. Within each system, 20 pitfall traps were placed along crossed transect lines with 4 pitfalls on each arm and four in the middle, spaced 20m apart. The traps were monitored on a monthly basis. To analyse effects of different farming systems on the biodiversity of the soil macrofauna, species richness, Shannon-Wiener diversity index (H') and evenness index will be calculated for each farming system.

Results and Discussion

The assessment of macrofauna species diversity and abundance in different agricultural systems may represent an important tool to farmers for evaluating management practices with the preservation of soil ecosystem services of macrofauna in mind. Sampling is still in progress and preliminary results will be presented.

Conclusions

Sustaining soil macrofauna diversity is essential to sustain ecosystem functions in the soil. Assessment of the diversity of soil macrofauna can function as a bio-indicator of community stability and define the ecological dynamics in the soil community and impact of stress.

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MORPHOLOGICAL CHARACTERIZATION OF COWPEA (*Vigna unguiculata* (L.) Walp.) GERMPLASMS CONSERVED IN THE GENE BANK

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Introduction

Improving local cowpea varieties and management practices can increase farmers' production and productivity, and reduce poverty. This cannot be achieved without knowing the genetic diversity available within and between local and regional germplasm collection. The study focused on the assessment of the performance and variability among the cowpea landraces collected from different agro-ecological zones of South Africa based on morphological traits.

Materials and Methods

A total of 8 cowpea accessions were assessed in this study. The experimental work was carried out at Buffelspoort Quarantine Station of the Department of Agriculture, Forestry and Fisheries, situated in North West Province during 2017/18 season. The field trials were in a randomized complete block design (RCBD) with three replications. Each accession was represented by 100 plants. The genotypes were described based on the descriptors for cowpea of IBPGR (1983). Quantitative and qualitative characters were recorded during the vegetative and reproductive stages and analyzed using SAS 9.3.

Results and Discussion

The majority of the cowpea accessions assessed had yellow flower (87.5%). Only 12.5% of the accessions presented flowers with white colour. Seeds had predominantly very small eye pattern and the seeds shape (ovoid and Rhomboid) and Testa texture (Rough and smooth) recorded 50% each. All the seeds of the cowpea accessions observed had green eye colour. The growth habit observed was intermediate for all accessions whereas 50% of the accessions indicated the growth pattern of determinate and indeterminate each. The number of pods per plant recorded for accession 5366.1.1.1 was significantly higher (89.67) than all other accessions. On the other hand, the pod length and pod width for accession 5386.1.1.1 recorded 193.00mm and 9.33mm, respectively, as the highest. The 100 Seed weight was recorded as the highest (13.62g) for accession 5386.1.1.1 whereas accession 5366.1.1.1 recorded 5.68g as the lowest.

Conclusions

The results from this study revealed the differential performance of the cowpea accessions and provided a useful information and knowledge about the diversity of these accessions conserved in the gene bank. The high yielding trait such as number of pods per plant we observed in accession 5366.1.1.1

References

Influence of pre - and postharvest factors on 'Benny' valencia sweet orange rind phenolics and their role in mitigating rind chilling and pitting susceptibility

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Introduction

South African citrus fruit must be cold sterilised as a phytosanitary measure against fruit flies, especially the oriental fruit fly (*Bactrocera dorsalis*). However, within the sweet orange group, 'Benny' valencia oranges are highly susceptible to rind damage disorders during cold sterilisation, including chilling injury and non-chilling rind disorder (pitting). The aim of this study was to investigate the effect of harvest time, postharvest dehydration plus waxing and storage temperature on rind phenolics, in order to mitigate manifestation of chilling and non-chilling rind disorders of 'Benny' valencia sweet oranges after cold sterilisation.

Materials and Methods

'Benny' valencia citrus fruit were harvested at early, mid and late season and, thereafter, subjected to three treatments, namely control (untreated), dehydrated at 25°C ±45% RH and waxed with Citrishine plus dehydrated at 25°C ±45% RH in the laboratory. After treatment, fruit were stored at -0.6 or 4.5°C for 28 days and, thereafter, for 7 days at ambient temperature. During the 7 days shelf-life, fruit were evaluated for non-chilling and chilling disorders, weight loss, electrolyte leakage and firmness. Thereafter, fruit were peeled and the peel freeze-dried, milled in liquid nitrogen and stored at -21°C for further physiological analysis. Milled flavedo was analysed for free and soluble-conjugated phenolics using a spectrophotometric method.

Results and Discussion

Non-chilling disorder was significantly higher for fruit harvested in the late season while chilling disorder was higher for fruit harvested in the early season, especially during storage at -0.6°C. Furthermore, dehydration stress without waxing increased manifestation of non-chilling and chilling rind physiological disorders at -0.6°C when compared with 4.5°C storage. With respect to both free and soluble conjugated phenolics the untreated 'Benny' valencia fruit showed higher rind phenolics, irrespective of harvest time or storage temperature.

Conclusions

Untreated fruit seem to be naturally responding to cold stress by up-regulating endogenous systems of total rind phenolics. Contrarily, postharvest treatments (dehydration and waxing plus dehydration) suppressed endogenous phenolics synthesis, resulting in poor defence against chilling and non-chilling disorders of 'Benny' valencia fruit.

References

RESPONSE OF DRY BEAN (*Phaseolus vulgaris* L.) GRAIN YIELD TO PLANT POPULATION AT DZINDI IRRIGATION SCHEME.

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Introduction

Dry bean is an important leguminous crop in the world. It is regarded as the third most important food legume after soybean and peanut. Determination of the optimal plant population density necessary for optimal yield is a major agronomic goal. The objective of the study was to evaluate the effects of plant population density on grain yield.

Materials and Methods

The trial was planted at Dzindi irrigation scheme during the 2012 season. Dzindi irrigation scheme is located 6 km south west of Thohoyandou, Thulamela municipality, Vhembe District of the Limpopo Province, South Africa. The trial was a 3x2 factorial experiment involving three plant populations (210 000, 150 000 and 70 000 plants ha⁻¹) and two varieties of dry bean (OPS-RS2 and Jenny) in a split-plot design with three replications. The recommended population is 150 000 plants ha⁻¹. The spacing between the rows was 90 cm. Number of plants germinated was determined nine days after planting. Destructive sampling was done by harvesting six plants per treatment at 30, 62 and 98 DAP. At 20, 62 and 98 days after planting (DAP), chlorophyll content and plant height from the same six plants were determined. After the plants were harvested they were put in brown bags and they were dried at 75 °C for ±48 hours. Yield data (seed yield, 100 seed mass) was collected from 1 m² in the middle of the plot. The number of pods per plant and number of seeds per plant was collected from 10 randomly selected plants per plot. Yield is expressed based on a 10% moisture content. Harvesting was done by hand.

Results and Discussion

The interaction relationship between dry bean varieties and plant populations significantly influenced the grain yield, grain yield per plant, chlorophyll content, plant height at 62 and 98 DAP, chlorophyll content at 62 and 98 DAP and dry matter production. The highest grain yield was achieved with OPS-RS2 at 150 000 plants ha⁻¹ (3.802 t ha⁻¹). The number of seeds per plant was influenced by plant population and dry bean variety. The number of pods per plant was only influenced by plant populations. There was a significantly positive correlation between grain yield per plant and pods per plant, number of seeds per plant and chlorophyll content.

Conclusions

The plant population of 150 000 plants ha⁻¹ was found to be the most suitable for both determinate and indeterminate dry bean varieties under these conditions

References

AVERAGE FRUIT MASS AND FRUIT SIZE OF THE MD2 SELECTIONS AND MD2 LINES PRODUCED IN HLUHLUWE, KWAZULU NATAL

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Introduction

The MD2 pineapple is one of the three pineapple cultivars produced in Hluhluwe in Northern KwaZulu-Natal for the fresh market. Pineapple fruit size plays a major role in the packaging and marketing of the fruit. Fruit of the same size and colour are packed in a box. The biggest fruit is a size 4 (2 kg) and the smallest is a size 16 (600 g). Bigger fruit fetch a good price. A study was conducted to evaluate the average fruit mass and fruit sizes produced by the MD2 lines and selections. The MD2 pineapple lines were seed embryos rescued in vitro (tissue culture) from MD2 pineapple fruit and proliferated for field evaluation. The selections were received from different farmers in the Hluhluwe area.

Materials and Methods

The experiment was conducted in Hluhluwe, KwaZulu-Natal (S2800'50, E32016'30) at the ARC-TSC in 2013. The MD2 selections were: DTV1, DTV2, AUSTRALIA, GWANZI, WE1, WE2, TCB, 2D1 MD2, LB and 1C and the MD2 lines were: 2A, DC2, DC3 and BC3. Three different plant sizes were planted for each MD2 selection and MD2 line namely plant size 1 (bigger), size 2 and size 3 (smaller). The experiment was maintained using the standard pineapple cultivation method. At fruit harvest 100 fruit from each plant size of the MD2 selection and MD2 line were weighed for average fruit mass; sorted according to sizes and the percentage of the different fruit sizes was calculated.

Results and Discussion

There was a negative correlation between plant size and fruit size, caused by the high percentage of natural flowering that affected the bigger plant sizes. Naturally induced fruit tend to be smaller than artificially induced fruit because they are produced before the plant reaches vegetative maturity. Bigger plants produced fruit with a lower average fruit mass and the average fruit mass increased with a decrease in plant size. The average fruit mass for the MD2 cultivar is 1.5kg. The average mass of the MD2 selections in all plant sizes in the experiment was less than 1.5kg. In the MD2 lines only DC3 plant size 3 produced an average fruit mass of 1.6kg. The results showed that in all the plant sizes of the MD2 selections and MD2 lines the fruit size percentages are evenly distributed between size 6, 8, 10 and 12.

Conclusions

All the MD2 selections and MD2 lines produced marketable fruit sizes. The highest average fruit massing the MD2 selections and lines was DTV1 and DC3 respectively.

References

Initial screening of South African commercial soybean [*Glycine max* (L.) Merr] cultivars for simple sequence repeats (SSR) conferring resistance to *Sclerotinia sclerotiorum*

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Introduction

Sclerotinia sclerotiorum (Lib.) de Barry, commonly known as *Sclerotinia* stem/ stalk rot is one of the pathogens that have a potential devastating impact on the growth of the soybean industry in South Africa. Several quantitative trait loci (QTLs) that play a role in soybean resistance to *Sclerotinia* stem rot have been identified and mapped on the soybean's integrated genetic linkage map. None of these QTLs and their underlying markers have, however, been evaluated in any of the commercial soybean cultivars grown in South Africa. The main objective of this study was to characterise simple sequence repeat (SSR) markers linked to QTLs that are reported to have an association with stem rot resistance on South African commercial soybean cultivars.

Materials and Methods

Twenty SSR markers that have been reported to have an association with stem rot resistance on soybean were evaluated on 29 commercial soybean cultivars that are currently planted in South Africa. SSR markers were characterised for genetic diversity across South African cultivars using GenALEX software package. The SSR markers data was further used to evaluate the genetic relationships across South African cultivars as well as between South African cultivars and those with known resistance to *Sclerotinia* stem rot.

Results and Discussion

Five markers were not polymorphic, and had a low genetic diversity across South African cultivars; while fourteen were polymorphic across a few or more cultivars. There was a wide distribution of shared alleles across cultivars; some cultivars shared alleles with a cultivar of known resistance (Maple arrow) , while, some shared alleles with a cultivar of known susceptibility (Williams 82) to *Sclerotinia* stem rot. These shared alleles across cultivars provided information on the genetic relationships between South African cultivars and those with known resistance; and therefore gave an insight on the genetic resistance of South African cultivars to *Sclerotinia* stem rot.

Conclusions

While this is only an initial study, knowing which SSR loci contains alleles that are shared between south African cultivars and Maple arrow provides an insight on the genetic resistance of South African soybean cultivars to *Sclerotinia* stem rot. The information from this study also provides valuable information on the genetic diversity of the selected SSR markers and aids South African soybean breeders in selecting appropriate stem rot resistance markers among those that have been previously reported.

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DIFFERENT GROWING MEDIA EFFECT ON CABBAGE SEEDLING GERMINATION AND GROWTH IN THE GLASSHOUSE

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Introduction

Cabbage (*Brassica oleraceae* sp. Capitata) is a vegetable crop, previously used as a medicinal plant for treating gout, stomach problems and headache in the early days (Chatterjee and Mal., 2016). In vegetable production, seedling stage is important as it influences growth and development, early yield and total yield per plant. According to Demir et al., (2010), use of quality seedlings grown under controlled conditions and a special growth medium is essential. One of the major concerns in seedling production is the poor productivity of growing media used, which could be ascribed to the water-holding capacity amongst other factors.

Materials and Methods

A study to determine the best growing media for seedlings was conducted under glasshouse conditions during 2017. Eight growing medium formulations composed of sand, hygromix, goat manure and pine bark at different ratios were used as treatments. Cabbage seeds were sown in seedling trays with 4 x 10 cavities, filled with the different growing media combinations. Initially two seeds were put in each cavity and this was thinned to one seedling after germination. The experiment was carried out in a Randomized Complete Block Design (RCBD), replicated five times.

Results and Discussion

The highest germination percentages were recorded on media containing pine bark and the lowest was recorded in pure Hygromix medium. There was no significant difference amongst the treatments containing manure and pine bark. The highest average plant height (127.6 mm) was recorded from Hygromix and manure mixtures while the lowest (92.45 mm) from pure sand and pure pine bark growing media. Hygromix and manure showed the highest root mass, leaf area, leaf fresh mass, root length compared with the other treatments. According to Bhardwaj (2013), pine bark provides the long-term drainage and aeration needed by plant roots. It also increases the bulk density and soil pH of the growing medium. Disadvantages of manure include possible high salts, fine particle size and weed seeds, while possible advantages include the nutrient contribution and potential improvement in medium physical properties.

Conclusions

The study showed that growth media significantly influence germination and growth in cabbage seedlings. Media with manure and pine bark were the best because seedling sown in these growing media combinations did better in germination, seedling growth and development parameters than in the other growing media tested. Overall results revealed that media supplemented with manure resulted in higher germination rate and better growth and development of cabbage seedlings compared to media without manure.

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EFFECTS OF LIME AND KRAAL MANURE APPLICATIONS ON MAIZE GRAIN YIELD, SOIL pH AND ACID SATURATION IN ACIDIC SOILS OF MHLONTLO LOCAL MUNICIPALITY, O. R. TAMBO DISTRICT, EASTERN CAPE PROVINCE, SOUTH AFRICA

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Introduction

The production potential of most soils in the Eastern Cape Province, where maize (*Zea mays* L.) is grown as a dominant crop across different soil types and climatic conditions, is often limited by factors such as acidity and low organic carbon contents. Although application of lime is known to ameliorate acidic soils, on the other hand, addition of kraal manure has also been found to improve soil pH because during its decomposition, organic acids are released to complexes with Al and Fe, which block the P retention and make P to be more accessible to plants (Sharma et al, 1990). A study was conducted to evaluate the effect of applied lime and kraal manure on maize grain yield, soil pH and acid saturation of acidic soils in Tsolo, Mhlontlo Local Municipality, O. R. Tambo District.

Materials and Methods

The experiment was arranged in a Randomised Complete Block Design with seven treatments, namely: {recommended rate of fertilizer with lime (RFL+), recommended rate of fertilizer without lime (RFL-), 5 and 10 tons/ha of sheep kraal manure with lime (5 KML+ and 10 KML+), 5 and 10 tons/ha of kraal manure without lime (5 and 10 KML-) and the unfertilized plot}, replicated three times. Soil samples were collected to determine soil physical and chemical properties, soil pH (KCl) and acid saturation (%). At harvesting, grain yield was determined at 12.5 % moisture content and all data were subjected to Statistica version 13.2 for analysis and LSD was used to separate the means.

Results and Discussion

Application of 5 tons/ha of kraal manure with lime significantly improved the acid saturation, where the highest acid saturation was 26.33% in RFL- while the lowest was 4% in 5 KML+ and soil pH improved through the application of 5 KML+. At harvesting, RFL+ produced the maximum mean grain yield (1806 kg/ha) while 5 KML- showed the lowest response (1065 kg/ha).

Conclusions

Although the results preliminary and the study is ongoing, there seems to be a potential benefits associated with application of sheep kraal manure at 5 tons/ha. Recommendations from further investigations will assist the resource-poor farmers of the Eastern Cape in ameliorating acidic soils with available kraal manure in their disposal.

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FERTILISER USE BY SMALL-SCALE FARMERS IN EASTERN CAPE

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Introduction

Soil fertility is defined as a condition of a soil that enables it to provide nutrients in adequate amounts and proper balance for plant growth. Environmental growth factors also need to be favourable (Doran et al. 1994). Management of soil fertility is an important factor influencing crop productivity. Madingana et al. (2009) stated that Eastern Cape small-scale farmers are faced with a variety of challenges. Low rainfall and poor rainfall distribution through the growing season are limiting production; however, soil fertility is a major constraint. This is mainly due to very low use of fertilizers as they are unaffordable and lack information and knowledge about them.

Materials and Methods

Soil samples were collected from small-scale farmers in Mhlontlo municipality of Eastern Cape (EC) during 2014-15. Chemical analysis of all parameters were conducted at ARC-ISCW soil analytical laboratory, using standard methods (Non-Affiliated Soil Analysis Working Group, 1990). A survey amongst selected farmers in the municipality was done during meetings with extension officers in mid-2017. Several questions in the survey collected information about the farmers' opinions about their soil fertility conditions dependent on their farming practices. Their use of fertiliser and cattle manure was also documented relative to their maize production in previous years.

Results and Discussion

About 30 % of EC small-scale farms (Goodland, 1995), practice under mixed farming (maize, vegetables, cattle and goats) primarily for home consumption and/or local marketing. About 63.6 % of the farmers do not use both cattle manure and inorganic fertilisers. Only 24.2 % are dependant on manure from their own cattle kraal. Mostly, these applications are done only once a season prior to ploughing. The soils have varying pH with higher values in deeper layers. They are mostly slightly acidic to slightly alkaline, with pH ranging from 5.22 to 5.64 in top 200 mm and from 5.70- 7.14 in deeper layers. Therefore maize should be able to grow under these conditions. The soils are sandy loam to sandy clay loam sand), so they limited water holding capacity. This is why the sporadic rainfall and poor distribution through the season is a limiting factor for crop production.

Conclusions

The current nutrient status of soils in EC limits their productivity, which in turn limits their ability to purchase inorganic fertilisers. Therefore restoring the soil productivity could be approached using conservation agricultural principles by introducing legume rotations. This requires development of innovative viable cropping systems to address this poverty spiral.

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SORGHUM ROOT ROT AND GRAIN MOLD PATHOGEN RESPONSES TO LEGUME ROTATION SYSTEMS

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Introduction

Sorghum, an essential economical crop in Africa and Asia, has an estimated annual yield loss of 30% due to pest and diseases. Root rots and grain molds are major constraints in many sorghum production areas. The study aimed to evaluate three sorghum cultivars for root rot and grain mold severity in legume based cropping systems.

Materials and Methods

During 2015/16, main plots were planted with either sorghum, dry bean, soybean, cowpea, bambara or fallow. In 2016/17, main plots were split into two sections with three replicates each. One section was re-planted with respective crops from the previous season (dry bean), while the second section was planted with three sorghum cultivars (PAN8816, PAN8706W and NS5511). This created a dry bean/sorghum as well as a dry bean monoculture treatment. Yield was calculated at harvest (t/ha; 12.5% moisture) and root rot severity was determined using a modified scale of 0-4 (Soonthornpoc et al., 2000). From the individual root samples, DNA extraction and qPCR analyses were carried out for the quantification of 12 fungal root pathogens. Data was subjected to ANOVA using GenStat and means were separated using Fischer's LSD (P=0.05).

Results and Discussion

Only cultivar as main variable had a significant effect on yield and root rot severity. NS5511 (2.4 t/ha) and PAN8816 (2.2 t/ha) yielded significantly higher than PAN8706W (1.6 t/ha). NS5511 had a significantly higher root rot severity index (177.2) than PAN8816 (105.0) and PAN8706W (0.00). qPCR analyses showed that *Fusarium chlamydosporum* occurred in higher levels in PAN8706W. Significantly higher concentrations of *F. graminearum* were observed in the grains of PAN8706W. Only two fungi (*Fusarium oxysporum* and *Phoma* spp.) were significantly affected by cultivar x treatment interaction. *Fusarium oxysporum* occurred in significantly higher levels in bambara/sorghum rotation system in PAN8816, while *Phoma* spp. occurred at significantly higher levels in PAN8706W with the cowpea/sorghum interaction.

Conclusions

Preliminary findings indicated that yield, root rot and grain mold were not significantly affected by legume based rotations with sorghum. Certain root rot pathogens were, however, affected by the rotation x cultivar interaction. The study is still ongoing

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THE EFFECT OF GLYPHOSATE APPLICATION AT DIFFERENT GROWTH STAGES ON MAIZE YIELD

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Introduction

Glyphosate, a broad-spectrum herbicide, is also a broad-spectrum chelator to macro- and micronutrients (Ca, Cu, Fe, K, Mg, Mn and ZN) and has the potential to indirectly affect plant photosynthesis, disease resistance and other functions. The aim of this study was to investigate whether the application of glyphosate on glyphosate resistant maize cultivars would result in yield reduction.

Materials and Methods

Three field trials were planted at Potchefstroom during 2016/17 and sprayed with Product A (540g ae/l), Product B (540g ae/l) and Product C (540g ae/l), respectively, at the label rate of 2 l/ha. Four RR cultivars (BG5785BR, PAN6R-710BR, P1814R and P2880WBR) received glyphosate applications at the V4, V6 and V8 physiological growth stages. An unsprayed control was included for each RR cultivar. The trial layout consisted of a strip-split design with three replicates (cultivar and plant growth stage as factors). Yield was calculated at harvest (t/ha; 12.5% moisture). Data were subjected to a strip-plot ANOVA using GenStat for Windows 15th edition (Payne, 2015) and means were separated using Fisher's Protected LSD at the 5% significance level.

Results and Discussion

The application of Product A did not result in yield reduction in any cultivar. The application of Product B resulted in yield loss for all four cultivars at 23%, 17% and 14% during the V4, V6 and V8 stages respectively. The interaction between cultivar and application date was significant ($p=0.022$) with Product C. Compared to their untreated controls, yield of PAN6R-710BR was significantly lower when Product C was applied at V6 and V8. Yield observed for BG5785BR was significantly reduced when glyphosate was applied at V8. P2880WBR did not show significant yield loss at any application time, whilst P1814R yielded significantly less when Product C was applied (V4, V6 and V8).

Conclusions

Yield was significantly reduced by two of the three glyphosate products tested. Additional field trials with more RR cultivars and glyphosate products must be conducted to confirm the findings of the current study

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Promotion of grain cowpea for sustainable maize/cowpea intercropping by smallholder farmers through introducing them to enhanced preparation methods

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Introduction

Maize/Cowpea intercropping is prevalent in Ga-Molepo but the intercropping is very light as extremely low plant densities of spreading cowpeas are utilised. There is need to introduce grain cowpea of upright bush architecture to intensify the intercropping and benefits of BNF. In the Ga-Molepo area, most farming is done by female farmers. It was hypothesised therefore that if women are introduced to new menus they are likely to be interested in more consumption/cooking of cowpea in the home, thereby being interested in the compact grain cowpea as opposed to the spreading 'morogo' type.

Materials and Methods

An exercise was conducted to introduce four cowpea dishes (two local and two Nigerian) to a predominately female farmer group. The participants tasted all the four dishes and commended on them. Follow-up focus group discussion were held to discuss their utilisation of cowpea grain at the household level and their willingness to grow cowpea for grain rather than for vegetable.

Results and Discussion

Results indicated that 53.3 % of the farmers consume cowpea in their households. About 85% of the farmers indicated that they liked the exotic dishes and they will like to try it in their households Focus group discussions showed that many farmers wanted more demonstrations of more menus and were willing to test grain cowpea varieties in their fields so that they can produce their own grain. They also said that they were willing to cook cowpea-based meals more often if the grain was available. At present, they can only access a lot of cowpea grain at the Lebopo cooperative but the cost was inhibitive. This preliminary exercise suggests good potential of introducing grain cowpea through cooking demonstrations with female farmers.

Conclusions

Adoption of grain cowpea would facilitate denser maize/cowpea intercropping and thus enhance the benefit these low resourced farmers can get from Biological Nitrogen Fixation.

References

DETERMINATION OF NON-PHYTOTOXIC CONCENTRATION AND OVERALL SENSITIVITY OF NEMAFRIC-BL PHYTONEMATICIDE ON POTATO 'MONDIAL G3' UNDER FIELD CONDITIONS

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Introduction

Nemafric-BL phytonematicides may cause phytotoxicity on various plant crop species and factors inducing them in the field are still unclear. According to Mashela et al. (2011), phytonematicides are used as alternative to synthetic chemical nematocides. However, phytonematicides have the potential to cause phytotoxicity if used at incorrect concentrations (Mashela et al., 2015). The mean concentration stimulation point (MCSP), which is crop-specific, constitute the concentration of the phytonematicide to be used at each application, without inducing phytotoxicity. The MCSP is developed using adapted Curve-fitting Allelochemical Response Dosages (CARD) computer-based model (Liu et al., 2003). Furthermore, the CARD model also provides the sensitivity index (k), which provides information of the sensitivity of the crop to the product. The degree of phytotoxicity of Nemafric-BL phytonematicide on potato cultivar 'Mondial G3' remains undocumented. The objectives of this study was to determine the MCSP and overall sensitivity of Nemafric-BL phytonematicide on potato cultivar 'Mondial G3' under field conditions.

Materials and Methods

Treatments namely, 0, 2, 4, 8, 16, 32 and 64% Nemafric-BL phytonematicide were arranged in a RCBD, with 9 replications. The data were on plant variables were collected and subjected to ANOVA using SAS software (SAS Institute, 2008). Significant plant variables means were subjected to computer-based CARD model to generate the biological indices D_m and R_h (Lui et al., 2003), which will allow for the calculation of MCSP values for one phytonematicides (Mashela et al., 2015) and overall sensitivity ($\sum k$) of potato 'Mondial G3'.

Results and Discussion

The Curve-fitting Allelochemical Response Data (CARD) model suggested that the non-phytotoxic concentration of Nemafric-BL phytonematicide on potato was at 4.47%. The overall sensitivity of the product was found to be 0 units for all measured variables. Similarly Pelinganga and Mashela (2012) observed significant results on dry shoot mass and plant height of tomato plant when exposed to increasing concentrations of Nemafric-BL phytonematicide. Because the overall sensitivity index ($\sum k$) of potato cultivar 'Mondial G3' to Nemafric-BL phytonematicide was at 0 units, the plant would be moderately to highly sensitive to the product (Lui et al., 2003).

Conclusions

CONCLUSION For potato cultivar 'Mondial G3', Nemafric-BL phytonematicide must be applied at 4% to avoid phytotoxicity.

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INFLUENCE OF LIQUID FORMULATIONS OF KLEINIA LONGIFLORA EXTRACTS ON GROWTH OF TOMATO PLANT

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Introduction

Paintbrush flower (*Kleinia longiflora* DC) is a succulent shrub native to Southern Africa. It is traditionally used in insect pest management. The plant has a potential to be used as an alternative to the withdrawn synthetic nematicides from agrochemical markets. Phytonematicide as alternatives is a fast-growing system in the management of plant parasitic nematodes. However, most phytonematicide used have phytotoxic effects on growth of plants protected against nematode pests (Mashela et al. 2015). Therefore, objective of the study was to assess the influence of increasing concentrations of *K. longiflora* in liquid formulations on growth of tomato plant.

Materials and Methods

The study was conducted at Green Biotechnologies Research Centre, University of Limpopo. A field study was initiated with seven treatments, namely, 0, 2, 4, 8, 16, 32 and 64 % fermented *K. longiflora* arranged in randomised complete block design (RCBD) with 12 replications. Herbaceous material from *K. longiflora* was harvested, chopped and dried in air-forced oven and ground. The 40 g of ground material was fermented using EM as described in Pelinganga (2013). Uniform tomato seedlings cultivar 'Floradade' three weeks old were transplanted. Tomato plants were planted at 60 cm for both inter-row and intra-row spacing. At 56 days after transplanting, data were collected on plant height, stem diameters and chlorophyll. Data were subjected to analysis of variance using Statistix 10.0 software at probability level of $P = 0.05$.

Results and Discussion

Data generated on this study indicate that treatments had no significant effect on plant variables collected. Dry shoot mass, dry root mass, Plant height and chlorophyll contributed 10, 28, 38 and 46%, respectively on total treatment variation. Therefore, irrespective of increasing concentration of fermented *K. longiflora* neither stimulated nor showed phytotoxic effects on plant growth.

Conclusions

Fermented crude extracts of *K. longiflora* had no significant effect on growth of tomato plant and therefore, appears that it neither stimulated nor reduced plant growth.

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Soil Surface crusting effects on infiltration and soil loss in selected South African soils.

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Introduction

Soil surface crusting is a major land degradation driver in arid regions of the world because of variations in rainfall characteristics. This study was conducted to determine the effects of rainfall intensity and slope steepness on soil crusting and its effects on infiltration rate and soil loss.

Materials and Methods

Soil surface samples (0-30cm depth) were obtained from four sites selected based on soil texture and clay mineralogy (Duplessis, 1987). Two of the soils were kaolinite dominated (K1 & K2) and the other two were smectitic (S1 & S2). A rotating disc rainfall simulator was used to apply rainstorms at two different intensities (45mm/h, 70 mm/h) to the study soils positioned at different slopes (5° and 8°) and infiltration rate, soil loss and penetration resistance measurements were made.

Results and Discussion

The results show that K2 had a significantly higher infiltration rate of 33.32 mm/h at 70 mm/h and 5° compared 18.47 mm/h of the same intensity at 8° slope gradient. This was significantly similar to the values obtained for the same soil at the lower intensity of 45 mm/h and both slope gradients (32.15 and 31.10 mm/h) and to the 29.96 mm/h of K1 at 45 mm/h and 8 degrees slope. S1 was significantly lowest at 11.64 mm/h at 70 mm/h intensity and 5° slope. On the other hand the infiltration rate of S1 at 45 mm/h and 5° slope (18.91 mm/h) was statistically similar ($\alpha = 0.05$) to that of K2 at 70 mm/h and 5° slope. Under these conditions (45 mm/h and 5°) S1 (137.02 kg/ha) is together with K1 (31.15 and 23.85 kg/ha) and K2 (71.00 and 28.33 kg/ha) regarding soils loss at both slope steepness levels and 45 mm/h intensity. Under 45 mm/h intensity and 5° slope, S2, S1 and K2 had higher penetration resistance. S2 at 13.46 Mpa was higher than K2 (0.56 Mpa) which was lower than S1 (1.08 Mpa) ($\alpha = 0.05$). These results suggested that highly weathered soils that are dominated by kaolinite (K1 and K2) are relatively more stable. This is was also reported by other researchers (Valentin, 1993; Ball et al, 2000 Pagliai, 2007). The influence of rainfall intensity and slope steepness is observable in that at higher intensity and slope steepness the soils showed less penetration resistance.

Conclusions

The study has shown that changes in rainfall intensity affect crust formation, which affects infiltration and soil loss. The study can be improved by measuring other crusting parameters such as micromorphology.

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USING “ALTERATION INDEX THREE” TO QUANTIFY THE IMPACT OF IRRIGATION WITH WINERY WASTEWATER ON THE INTERNAL SOIL ENVIRONMENT

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Introduction

The Western Cape of South Africa is currently facing severe water scarcity and as the demand for water dramatically increases, so does the interest in reusing winery wastewater for irrigation in vineyards. The impact that water containing winery waste could have on the internal soil environment and particularly, the activities and functioning of microorganisms responsible for breakdown of soil organic matter and mineralization of nutrients, is very much uncertain. The research reported here is aimed at investigating the soil alteration response after multiple irrigation cycles with winery wastewater, compared with high quality water containing no winery wastes, using soil alteration index three (AI3).

Materials and Methods

Soils from four vineyard areas were irrigated, in pots, over four simulated seasons with municipal water, and with winery wastewater diluted to a chemical oxygen demand of 3000 ml/L. The soils were: alluvial sand, aeolian sand, as well as shale and granite derived soils. Pot soil samples were taken from the top- (0-10cm) and subsoil (10-20cm) layers at different sampling times during the year. Urease, β -glucosidase and acid phosphatase activities were determined after each season. AI3 indices were generated using the formula by Puglisi et al. (2006). The pot trial followed a statistical design.

Results and Discussion

Irrespective of the simulated season and of the soil type, better overall AI3 index scores were observed in treatments where wastewater was used for irrigation compared with municipal water irrigation. This improvement may have been due to the inducement of soil microbial activity through the supply of easily decomposable organic material in wastewater (Anissimova et al., 2014) and the ensuing metabolic processes involved in decomposing soil organic matter. The AI3 also accurately reflected gradients in mineralizable substrates transecting the two soil layers (0-10 cm and 10-20 cm), with the top layer being consistently better than the subsoil layer.

Conclusions

Vineyards soils may benefit from winery wastewater as an alternative source of water for irrigation. Winery wastewater inputs have the added advantage that it contains substrates that may enhance soil microbial enzyme activity and improves soil fertility.

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EFFECT OF MINIMUM TILLAGE ON YIELD OF DRY BEAN CULTIVARS IN SUBSISTENCE FARMING

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Introduction

Dry bean (*Phaseolus vulgaris* L.) is an important grain crop popular for its high protein content and many other health benefits, rendering it ideal as a food security crop. Many subsistence farmers in the Limpopo province of South Africa grow dry beans every season either to generate income or to the consumption needs of their own households. The majority of these farmers rely on the government for ploughing equipment and other related resources. This study aimed at determining the yield of ten selected commercial dry bean cultivars of the market classes of South Africa using minimum tillage as a treatment and conventional tillage as control.

Materials and Methods

The trial was established in four-row, five-meter long plots replicated three times in a randomized complete block design fashion. Adjacent rows were 75 cm apart (inter-row spacing) and seeds were 7.5 cm apart (intra-row spacing). At planting, fields were fertilized with 250-300 Kg/ha 3:2:1 (25) N:P:K. For the minimum tillage system, only hand hoes were used at planting while mouldboard plough and hand hoes were used for the conventional tillage system. The trial was irrigated twice per week. Weeds were controlled using hand hoes for the conventional tillage system while herbicides (Bateleur Gold at planting and Basagran post planting) were used for the minimum tillage system through the growing season. At maturity, the trial was manually harvested and seed weighed for yield data.

Results and Discussion

Generally, cultivars yielded better under conventional tillage system with PAN 9292 (1 518 Kg/ha), Teebus-RR1 (1 413 Kg/ha) and Kamiesberg (1 233 Kg/ha) having yielded higher than all the other cultivars. Majuba (385 Kg/ha), DBS 830 (480 Kg/ha) and Teebus (550 Kg/ha) had the lowest yield under minimum tillage system. Conservation tillage, along with some complimentary practices such as soil cover and crop diversity has however emerged as a viable option to ensure sustainable food production and maintain environmental integrity.

Conclusions

Yield of the ten dry bean cultivars was not superior under minimum tillage system in the one season of the trial. It is also widely reported and generally understood that the benefits of minimum tillage are evident over a period of time. In addition to expanding the study to other localities, the trial will be repeated in the coming season at the same area of the same farm in order to confirm the results.

References

BIOCHAR AND POULTRY MANURE EFFECTS ON SELECTED SOIL PHYSICAL AND CHEMICAL PROPERTIES

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Introduction

Poultry manure (PM) is an inexpensive source of fertilizer but it decomposes quickly and releases carbon and nutrients to soil. In contrast, biochar (BC) ameliorate soil physical properties and has a great capacity to retain nutrients due to its large surface area. This study investigated the effects of BC and PM application on selected soil physical and chemical properties.

Materials and Methods

A field experiment was conducted at the university of Venda experimental farm during 2015/2016 and 2016/2017 seasons. The experiment was a 4 x 3 factorial arrangement consisting of four rates of BC (0, 5, 10 and 20 t ha⁻¹) and three rates of PM (0, 2, and 4 t ha⁻¹) in a RCBD replicated three times. Maize was planted in both seasons and after harvest, selected soil physical and chemical properties were determined. Data was subjected to ANOVA using Genstat software and means were compared at $P < 0.05$.

Results and Discussion

Soil aggregate stability, organic carbon, Ca²⁺, Mg²⁺ and K⁺ increased with increasing rates of BC and PM application at 0 - 15 cm depth in both seasons. This suggests that BC and PM improved soil ability to retain and supply nutrients through improved soil structure. The combination of BC at 20 t ha⁻¹ and 4 t ha⁻¹ PM significantly ($P < 0.05$) decreased soil bulk density at 5 - 10 cm depth but increased soil available P and total N at 0 - 15 cm and 15 - 30 cm depth in both seasons. This is in agreement with the findings of Agegnehu et al, (2015) that biochar in combination with organic matter (compost) can stabilized soil structure and improves nutrients content.

Conclusions

Application of BC in combination with PM was an effective management practice and it can be recommended for soil with low available phosphorus and low total nitrogen.

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SYMBIOTIC PERFORMANCE OF FOUR CHICKPEA GENOTYPES: RESPONSE TO PHOSPHORUS FERTILIZER AND RHIZOBIAL INOCULATION

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Introduction

Chickpea (*Cicer arietinum* L.) has the ability to fix atmospheric nitrogen (N) through symbiosis with compatible rhizobium bacteria. However, symbiotic N fixation increases the phosphorus (P) requirement (Schulze et al., 2006), and hence nodule formation and N fixation are limited by low P availability and absence of the bradyrhizobial strain. Therefore the objective of this study was to evaluate the effect of P fertilizer rates and rhizobial inoculation on biological nitrogen fixation (BNF) of different chickpea genotypes.

Materials and Methods

The study was conducted at the University of Venda, Thohoyandou and University of Limpopo, Syferkuil, South Africa. Treatments consisted of a factorial combination of four desi chickpea genotypes (Accession #1, #2, #3 and #5), two P rates (0 and 90 kg P ha⁻¹) and two rhizobial inoculation levels (with and without rhizobium) laid out in a randomized complete block design and replicated three times. Symbiotic performance was determined using the ¹⁵N natural abundance technique (Unkovich et al., 2008).

Results and Discussion

The symbiotic performance (Ndfa% and N-fixed) varied with genotype, inoculation, P and location. Accession #1 fixed greater N (by 42, 12.5 and 10%, respectively) compared with Accession #2, #3 and #5 at Syferkuil. In contrast, N fixed was 58-188% greater in Accession #2 compared to the rest at Thohoyandou. On average, N fixation was greater with P fertilizer application and rhizobial inoculation as expected. The better N-fixation in Thohoyandou compared with Syferkuil was probably due to greater crop biomass in Thohoyandou. N-fixation was directly proportional to Ndfa% and universally proportional to δ¹⁵N, hence P application with rhizobium maximized the performance of the genotypes.

Conclusions

Phosphorous fertilizer application with bradyrhizobial strain was effective in improving BNF of chickpea in both locations, but the performance varied across locations and with genotypes.

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Impact of conservation agriculture on soil health: lessons from the university of fort hare long-term trials

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Introduction

Conservation agriculture (CA) consists of three main elements (i) minimum soil disturbances, (ii) maximum organic soil cover and (iii) crop rotation. It is a climate-smart farming technology but its adoption and success among South African smallholder farmers has been limited due in part to lack of robust local evidence for its effectiveness. Therefore, two multi-location trials were set up in October 2012 at the Fort Hare research farm and Phandulwazi High School to investigate the effects of CA components on C-sequestration and CO₂-emission mitigation, soil health as well as crop yields for the provision of key CA entry points for smallholder farmers.

Materials and Methods

The field trials were laid in a split split-plot design. The main plots were no-tillage (NT) and conventional tillage (CT); sub-plots were four crop rotations; maize-fallow-maize (MFM), maize-fallow-soybean (MFS); maize-wheat-maize (MWM) and maize-wheat-soybean (MWS). The sub sub-plots were allocated to residue management; residue removal and residue retention.

Results and Discussion

Biomass and carbon inputs for crop rotations were in the order: MWM > MWS > MFM > MFS. The MWM and MWS rotations as well as residue retention had greater levels of particulate organic matter. Residue retention was effective in increasing soil organic carbon in the 0-5 cm depth. CO₂ flux was significantly increased by tillage compared to no-till, regardless of site. The mean CO₂ fluxes were significantly influenced by air temperature and soil bulk density and was higher in summer than winter and were highest during the first three weeks after tillage. Biological activity was improved with no-till than conventional tillage, as well as with residue retention than their removal. Arylamidase, a nitrogen-linked enzyme, responded positively to MFS and MWS rotations. Earthworm abundance was negatively affected by tillage but greatly enhanced by residue retention under no-till. Soil Quality Indices calculated using the Soil Management Assessment Framework revealed that inclusion of soybean in rotations coupled with residue retention significantly improved the overall quality of the two site soils. Crops under no-till with residue retention performed much better under severe drought than those under conventional tillage. High biomass and carbon input were observed under the MWM and MWS rotations indicating their potential for enhancing carbon sequestration under the rain-fed conditions of the Eastern Cape.

Conclusions

The results indicate that CA can improve yields; reverse soil degradation, and mitigate greenhouse gas emissions under rain-fed conditions in the Eastern Cape. The MWS rotation is recommended for smallholder farmers in the Eastern Cape.

References

LINKAGE OF SOIL FERTILITY MANAGEMENT INTERVENTIONS TO FARMERS' MARKET ACCESS IN THE HIGHLANDS OF SOUTH-WESTERN UGANDA

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Introduction

Lack of profitable markets is one of the proxy causes of soil degradation in potato production systems. The study was conducted in the highlands of south-western Uganda to evaluate the effects of farmer-market linkages on farmers' decisions to allocate soil fertility management innovations to potato fields.

Materials and Methods

Focus Group Discussions and household survey were conducted in Kabale district with farmer groups that had rural and urban markets for potato produce. Participating households were identified from project records and community meetings. These were 120 households which had gone through project activities; and sampled 227 households that were not trained in soil fertility management, lacked social capital enhancements and relied on rural markets. The latter group was selected to depict how the situation would be without the project interventions. The groups were further stratified into Wealth Categories (WCs), using farmers' own criteria. The collected data were analyzed using SPSS.

Results and Discussion

The synergy of improved market linkages, social capital and knowledge for farmers in soil fertility management had no significant influence on farmers' decisions to allocate mineral fertilizers and Farmyard Manure (FYM) to potato fields ($p > 0.05$). This was attributed to high costs of mineral fertilizers; and highly fragmented farmers' fields on steep slopes that could not favor the use of FYM. However, use of FYM was significantly influenced by wealth category of households, income from potato sales; and education level and age of the household heads ($p < 0.05$). Wealthy endowed households had cattle that provided FYM for potato production that resulted into higher tuber yields and income. The synergy had significant influence on farmers' decisions to allocate green manure insitu to potato ($p < 0.05$). Potato production was an economic activity for farmers and due to limited land, there was no systematic crop rotation followed. This caused build up of diseases especially potato bacterial wilt (*Ralstonia solanacearum*) that reduced potato yields up 30-00 %. To manage the bacterial wilt farmers integrated legumes such as *Crotalaria* spp. to break its cycle.

Conclusions

Linking farmers to markets, and improving their social capita and knowledge in soil fertility management does not necessarily reciprocate into improved soil fertility management.

References

Field performance of two soil moisture sensors in Free State, South Africa

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Introduction

Soil water content (SWC) is the key parameter that governs the partitioning of the mass and energy fluxes between the land and the atmosphere through its influence on surface evaporation, runoff, albedo and emissivity (Shang et al., 2007). Despite the high spatial resolution and free availability of satellite data, remote sensing methodology for estimating SWC still needs calibration and validation with ground-truth data which are not readily available at most weather stations (Brocca et al., 2017). Therefore, an accurate, long-term and continuous SWC dataset is essential to calibrate and validate both models and remote sensing methodologies for estimating SWC in South Africa. A wide range of soil moisture sensors are used for near real-time continuous monitoring of SWC (Matula et al., 2016). However, few, if any, studies have investigated the accuracy of different types of soil moisture sensors in South African soils. Therefore, the main aim of this study was to evaluate the accuracy in field performance of Decagon and DFM soil moisture sensors that are used by the Agricultural Research Council for continuous in-situ real-time SWC monitoring.

Materials and Methods

Intact soil cores and bulk samples, collected from 15, 30 and 60 cm depths at Bethlehem and Bainsvlei in the Free State, were analysed to determine their bulk density (ρ_b), total porosity (θ_t), particle size distribution, and electrical conductivity (EC). Laboratory calibration equations were established using soil packed columns at six water content levels (0, 0.1, 0.2, 0.3, 0.4, and 0.5 cm³ cm⁻³). The factory default calibrations were tested against observed SWC from core samples using the gravimetric method. New soil-specific calibration equations were developed for each sensor, which were evaluated using an independent dataset.

Results and Discussion

The soil clay content, ρ_b , θ_t and EC significantly varied with sampling depth. Calibration results indicated a good correspondence between the measured values and known volumetric soil water content. Variations in ρ_b and θ_t at the three depths significantly affected the laboratory calibration functions of the sensors. The laboratory calibration equations for all sensors were more accurate than the corresponding default equations and could therefore mitigate the effects of varying soil properties and improve the sensors' accuracy for SWC measurements.

Conclusions

The DFM probes exhibited better precision than the Decagon soil moisture sensors.

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Cleome gynandra L. GROWTH AS AFFECTED BY PLANTING METHODS AND NITROGEN LEVELS

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Introduction

Cleome gynandra belongs to the Capparaceae family and subfamily Cleomoideae (Sonwunmi, 2015). Chweya and Mnzana (1997) state that cleome can be grown in wide range of environmental conditions, a soil pH of 5.5-7.0 and well-drained soils. It is a highly nutritious vegetable, rich in vitamin A and C and minerals such as calcium and iron, and protein (Sonwunmi, 2015). Cleome is not cultivated in South Africa (Jansen van Rensburg, 2007) but it has the potential of providing the nutrition needed to combat malnutrition and provide diversity, broadening the food base and ensuring genetic conservation. Therefore, there is a need to investigate and determine the optimum agronomic management practices.

Materials and Methods

A pot trial was conducted to evaluate the effect of planting methods and nitrogen levels on *Cleome gynandra* L. in a glasshouse of the University of Fort Hare, Alice. A factorial experiment [two planting techniques (direct planting and transplanting) and three levels of nitrogen (70, 120, 170 kg N/ha)] was conducted. All plants received 130 kg of K (in the form of KCl) and 75 kg of P (as superphosphate). The trial was laid out as a randomised complete block design, replicated three times. Each treatment combination was represented by three pots in each block. Seed for both the direct and transplanted seedlings was planted on the same day. Seedlings were fertigated. After three weeks, LAN (28%) was applied according to their treatment levels. Four weeks after transplanting, parameters such as plant height, stem diameter, stem fresh mass, leaf fresh mass and total fresh mass were measured. Data were subjected to analysis of variance using statistical software.

Results and Discussion

It was found that 120 kg N/ha showed significantly higher plant height and stem fresh mass than that of the 70 and 170 kg N/ha treatments. These findings are in agreement with those obtained by Chweya and Mnzava (1997), where they concluded that 120 kg N/ha is the optimum fertilizer rate for *Cleome gynandra* L. Leaf fresh mass and total fresh shoot mass increased with the increasing nitrogen level. The transplanting (indirect planting) method had the highest treatment means for leaf fresh mass and total fresh mass.

Conclusions

The results showed that N at 120 kg/ha is optimum for cleome production. Indirect planting was found to be the best growing method, but for recommendation, a cost analysis needs to be considered, as seedling raising and transplanting are labour-intensive.

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RESPONSE OF SOIL MINERAL NITROGEN TO TOPDRESSED NITROGEN FERTILISATION ON WHEAT IN CONSERVATION AGRICULTURE SYSTEMS

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Introduction

The use of soil nitrogen (N) tests to determine topdress N application requirement can be regarded as an important management tool. To ensure successful implementation of this management method, accurate predictions of the response of soil test N value to applied fertiliser N is essential. The aim of this study was to determine the relation between topdressed fertiliser N rate and the resultant increase in soil mineral N test value.

Materials and Methods

Wheat (SST 056) was planted five different locations differing in soil properties and climatic conditions in the grain producing areas of the Western Cape. The trial was laid out as a randomised block with four replicates. The N treatments comprised of planting with 25 kg N ha⁻¹ and topdress 0, 25, 50, 75, 105, 135 and 165 kg N ha⁻¹. A control treatment did not receive any fertiliser N. Soil samples were taken to a depth of 300 mm and NO₃⁻-N and NH₄⁺-N determined colorimetrically on a SEAL AutoAnalyzer 3. For the purpose of this presentation total mineral N was calculated as the sum of NO₃⁻-N and NH₄⁺-N.

Results and Discussion

Scatterplots, plotting the total soil N (mg kg⁻¹) against total applied N (kg ha⁻¹) were created for each system. Combined results for 2016 and 2017 had varying R² values. The R² values for certain systems differed with more than 50% when comparing the two years. Some of the systems, on the other hand, showed a much stronger relationship between years, where R² values were within 1% of each other.

Conclusions

Preliminary results showed that the response is specific to a site's soil characteristics, cropping system and possibly climatic conditions. The different years had different effects on the relationship between soil N and total N applied at the respective sites. Further studies are warranted before accurate prediction models can be drawn up.

References

THE INFLUENCE OF NITROGEN SOURCES ON YIELD AND QUALITY OF WHEAT IN CONSERVATION AGRICULTURE SYSTEMS

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Introduction

Nitrogen (N) fertilisers differ in their response to environmental conditions. Leaching and volatilisation are two of the most important parameters influencing N use efficiency. Different formulations are therefore developed to be used under specific soil, climatic and management conditions. To the producer cost (R/kg N) is important. The aim of this study was to evaluate the efficiency of topdressed N sources on wheat yield and quality.

Materials and Methods

Five N sources namely, ammonium sulphate, urea, urea plus urease inhibitor, limestone ammonium nitrate and limestone ammonium nitrate plus sulphur were evaluated. The trial was laid out as a randomised block design, with four replicates. Topdressed N rate was cropping system and site specific, based on the general recommendations for the different systems and areas. Six research sites, namely Riversdale, Riviersonderend, Caledon, Moorreesburg, Darling and Porterville were included in the study. Application rates were 35, 53, 75, 65 and 63 kg N ha⁻¹ for wheat after canola at Riversdale, Riviersonderend, Moorreesburg, Darling and Porterville respectively. At Moorreesburg, Darling and Porterville 48, 35 and 35 kg N ha⁻¹ were applied on wheat after medics respectively. At Caledon 20 kg N ha⁻¹ was applied after lucerne. Grain yield and quality were recorded.

Results and Discussion

Nitrogen source did not influence wheat grain yields at Tygerhoek (C/W), Caledon (L/W), Langgewens (C/W) and Darling (C/W). Differences were recorded in all M/W sequences included in the study however no trend could be found. LAN+S resulted in the lowest (not always significant) yield in M/W at Porterville and the highest (not always significant) yield in M/W at Langgewens. At seven of the sites protein content did not differ ($P > 0.05$) between treatments.

Conclusions

Preliminary results showed that choice of N source might be influenced by cropping system and possibly site. Final recommendations will only be formulated on completion of the study after at least 3 years of data capturing. The current study showed that the cost of N could be the deciding factor when a decision on N source must be made. A similar study where sub-optimum N levels are tested is suggested.

References

Investigating the sustainability of indigenous food crops at Makonde Village in Limpopo Province

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Introduction

Poverty, food insecurity and malnutrition poses major concerns in South African rural areas due to dietary shift from indigenous and traditional plants to cash crops and exotic plant food (van der Hoeven et al., 2013). Globally the use of indigenous crops is declining in rural areas even though these crops are affordable sources of several micronutrients (Uusiku et al., 2010). Rural people tend to be disadvantaged relative to their urban counterparts and poverty rates increase as rural areas become more remote. Communities in rural areas tend to have less access to social services, thus exacerbating the effects of rural poverty. Rural agroprocessing has a large potential for growth and socio economic economic impact specifically on job creation and income generation.

Materials and Methods

The experiment was conducted at Makonde Village in Limpopo Province. Soil samples were taken and analysed at Madzivhandila Agricultural College for the chemical analysis of different minerals. Seeds of each of the indigenous leafy vegetables namely Bambara beans (*Vigna subterranean*), cowpeas (*Vigna unguiculata*), Amaranthus (*Amaranthus cruentus*), Corchorus olitorius L., okra (*Abelmoschus esculentus*), nightshade (*Solanum retroflexum*), Chinese mustard spinach (*Brassica rapa*), bitter watermelon (*Momordia charantia*), kale (*Brassica oleracea*) and cleome (*Cleome gynandra*) were planted on deep well drained sandy loamy soils of at least 90cm depth with no nutrient deficiencies. Each indigenous crops were planted in a block of 5x5m in a RCBD replicated three times. Plant spacing of kale, nightshade, bitter watermelon and Chinese mustard cabbage was 25cm between rows and 10cm within rows, for Bambara beans, okra and cowpeas spacing was 90cm between rows and 7.5cm within rows whereas for Amaranthus, Corchorus olitorius L., and cleome spacing between rows was 50cm and within rows was 1m. Leaf harvesting for kale Corchorus olitorius L, and Chinese mustard spinach started from the sixth week after the emergence of the seedlings and was done continuously at the frequency of 7, 14, 21 and 25 days respectively wherein the parameters recorded at each frequency were number of bunches, leaf width, leaf yield, petiole's mass and length. Number of pods per plant on cowpeas, Bambara beans and okra were recorded. Yield was determined by counting and weighing the number of seeds per pod of Bambara beans and cowpeas. Emergence was counted for each crop from planting up to 14 days. Number of seedlings that survived were counted per crop until stand establishment was reached (30-50 days) after planting. Other data collected was plant height, number of leaves and pod/leaf length on indigenous leafy vegetables planted. Furrow irrigation method was used during the experiment. No chemical fertilisers, pesticides and herbicides were applied on the trial. Weeding was done by hand when weeds were visible.

Results and Discussion

The indigenous vegetables responded well on growth aspects such as emergence, number of leaves and stand establishment, flowering and yield however it was observed that due to heat wave that occurred during the trial some bitter watermelons whimpered along and produced compact vines without flowers other bitter watermelons produced flowers that don't set fruits and some bitter watermelons produced fruits that were misshaped resulting to poor yield. There were no yellow specks that turned yellow or black and no wilting of vines, no round white powdery spots and coating on leaves of bitter watermelon therefore the issue of virus attack was ruled out however it was assumed that there were inadequate pollinators and the dry soil due to increased soil moisture loss and high temperatures. Okra germinated and flowered however pods didn't form in some crops, pods had holes, deformed or tough and woody in some plants. Cowpeas and Bambara beans had a good yield and experienced no problems at all. Cleome gynandra, *Solanum retroflexum*, and *Amaranthus cruentus* did not germinate at all. Kale Corchorus olitorius L, and Chinese mustard spinach had good yield and responded differently to harvesting frequencies. The indigenous vegetables were well received by the community as indicated by high sales of kale, Corchorus olitorius L, and Chinese mustard spinach, cowpeas and Bambara beans however the soils will further be tested for viruses and other diseases.

Conclusions

The experiment was conducted as a first step for development of the of nurseries and identification of markets

for selected indigenous crops in order to sustain the use of these crops. Most crops indicated that they adopted well to Makonde soils and weather however the economic aspect of these crops will be determined during the end of the experiment with the aid of harvests and sales made. The soils will be tested for various diseases and viruses. Introduction of different pollinators for bitter watermelon will be looked at during the next season of planting.

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RESPONSE OF KENAF (*HIBISCUS CANNABINUS* L) CULTIVARS TO ROW SPACING AND PLANTING DENSITY ON GROWTH AND FIBRE QUANTITY

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Introduction

Kenaf (*Hibiscus cannabinus* L.) is a fiber plant native to eastcentral Africa grown for several thousand years for food and fiber. Plant density and row spacing have a more pronounced effect on growth and yield than on fibre percentage. Usually with more space available, the plants grow taller and develop thicker stems. Increased plant populations leads to higher yields, while increase in the row spacing leads to lower yields. with wider rows more detrimental to yield. Higher plant populations will not necessarily result in higher yields. The cost of planting extremely high plant populations is not always economically viable. Therefore, the objective of this study was to determine the optimum row spacing and plant density for optimum yield and growth of Kenaf cultivars under dryland conditions.

Materials and Methods

The study was conducted under dryland conditions at Rustenburg (NW) during 2014/2015 growing season. The trial design was a split plot with main plot treatments as row spacing (30cm, 35 cm and 40 cm) and sub plots comprised of planting densities (600 000 plant ha⁻¹, 500 000 plants ha⁻¹ and 400 000 plants ha⁻¹) with two cultivars, Elal 1 and Raz 2 as treatments. Plants were harvested manually at flowering stage (Duke and Ducellier, 1993). . A sample of ten fresh stems was randomly selected to determine dry stem yield (kg.ha⁻¹), fibre yield (kg.ha⁻¹) and basal stem diameter. Fresh stalks were oven dried for 5 days at 60 oC. Fibre yield(%) was computed using formula, thus the weight of fibre in the above ground dried stalk divided by dry stalk mass x 100.

Results and Discussion

There were significant differences ($P \leq 0.05$) observed in fresh biomass, green stem, dry stem yield and fibre yield of cultivars as influenced by row spacing, planting density, and row spacing x planting density interactions. Kenaf yield tends to increase at lower row spacing of 30 and 35 cm with combination of high planting densities for both cultivars. Elal1 dry stem yield was the highest at 30 cm and 627 778 plants ha⁻¹, with 13 552 kg ha⁻¹. This was 68% higher than at 40 cm and 616 667 plants ha⁻¹. Plant height and diameter did not differ significantly between cultivar, row spacing and plant densities. Fibre quantities were better at the lowest row spacing and high planting densities.

Conclusions

Minimum row spacing and plant densities for optimum yield will be 30 to 35 cm and 500 000 to 600 000 plants ha⁻¹ for both cultivars.

References

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EFFECT OF PLANTING TIME FOR ALL YEAR MAXIMIZATION DRYBEAN PRODUCTION (Phaseolus Vulgaris L.) IN WARMER CLIMATIC ZONES OF LIMPOPO PROVINCE, SA

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Introduction

Drybean is a warm-season annual legume crop grown primarily for its protein and energy-rich dry seeds (Buruchara et al., 2011). Drybean in both unprocessed and canned forms, constitute a vital, palatable and nourishing part of the diet of many people. Drybean are common particularly in rural areas only as furnished by products, i.e. as canned or sold in retail stores in small packages. The crop has a potential to increase the number of local businesses and employment opportunities given its utilization, consumption and its market price. The demand for South African export drybeans to the neighbouring African countries is on the increase, is creating opportunities to increase drybean production. The objective of the study was to determine the effect of planting time of two drybean varieties.

Materials and Methods

A 2X3 factorial study was conducted at Mudavula community project in Thulamela Municipality, Vhembe District during the 2016/17 season. Two red speckled drybean varieties RS5 and Kranskop which are determinate and indeterminate respectively, were planted in three consecutive planting dates with three replications. The three planting circles were regarded as early, mid and late planting. The planting dates were approximately 30 days apart, with first planting done in February 2017 through to April 2017. The following data was collected: biomass, number of seeds per plant, pods per plant, hundred seed weight, and grain yield. The data was statistically analysed using SAS 9.4.

Results and Discussion

The results revealed that grain yield, hundred seed weight and number of pods plant⁻¹ were influenced by planting time for both varieties. The mid-planting time contributed to significant high grain yield irrespective of the variety, followed by early and late planting times. The highest grain yield was produced by RS5 from mid-planting circle with a mean yield of 2.84 t ha⁻¹ followed by Kranskop with grain yield of 2.14 t ha⁻¹. The low grain yield from late planting time would be attributed to low temperatures which coincided with the crop flowering stages. The yield plant⁻¹, number of pods and seeds plant⁻¹ were highly influenced by the interaction between planting times and varieties. The highest number of seeds plant⁻¹ were found with Kranskop (46) and the lowest with RS5 (35) on mid-and late planting time respectively.

Conclusions

The results obtained from this study showed that drybean yield was affected by planting time irrespective of variety. The prospects of the study are interesting and these preliminary findings will be validated in the next season.

References

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Evaluation of Cowpea (*Vigna unguiculata*) Germplasm for Field Performance and Drought Tolerance in South Africa

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Introduction

Cowpea (*Vigna unguiculata*), a drought tolerant and nutritious food legume with most edible parts, has the potential to improve the food and nutrition security particularly in Sub-Saharan Africa. However, yields are generally low due to none of availability of improved varieties and drought stress among other production cowpea production constraints. Therefore, the study was conducted to evaluate cowpea germplasm for agronomic performance and drought tolerance.

Materials and Methods

A field experiment (experiment #1) was conducted at ARC-VOP experimental farm during 2015/2016 growing season to evaluate the agronomic performance of 10 cowpea genotypes under full irrigation. The experiment was arranged in RCBD replicated three times. Data collected include pod number per plant, 100 seed weight and total yield among other indicators. In experiment #2, 28 genotypes were evaluated for drought tolerance in the drought screening house using plastic box evaluation method in January, 2017. The genotypes were subjected to water stress condition for measurement of proline content, leaf wilting index, relative water content and stem greenness. Data collected was subjected to analyses of variance followed by mean separation at 5% level and principal component analysis (PCA).

Results and Discussion

Analysis of variance for the traits revealed that differences among cowpea genotypes were highly significant for all the traits. This indicated that there was a high level of genetic variability among the genotypes studied. The principal component analysis also showed the total variability among the genotypes. The pre-screening results showed that genotype Acc3916, Acc2355, Acc1168 and Acc1257 were drought tolerant while IT96D-602 reached the reproductive stage to escape drought stress.

Conclusions

The significant differences found among the genotypes enabled the identification of potential parental lines for future cowpea breeding programme aimed at improving the yield and drought tolerance within the species.

References

Effect of nitrified urine concentrate on black nightshade (*Solanum nigrum*) biomass and nutritional quality.

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Introduction

Nitrified urine concentrate (NUC) is a urine based nitrogen (N) fertiliser product processed by nitrification and distillation. NUC could be used as an N- fertiliser source for the production of Black nightshade (*Solanum nigrum*) (an underutilised African leafy vegetable). It is often produced under nutrient and water limiting conditions. NUC could provide a potentially new fertilizer source to improve productivity. Previous studies have been carried out using other fertilizer sources such as chicken manure and chemical commercial fertilisers. There are no studies on the use of NUC on Black nightshade. The objective was to investigate the effect of NUC as a nitrogen source on Black nightshade biomass and nutritional quality under limiting water conditions.

Materials and Methods

A pot experiment was carried out in a greenhouse at the University of KwaZulu-Natal as a 2x3x3 split-split plot design replicated 4 times. Two separate controls were set at 100% and 50 giving a total of 80 experimental units. The main plot was water-2 levels, (100% field capacity (FC) and 50% FC)), the sub-plot, nitrogen source-3 levels (NUC, chicken manure and Urea), sub-plot, application rate-3 levels (2.6 g/pot, 5.2 g/pot and 7.8 g/pot. Data was collected on dry mass, proteins (Bradford assay), and antioxidant capacity 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging ability on edible leaves. Data was analysed using GenStat 18th edition statistical software package.

Results and Discussion

There was a highly significant ($p < 0.01$) interaction between fertilizer and water on DPPH%. The level of DPPH increased in both NUC and Urea treatments (71.6% and 47.9% respectively) at 50% due to possibly salts in NUC. Once off application could have shocked the plants resulting in production of reactive oxygen species increasing DPPH% while restricting N uptake hence low protein synthesis in these fertilizer treatments. Control and CM had comparably lower DPPH%. Chicken manure had significantly higher protein content (1.93 mg/g) at the highest application rate compared to all the other treatments ($p < 0.01$) due to mineralization which allowed uptake of N and its conversion into proteins. Plants treated with NUC died at both waater levels probably due to salts which could have damaged roots. Biomass significantly decreased with increasing application rate at 50% and 100 (averages of 15(CM),7(urea), 2.6 t/ha(NUC), control 12.7t/ha and 16.4(CM), 4.7 (urea) 2.5(NUC), control 18.9t/ha respectively. At both water level using NUC, plants died possibly due to salts.

Conclusions

Death of plants at the highest application rate using NUC requires further investigation for the presence of salts.

References

Nematode resistance in sweet potato cultivar 'Mafutha' to *Meloidogyne javanica*

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Introduction

Most sweet potato-producing regions in South Africa are heavily infested by the root-knot (*Meloidogyne* species) nematodes, which are difficult to manage since the withdrawal of the highly effective fumigant synthetic nematicides. The withdrawal resulted in the introduction of various alternative nematode management strategies, with nematode resistance being the most preferred. However, progress in the use of nematode resistance had been hindered by limited information on accurate species identification since *Meloidogyne* species have a wide host range and some biological races.

Materials and Methods

A study was conducted under greenhouse conditions, arranged in randomised complete block design, with six replications. Treatments comprised 0, 25, 50, 125, 250, 625, 1250, 3125 and 5250 eggs and second-stage juveniles (J2). Uniform rooted sweet potato cuttings were transplanted in 20-cm-diameter plastic pots filled with steam pasteurised (300°C for 1 hour) loam soil and Hygromix mixed at 3:1 (v/v) ratio. Cuttings were fertilised using 2 g 2:3:2 (22) NPK and 2 g 2:3:2 (43) Multifeed fertiliser a week after planting and plants were irrigated with 250 ml water every other day.

Results and Discussion

The reproductive factor values at all levels of inoculation were greater than one, with cultivar suffering damage from the nematode infection, suggesting that cv. 'Mafutha' was susceptible to *M. javanica*.

Conclusions

Cultivar 'Mafutha' is susceptible, therefore is not suitable to be included in crop rotation programmes intended to manage tropical *Meloidogyne* species in Limpopo Province, South Africa.

References

STEM BORER INFESTATION AND DAMAGE ON GM AND NON-GM MAIZE HYBRIDS IN NORTHERN CAPE PROVINCE, SOUTH AFRICA

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Introduction

Lepidopteran stem borers, *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae), *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) and *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae) are the most important insect pest of maize in South Africa. Unavoidable yield losses associated with these stem borers are widely reported throughout the country. This study was conducted to quantify stem borer infestation and damage in genetically modified (GM) varieties and traditional hybrids.

Materials and Methods

Two-step surveys were conducted at knee height growth stage and cob mature stage to assess stem borer infestation and damage on GM and traditional hybrids in Frances Baard, John Taolo Gaetsewe, Pixley ka Seme and ZF Mgcawu during 2015 - 2016 growing season. Test plants were selected using the systemic sampling technique, dissected in the field to collect data on foliar and stem damage. The number of larvae and pupae recovered were counted and reared at the University of Fort Hare for identification. Collected stem borers larvae and pupae were identified on BLAST using the Cytochrome Oxidase subunit I (COI) sequence analysis. Cobs of the plants sampled at mature stage were collected to assess the relationship between infestation, damage parameters and grain yield.

Results and Discussion

Mixed populations of *B. fusca* (56.5%) and *C. partellus* (43.5%) were collected on non-GM maize but only *B. fusca* was recorded on GM. The percentage infested non-GM maize stalks ranged from 86% to 100% at knee high and 20 - 68% at the mature stage. The percentage infested GM maize stalks ranged from 12% to 32% at knee high and 7 - 20% at the mature stage. Stalk borer damage was significantly higher at knee height than at cob mature stage. There was comparatively more damage observed at knee height stage than at maturity stage. Tunnel length was shorter at knee-high than at mature stage for both GM and non-GM hybrids. Although there was a weak significant correlation between foliar damage, the number of larvae or pupa and grain yield, a strong significant negative correlation between the stem boring tunnel length and the grain yield was observed in both GM and non-GM hybrids exhibited.

Conclusions

The occurrence of *B. fusca* and *C. partellus* is a threat to maize production in Northern Cape. Feeding damage by the two stem borers, particularly the stem boring tunnel length negatively influenced grain yield.

References

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EFFECT OF COVER CROPS AND SOIL MANAGEMENT ON CONYZA SPECIES

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Introduction

These annual summer growing broadleaf annuals compete with the grapevines for nutrients and water. The objective of the study was to determine the effect of different weed management treatments on the stand of the *Conyza* species, a group of species which had a significant stand in the experiment vineyard.

Materials and Methods

Twelve treatments were applied in a full-bearing seven year old drip irrigated Shiraz/101-14 Mgt vineyard established on a sandy to sandy clay loam soil near Stellenbosch (33o58'S, 18o50'E). Five cover crop species and a treatment in which no winter cover crop was established (Weeds) were evaluated. Two management practices were applied to each of the winter treatments, namely, full surface post-emergence weed control (CC) or slashing of cover crops/weeds, which was immediately mechanically incorporated into the soil (MC) during grapevine bud break. The dry matter production (DMP) of the *Conyza* species were determined at the end of August (winter growth), end of November (grapevine berry set) and the beginning of April (post-harvest).

Results and Discussion

The *Conyza* species were totally suppressed by the cover crop treatments during winter, with the exception of the MC treatments of Pallinup oats (*Avena sativa* cv. Pallinup), canola (*Brassica napus* cv. AVJade) and Nemat (*Eruca sativa* cv. Nemat) during 2009. It seems CC combined with the cover crop mulches could not prevent the *Conyza* species from germinating between grapevine bud break and berry set. From grapevine berry set to post harvest (April 2010) these weeds were detected, once again, in all the treatments. In the two Pallinup oats treatments and Nemat (CC) the stand in April 2010 even tended to be higher than that of April 2009. The same trends were observed during the 2010/11, 2011/12 and 2012/13 seasons. Most of the treatments could reduce the seedbed of the *Conyza* species over time, when comparing the stand in April 2013 with the pre-treatment stand in April 2009.

Conclusions

The *Conyza* species can germinate during summer, especially from December onwards, under relatively dry conditions. This is an indication that chemical control should be considered during December and January, to eradicate this weed over the medium to long term.

References

AGRONOMIC PERFORMANCE OF TEN CHICKPEA GENOTYPES IN DIFFERENT AGRO-ECOLOGICAL REGIONS OF NE SOUTH AFRICA

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Introduction

Chickpea (*Cicer arietinum* L.) is an important grain legume in the world, ranking third after soybean and dry bean. It can grow in areas with low rainfall and poor soils, and thus may be an important food security crop for smallholder resource-poor farmers in the dry environments of Limpopo and Mpumalanga Provinces, South Africa (Thangwana and Ogola 2012; Matthews et al. 2011). However, no suitable genotypes have been identified and recommended for these regions. Therefore, this study evaluated the performance of ten chickpea genotypes in diverse environments in NE South Africa.

Materials and Methods

Ten desi chickpea genotypes (ICCV3110, ICCV3111, ICCV3203, ICCV4105, ICCV4110, ICCV6103, ICCV8101, ICCV92944, ICCV97024 and ICCV97125) were sown in a field experiment, laid out in a completely randomized block design replicated three times, at the University of Venda, Thohoyandou, the University of Mpumalanga, Nelspruit and the University of Limpopo, Syferkuil in winter 2016. Aboveground biomass, number of pods per plant (NPP), number of seeds per pod, hundred seed weight (100-SW), grain yield and harvest index (HI) were determined at harvest maturity.

Results and Discussion

Agronomic performance of the ten genotypes did not vary with environment. Site had a significant effect on all parameters except NPP. Grain yield was 25 and 62% greater in Syferkuil (2805 kg ha⁻¹) compared with Thohoyandou (2237 kg ha⁻¹) and Nelspruit (1735 kg ha⁻¹), respectively. Similarly, total shoot biomass and grain yield varied with genotype, ranging from 3940 and 1499 kg ha⁻¹ (ICCV6103) to 5899 and 2842 kg ha⁻¹ (ICCV8101), respectively. The greater grain yield at Syferkuil and in ICCV8101 was likely due to the greater biomass in both cases.

Conclusions

These findings show that Syferkuil may be the best environment for chickpea production and that ICCV8101 is probably the most adapted genotype in this region.

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EFFECTS OF LOCATION AND HARVESTING TIMES ON CHEMICAL QUALITY OF MIMUSOPS ZEYHERI FRUIT

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Introduction

Transvaal red milk wood (*Mimusops zeyheri*) fruit has the potential to contribute to food security, health, nutritional and economic welfare (Mashela and Mollel 2002). However, fruit marketable quality is largely determined by the stage of development of fruit at harvest and the effect of harvesting date. Inadequate post-harvest practices in indigenous fruit plants forms part of the major constrains in expanding their production. Therefore, the objective of the study was to investigate the effects of location and harvesting times on the chemical quality of *M. zeyheri* fruit.

Materials and Methods

A 2 × 4 factorial experiment in a completely randomised design with five replications was conducted. The first factor consisted of Bochum and Turfloop locations, whereas four harvesting times were the second factor. Data were subjected to analysis of variance using Genstat 18.2.

Results and Discussion

There was a significant interaction ($P \leq 0.05$) between location and harvesting time for all chemical variables except TSS:TA ratio, with variables contributing 10-49% in total treatment variation (TTV). Relative to the arbitrary standard of Bochum and first harvest time, all pairwise comparisons except for pH were reduced by 11-51%, whereas pH was increased by 10-32%. However, location main factor had a significant effects on TSS:TA ratio, contributing 66% in TTV. Fruits from Bochum gave TSS:TA ratio which was 20% higher when compared to those from Turfloop.

Conclusions

Results of this study suggested that location and harvesting time of *M. zeyheri* fruit had an interactive influence on post-harvest quality of the fruit.

References

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EFFECT OF PROCESSING AND HEAT TREATMENT ON ANTIOXIDANTS OF ORANGE FLESHED SWEET POTATO

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Introduction

Nationwide, sweet potato (SP) consumption had been observed to decline as income rises among households (FAOSTAT, 2008). The observed change is often associated with urbanisation, partly because SPs are perceived as “poor man’s food” and mostly due to limited post-harvest processing methods being available. However, processing and heat treatment (HT) had been reported to affect some useful antioxidants in SPs. Therefore, the interaction of processing and HT on antioxidants of Orange fleshed ‘Bophelo’ sweet potato (OFBSP) was investigated.

Materials and Methods

The experiment was a 2 x 3 Factorial, arranged in a CRD in triplicates, where Factor A represented processing methods (peeled and unpeeled) and Factor B represented HT (raw, baked and boiled). Processed OFBSP varieties were boiled or baked until tender. The raw processed OFBSPs served as standards. After HT, all samples including standards were dried and then ground to a fine powder prior to beta carotene (BC) and total phenolic (TP) analysis. Beta carotene was determined using AOAC (1980) method, while TP was determined using the Folin-Ciocalteu method (Panda and Picha, 2008). All data were subjected to ANOVA using Statistix 10.0.

Results and Discussion

Processing x HT interaction significantly ($P \leq 0.05$) affected BC and TP, contributing 68% and 16% total treatment variation in OFBSPs, respectively. In the unpeeled raw OFBSPs, boiling and baking significantly decreased BC by 50% and 44% respectively, whilst TP increased by 20% and 131%, respectively. In contrast, in peeled raw OFBSP, boiling and baking increased BC by 10% and 30%, respectively, while TP was increased by 69 and 89% in, respectively. Generally, results confirmed that the OFBSP is an excellent source of BC and TP.

Conclusions

Beta carotene in OFBS was increased when the tubers were peeled prior to baking, while TP was increased by both baking and boiling when peeled. Therefore, peeling sweet potato tubers prior to processing is recommended.

References

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MAIZE YIELD RESPONSE TO INTERCROP WITH LABLAB UNDER RAIN-FED CONDITIONS IN LIMPOPO PROVINCE

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Introduction

Farmers intercrop legumes with maize primarily to produce more food, maintain soil fertility and conserve soil moisture content. Most small scale farmers in Limpopo province often intercrop maize with cowpea, groundnut, and bambara groundnuts. Lablab, a forage legume with a wide range of uses in agriculture such as animal feed and soil fertility improvement also has the potential to be grown as intercrop with maize. However, there is scant information on the performance of maize/lablab intercropping in Limpopo. Therefore, the objective of this study was to assess the effects of maize/lablab intercropping on maize yield production.

Materials and Methods

Field experiments were conducted during the 2016/17 growing season at the University of Venda (Univen) and University of Limpopo (Syferkuil) experimental farms. Yield productivity of maize and lablab sole, maize/lablab simultaneously planted, and maize with lablab planted 28 days afterwards (DAW) were evaluated. Data was subjected to ANOVA using Genstat (version 17). Significant differences between the treatments were determined at 5% level of significance using the standard error of difference of means.

Results and Discussion

The total land equivalent ratio (LER) at both locations for the two crops gave a high and positive value (1.79) which suggests favorable yield advantage for maize/lablab intercrop. However, the maize sole and simultaneously planted maize/lablab system produced lower maize yields (3460 and 3758 kg/ha at Syferkuil, and 2712 and 2548 kg/ha at Univen, respectively) than when maize with lablab planted 28 days afterwards (DAW) (4576 kg/ha at Syferkuil and 3548 kg/ha at Univen). Lablab yields were not different between planting dates.

Conclusions

From the results obtained, it can be concluded that it is advantageous to intercrop lablab with maize, and delayed planting of lablab should be a recommended practice.

References

MICROBIAL ENZYMATIC RESPONSES TO FERTILISER MIXTURES IN A LOAMY SAND SOIL UNDER MAIZE PRODUCTION

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Introduction

Modern maize production depend heavily on fertilisers for secure food production. The nutrition and production of these crops cannot be understood by only focussing on fertilisers, but also on soil biology (Adesemoye & Kloepper 2009). Excessive fertiliser application may have harmful impacts on the soil microbial life. The use of different chemical fertiliser mixtures may reduce damaging effects on microbial activity in our agricultural soils leading to probably a more diverse and balanced microbial composition (Sarathchandra et al. 1993). Hence, a more abundant and diverse microbial population may cycle nutrients more efficiently. The study aimed to evaluate the effects of various chemical fertiliser mixtures on soil microbial enzyme activity in a loamy sand soil under local maize production.

Materials and Methods

A 90-day pot experiment comprising of two maize plants planted in a loamy sand soil (16% clay), typical of local maize producing areas was conducted. Treatment combinations of ammonium gas (simulated), ammonium sulphate, black urea, urea, limestone ammonium nitrate (LAN), mono-ammonium phosphate (MAP), superphosphate, potassium chloride and potassium sulphate were applied at two rates (zero and optimal recommended rate) to the soil. The experimental layout was a randomised complete block and consisted of three replications. Soil samples were collected at 90 days after planting and subjected to microbiological tests that included enzyme assays viz. β -glucosidase, and urease. Maize plants were cut off at the first internode above the soil and plant material dried (45°C) for at least 10 days prior to being weighed to calculate biomass from each pot. Data were statistically analysed using Statgraphics software.

Results and Discussion

β -glucosidase activity was significantly higher at optimal rates in the combination comprising ammonium sulphate and potassium sulphate. The highest urease activity was detected at the optimal N (simulated ammonium gas) and P (MAP) rates combined with zero K (potassium sulphate) in the loamy sand soil. Plant biomass was also affected by fertiliser combinations.

Conclusions

The source of fertiliser as well as combinations of fertiliser mixtures indeed affected soil microbial activities.

References

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Preliminary results on the effect of a low-density, white shade net on the phenology and fruit quality of 'Nova' mandarins

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Introduction

Shade nets are increasingly used by South African mandarin growers. Although benefits, such as protection against hail and sunburn and improved fruit quality were reported, there is still a lack of scientific evidence on the effect of these shade nets on tree performance, production and postharvest fruit quality of mandarins. This study provides some preliminary results on the effect of a low-density, white shade net on phenology and fruit quality of 'Nova' mandarins.

Materials and Methods

The study was carried out in the Ohrigstad area in Limpopo during the 2017 season on bearing 'Nova' mandarin trees. Two treatments were applied in a randomised pseudo-block design with one treatment covered with a low-density (20%), white shade net and the other treatment left uncovered. Phenology (leaf area and thickness, and shoot length) and postharvest fruit quality (fruit size, colour, juice content, TSS and TA) data were collected.

Results and Discussion

None of the phenological parameters measured were significantly affected by the shade net. In terms of postharvest fruit quality, the net resulted in fruit with a higher juice content (11% increase), but lower TSS and TA (~5% decrease). Fruit size and colour were not significantly affected by the shade net.

Conclusions

The results of this preliminary study showed that the shade net will have an effect on postharvest fruit quality. It is important that this study be extended to gain knowledge on the effect of white shade nets on tree performance, production and postharvest fruit quality of 'Nova' mandarins.

References

EFFECT OF COVER CROPS AND SOIL MANAGEMENT ON RYEGRASSES (LOLIUM SPECIES)

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Introduction

Ryegrass, have become a problem weed in the vineyards of the Western Cape. Ryegrasses have the ability to become resistant to the herbicides regularly used in vineyards, especially glyphosate and paraquat. It is, therefore, of prime importance that the species should be controlled effectively before resistance to herbicides develops. The objective of the study was to determine the effect of different weed management treatments on the stand of the ryegrasses (a group of species that dominated the spectrum in the experiment vineyard).

Materials and Methods

Twelve treatments were applied to a full-bearing, seven-year-old drip irrigated Shiraz/101-14 Mgt vineyard established on a sandy to sandy clay loam soil (33°58'S, 18°50'E) near Stellenbosch. Five cover crop species and a treatment in which no winter growing cover crop was established (Weeds), were evaluated. Two management practices were applied to each of the winter treatments, namely full surface post-emergence weed control (CC) or slashing of cover crops/weeds which was immediately mechanically incorporated into the soil (MC) during grapevine bud break. The dry matter production (DMP) of the ryegrasses were determined at the end of August (winter growth), at the end of November (grapevine berry set) and the beginning of April (post-harvest).

Results and Discussion

No ryegrasses were detected in the beginning of April. With the exception of Pallinup oats (*Avena sativa* cv. Pallinup), MC allowed the ryegrasses to maintain a significant stand throughout the study. This indicated that: 1) the seedbed was possibly not exhausted over time, 2) mechanical removal of the above ground growth created conditions favourable for seed germination or 3) MC did not control all the ryegrasses, thus allowing seed production. The CC treatment of the cover crops suppressed the ryegrasses. Nemat (*Eruca sativa* cv. Nemat) and Pallinup oats are the preferred cover crops.

Conclusions

To control this problem-weed quickly and effectively the CC treatments of Pallinup oats or Nemat should be applied.

References

EFFECTS OF NEMARIOC-AG PHYTONEMATICIDE ON GROWTH OF POTATO AS POST-EMERGENCE APPLICATION

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Introduction

Nemarioc-AG phytonematicide when used as pre-emergent nematicide, improved growth of potato (*Solanum tuberosum*) plants. However the influence of this product on growth of potato when used as post-emergent product is not documented. The objective of this study was to assess the influence of Nemarioc-AG phytonematicide on growth of potato growth when applied as post-emergent product.

Materials and Methods

The study was conducted under microplot conditions, with treatments viz. 0, 2, 4, 8, 16 g Nemarioc-AG phytonematicide, arranged in a randomised complete block design, with 14 replications. Tuber seeds were planted in 30 cm diameter pots, with various level of Nemarioc-AG phytonematicide. Treatments were initiated seven days after 100% emergence. At 56 days after initiation of treatments, plant height, stem diameter, chlorophyll content, root galls, fresh root, potato tubers, fresh shoots and dry shoots were collected. Data was be subjected to analysis of variance using Statistix 10.0.

Results and Discussion

Treatment had no significant effect on all plant variables. Generally, plant respond to increasing concentrations of allelochemicals in one of three ways: stimulated, no effect, and inhibited. Stimulation and inhibition are each characterised by significant treatment effects, whereas treatment effects are not significant under neutral phase.

Conclusions

Nemarioc-AG phytonematicide had no effects on potato growth when applied in granular formulation at post-emergence.

References

DENSITY-DEPENDENT GROWTH PATTERNS OF SWEET POTATO CULTIVAR 'BOPHELO' TO NEMAFRIC-BL PHYTONEMATICIDE CONCENTRATIONS

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Introduction

The relationship between plant growth and increasing concentrations of phytonematicides has been characterised by density-dependent growth (DDG) patterns (Mashela et al. 2015). The DDG pattern responses are explained by three phases, namely, the stimulation, neutral and inhibition phases (Mashela et al. 2015). The objective of the study was to investigate the DDG responses of sweet potato cv. 'Bophelo' to increasing concentrations of Nemafric-BL phytonematicide.

Materials and Methods

Cuttings were raised in plastic pots inside the greenhouse, where each plant was inoculated with 5 000 second-stage juveniles (J2) and eggs of *Meloidogyne incognita*. Treatments, namely, 0, 2, 4, 8, 16, 32 and 64% NemafricBL phytonematicide were arranged in a randomised complete block design, with 10 replicates.

Results and Discussion

NemafricBL phytonematicide concentrations significantly affected plant variables. The plant variable means displayed DDG patterns when plotted against increasing concentrations of Nemafric-BL phytonematicide, which had stimulation, neutral and inhibition effects. The relationships between plant variables and increasing concentrations were explained by 82-98%. Relative to untreated control, the product reduced vine length, stem diameter and dry root mass by 37%, 22% and 67%, respectively. Pelinganga et al. (2012) also observed DDG patterns when tomato plant variable means were exposed to increasing Nemafric-BL phytonematicide concentrations.

Conclusions

Sweet potato cv. 'Bophelo' exhibited all three phases of DDG pattern when exposed to increasing concentrations of Nemafric-BL phytonematicide

References

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EFFECT OF HARVEST STAGE ON QUALITY OF CHERRY TOMATO (LYCOPERSICON ESCULENTUM VAR. ROMANITA)

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Introduction

Cherry tomato is one of the most important fresh produce in SA and their harvesting is limited to a ripening stage demanded by the consumers. Generally, tomatoes harvested at fully ripe stage are susceptible to injuries during harvest and post-harvest storage resulting in high amount of qualitative and quantitative losses (Teka, 2013). This study was conducted in order to determine optimum harvest stage for cherry tomato.

Materials and Methods

The experiment was arranged to include 3 harvest stages (mature green, half ripe and ripe red-positive control) X 6 ripening days (0, 2, 4, 6, 8 and 10), with 10 replicates fitted in a completely randomised design. Uniform and disease free cherry tomatoes were evaluated for the following selected quality parameters: subjective (eye colour) and objective colour were determined using colour chart and Chromameter, respectively; fruit firmness was determined using non-destructive Sinclair firmometer; total soluble solids were measured using refractometer and titratable acidity of tomato was estimated by titration method. Weight loss percentage was calculated based on initial and final weight of fruit. Chroma (C^*) and hue angle values were calculated based on a^* and b^* according to the following formulas: Hue angle (h°) = $15 \tan^{-1}(b^*/a^*)$ and Chroma (C^*) = $15a^{*2} + b^{*2}$.

Results and Discussion

The results indicated that subjective (eye colour) and objective colour (Lightness, Chroma and Hue angle) fruit firmness, total soluble solids and percentage of weight loss were increased with the advancement of ripening period, irrespective of harvest stages while the percentage of titratable acidity was decreased with prolonged ripening time. The highest value of TSS (5.13 °Brix) and TA (0.93%) was recorded in half ripe and mature green tomatoes during the first day of observation, respectively. The highest percentage of weight loss was measured in half-ripe tomatoes.

Conclusions

The results indicated that cherry tomatoes can be harvested at mature green and half-ripe stage without compromising the fruit quality. Tomatoes harvested at these stages are firmer and therefore less susceptible to physical damage during post-harvest handling.

References

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Genetic analysis of maize (*Zea Mays L.*) single cross hybrids under multiple-stress and non-stress environments

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Introduction

The frequent occurrence of drought combined with low levels of soil nitrogen (N) limit maize production by smallholder farmers in South Africa. Many smallholder farmers grow their crop in dryland areas; with little to no use of fertilizers, therefore their yields are extremely low. Maize breeding efforts targeting varieties with combined tolerance to drought and low N stress are crucial for improved maize productivity in South Africa. The objectives of the study were to (i) to assess yield potential of single cross maize hybrids under non-stress, drought and low N stress conditions, (ii) estimate general and specific combining ability of inbred lines, and (iii) to determine the mode of gene action involved in the expression of yield and major secondary traits under non-stress and stress environments.

Materials and Methods

Seventy-two experimental hybrids generated from a line by tester mating design were evaluated along with three checks under two non-stress, two drought and three low N stress conditions in South Africa during the 2015/16 season. All trials were designed in an (0.1) α -lattice design with two replications per 2-row plot entry. Combined analysis of variance were performed using Genstat 18th edition. Analysis of variance of a line by tester were performed using the line by tester procedure embedded in the analyses of genetic designs software with 'R' (AGD-R).

Results and Discussion

Hybrid L2/T4 and L4/T4 were the most superior hybrids with high mean grain yield across sites. Line 2, Line 3, Line 4 and Line 6 were good overall general combiners for grain yield and several agronomic traits across all environments. Additive gene effects were more important in controlling grain yield and most secondary traits under drought and low N stress conditions, suggesting that response to selection for yield and other secondary traits can be achieved rapidly.

Conclusions

The findings of the study suggest the possibility of developing lines with improved tolerance to drought and low N stress. The identified superior hybrids with high grain yield than the best checks have potential for commercialization, and will contribute to smallholder farmer's productivity in South Africa. The superior lines with high general combining ability effects for most traits across sites can be nominated as potential inbred testers for evaluating new inbred lines under drought and low N stress. The predominance of additive gene action in conditioning grain yield and most secondary traits under stress conditions underscores the possibility of achieving breeding progress in developing drought and low N tolerant varieties.

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YIELD RESPONSE OF SWEET PEPPER INTERCROPPED WITH GREEN BEANS IN THREE MUNICIPALITIES OF MPUMALANGA PROVINCE

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Introduction

For centuries, many crops have been grown in association with one another to promote diversity and yield stability. Today, traditional multiple cropping systems still provide a significant contribution to food security for households. Intercropping, which is one of the diverse cropping systems, is most appropriate for smallholders in relatively population-dense areas with small landholdings. The objective of this study was to evaluate the productivity of a pepper-bean intercrop.

Materials and Methods

Yield response of sweet pepper (cv. Maor) intercropped with green beans (cv. Contender) was investigated in three trial sites (Greylingstad, Driefontein and Thulamahashe), in a randomized complete block design with four replications. The intercrop combinations were 1:1 (1 row pepper to 1 row beans), 2:1 (2 rows pepper to 1 row beans) and both crops planted in pure stand. Plant height was measured and the yield components for each crop were determined at harvest.

Results and Discussion

The yield for sweet pepper was not significantly affected by intercropping, but there was a slight decrease in yield of sweet pepper under intercropping compared to monocrop, however, 1:1 intercrop combination yielded more than the 2:1 intercrop combination at all sites. There was also a slight decrease in green beans yield under intercropping compared to monocrop, but there was insignificant variation between combinations. The Land Equivalent Ratio (LER) which is the most common index for measuring the advantages of using intercropping systems on the combined yield of both crops was calculated. The average LER for 1:1 intercrop combination was 1.73 compared to 1.65 for 2:1 intercrop combination. The LER results indicated that intercropping was more productive than sole cropping.

Conclusions

Yield advantage of intercropping was indicated by LER values higher than 1, indicating that intercrops were more productive than sole crops.

References

Crop load, harvest time and storage period affects 'Hass' skin colour change during ripening

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Introduction

Avocado fruit (*Persea americana* Mill cv. Hass) supposed to change colour from green to purple to black during ripening as a subjective ripeness indicator. However, South African 'Hass' avocado fruit have been showing poor skin colour change during ripening, which compromises market competitiveness. So far, the factors causing the poor 'Hass' avocado skin colour change conundrum are not yet known. The aim of this study was to investigate the effect of crop load, harvest time and storage period on 'Hass' avocado skin colour change during ripening.

Materials and Methods

Crop load was manually adjusted by fruit thinning from the initial total fruit-set to 25, 50 and 100% (control) fruit per branch. Fruit were harvested at early, mid-and late maturity from trees with adjusted crop loads, and thereafter cold stored at 5.5°C for 28 days. During storage, fruit were sampled at 0, 7, 14, 21 and 28 days and ripened at 25°C. During ripening, fruit were evaluated for fruit weight, firmness, subjective-colour and objective-colour (lightness-L*, chroma-C* and hue angle-h°), total colour difference (objective and subjective), days to ripening and chilling injury at 0, 2, 6 and 8 days.

Results and Discussion

Principal component analysis (PCA) and Pearson correlation were used to visualise the change in colour parameters and their relationship with fruit firmness. There was a significant ($P < 0.05$) and strong positive ($r = 0.811$ and 0.858) relationship between h° and fruit firmness at 7 and 14 days of cold storage, respectively. Furthermore, principle component analysis (PCA) also showed that fruit harvested from trees with 25% crop load were associated with highest skin colour change across all storage periods, irrespective of harvest time. Moreover, the results showed that skin colour change declined with increasing crop load and storage period, and increased with prolonged harvest time.

Conclusions

In conclusion, crop load adjustment could be considered as a tool to mitigate poor skin colour change of 'Hass' avocado fruit during ripening.

References

MULTI-PARENTAL BREAD WHEAT (*TRITICUM AESTIVUM* L.) POPULATIONS FOR UNLOCKING GENETIC COMPONENTS CONTROLLING RUSSIAN WHEAT APHID RESISTANCE (*DIURAPHIS NOXIA*): A REVIEW

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Introduction

Bread wheat (*Triticum aestivum* L.) is one of the top import commodities in South Africa due to the inability of the country to meet its own demands. This can be attributed to the many biotic and abiotic factors that greatly affect healthy and sufficient production of this cereal. One biotic stress that has greatly affected the production of wheat in South Africa is the Russian wheat aphid (RWA, *Diuraphis noxia*). This insect pest causes irreversible damage to susceptible plants which often lead to death, thereby reducing plant and economic yields. Means to control the pest are available; the most widely used being breeding for host plant resistance. Conventional pre-breeding and breeding methods, coupled with molecular techniques is the current strategy of choice in the fight against aphids. This review looks at the advantages and possibilities of using multi-parental mapping populations for studying RWA resistance over bi-parental mapping populations. For many years, bi-parental mapping populations have been used for deciphering wheat genetic control but in recent years, multi-parent populations have shown to have more advantages over the former (Sneller et al., 2009).

Materials and Methods

In bi-parental mapping populations, single F1 or F2 crosses only sample the alleles present in the two crossing parents, which limits the amount of genetic variability in that breeding programme (Würschum, 2012). Multi-parental populations offer the possibilities of sampling many allele combinations and estimation of quantitative trait loci (QTL) effects across a wide array of representative genetic backgrounds. They also allow for increased recombinations and mapping resolution, as well as increased power to detect loci with small phenotypic effects (Ogut et al., 2015).

Results and Discussion

Deciphering the genetic control responsible for Russian wheat aphid resistance in wheat has been a slow process and not much progress has been made to date. Past studies have utilised bi-parental mapping populations to study this complex trait. This paper proposes the shift towards multi-parental mapping populations as this approach has been shown to be more advantageous.

Conclusions

Progress in studying the genetic control of the RWA resistance in wheat will be achieved if new or different avenues are explored and exploited. Multi-parental mapping populations seem the fitting method to utilise in these current food crisis times.

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BENEFITS OF GRAZING COVER CROPS

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Introduction

Cover crops deliver multifunctional services, which can improve the system's production potential. Grazing is one of the numerous functions of cover crops, but the risk of perceived decreased positive effects on crop production prevents Western Cape producers from grazing cover crops. This study aimed to determine the effect of grazing cover crops on the mineral content of cover crop residue.

Materials and Methods

During 2016 trials were conducted in the Swartland region which has a Mediterranean climate. Two different cover crop mixes were assessed (mainly legumes and mainly cereals). Twenty-four whole plots were each divided into two sub-plots according to management, i.e. 1) grazed by sheep, 2) rolled as mulch. Aboveground plant biomass samples were collected prior to grazing and after the growing season. The biomass samples were analysed for nutritional value and mineral content. Fisher's LSD test was used at a 5% significance level to analyse all data.

Results and Discussion

These cover crops can be a good source of fodder as it had 19% crude protein, 10 MJ kg⁻¹ metabolisable energy and 80% in vitro digestibility. The mulch and grazed plots respectively had 3754-4449 kg ha⁻¹ and 2367-2774 kg ha⁻¹ herbage material left after the growing season. Although grazing reduced the amount of aboveground biomass, the concentration of nitrogen, phosphorus, calcium, magnesium, sodium, iron, zinc, manganese, boron, aluminium and sulphur in the cover crop residue was improved ($p < 0.05$) following regrowth at the end of the season. This indicates that grazing is not just the removal of material and minerals, but also causes a change in the quality of cover crop residue. The total amount of minerals available in the material per hectare were, however, reduced by grazing, except for aluminium, iron and sodium ($p < 0.05$). When the two mixtures were interpreted separately it is clear that grazing had a smaller effect on the mainly legume mixture. In the material of the mainly legume mixture the amount of phosphorus was the only mineral in herbage that was reduced by grazing ($p < 0.05$).

Conclusions

Cover crops can provide high quality fodder and grazing of cover crops can improve mineral content of herbage following regrowth. The effect of grazing cover crops is influenced by the cover crop mixture. Although grazing reduces the amount of material of cover crops, it does not necessarily reduce the amount of minerals in the soil cover. Cover crops can provide an opportunity to incorporate livestock into conservation agriculture systems.

References

IS TREE MORPHOLOGY OR ENVIRONMENT CONTROL MORE INFLUENTIAL ON TREE WATER USE? A REVIEW

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Introduction

Forests contribute significantly to the hydrological cycle through transpiration (T). Although tree T studies for several tree species have been conducted, the drivers of T at the global scale, under different climatic conditions remain unknown. This study aimed i) to assess the effects of tree morphological traits and environmental controls on tree water use and ii) to establish the trends of tree transpiration measurement techniques.

Materials and Methods

A keyword based search of “whole tree transpiration” and “tree water use” was performed using EBSCOHost, ISI Web of Science and Scopus. The search obtained 94 studies at globally distributed sites published between 1970 and 2016 from which T data was extracted. Morphological traits; tree height (H), diameter and breast height (DBH), and of environmental controls; mean annual precipitation (MAP), mean annual temperature (MAT) and altitude (Z) were also captured from these studies. The T measurement technique employed in each of the studies was recorded. Prior to analysis, T data was normalised using log transformation, here presented as $\ln T$.

Results and Discussion

A majority of study sites were found in North America (31%), Australasia (24%), Europe (21%), and Asia (14%), with only a few sites in Africa (5%) and South America (5%). A wide range of environmental conditions in MAP (280–3500 mm), MAT (1–29 °C), and Z (1–4595 m) were observed. H ranged from 1.5 m to 76 m and DBH ranged from 2 cm to 134 cm. $\ln T$ varied between 0 and 7.1 $\ln \text{ d}^{-1}$. $\ln T$ was significantly positively correlated to H ($r_s = 0.55$); and DBH ($r_s = 0.62$) ($P < 0.1$), suggesting that tree water use increases with both H and DBH. A weak positive correlation was observed between $\ln T$ and environmental controls MAP, MAT and Z ($r_s = 0.16$). The associations of $\ln T$ with MAT ($r_s = 0.04$) and Z ($r_s = 0.01$) were not significant ($P < 0.1$). Thermodynamic methods were the most commonly used (82%) to measure T (1970 to 2016) as compared to 3% for non-thermal based methods. From 1990 to 2016, studies using thermodynamic methods increased to 97%, 60% of the studies used thermal heat dissipation probes, 21% used heat pulse velocity, and the rest of the thermodynamic methods collectively employed the remaining 16%.

Conclusions

Tree morphological traits, (H and DBH) have a primary control, and must be considered for global scale modelling of T in forest ecosystems. The findings also reveal the prominence of thermodynamic methods of T measurement.

References

Potential toxicity of phytonematicides to potato (*Solanum tuberosum* L.) seeds when used as active ingredient carriers

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Introduction

The application methods of phytonematicides are costly (Mashela et al. 2013). Priming of potato (*Solanum tuberosum* L.) seeds with phytonematicides solutions could be an ideal method, however, phytotoxicity could potentially occur. The objective of this study was to determine whether priming of potato seeds with phytonematicide solutions would be suitable for use as a carrier of active ingredients without reducing tuber yield in potato production.

Materials and Methods

A 2 × 2 × 2 factorial experiment, was initiated in microplots with treatments arranged in a randomised complete block design, with 14 replicates. The first, second and third factors comprise Nemarioc-AL (A), Nemafric-BL (B) and Mormo-Nem (N) phytonematicides, the treatments included (1) untreated control A0B0N0, (2) A0B0N1, (3) A0B1N0, (4) A0B1N1, (5) A1B0N0, (6) A1B0N1, (7) A1B1N0, and (8) A1B1N1. Seeds were primed for seven hours prior to sowing. Fifty-six days after inoculation, plant and nematode variables were collected and analysed. Data were subjected to ANOVA using Statistix 10.1 software and means were separated using Wallar-Duncan multiple range test at ($P \leq 0.05$) probability.

Results and Discussion

Second order interactions were not significant for any variable. The first order Nemarioc-AL and Nemafric-BL interaction had a significant effect on fresh tuber mass contributing 39% in total treatment variation (TTV) of the variable. Apparently, this interaction was due to the combined effects of the two different active ingredients (Mashela et al. 2017).

Conclusions

In erms of plant growth, the two cucurbitacin-containing phytonematicides were suitable for using the seed as a carrier, without inducing phytotoxicity.

References

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INFLUENCE OF FLAG LEAF CHLOROPHYLL AND NITROGEN CONTENT ON WHEAT GRAIN YIELD

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Introduction

The aim of topdressing N fertiliser is to ensure optimum leaf nitrogen levels until relatively late in the growing season. Non-destructive, in season, measurement of chlorophyll content can be useful as indicator of leaf N status. The aim of this study was to relate the flag leaf chlorophyll content of wheat with leaf N content and grain yield of wheat.

Materials and Methods

Six research sites namely Riversdale, Rivieronderend, Caledon, Moorreesburg, Darling and Porterville were included in the study. Data were recorded during 2016 and 2017 on a wheat study where topdressed fertiliser N rates ranging between 0 and 165 kg ha⁻¹ were applied. A control that received 0 kg N ha⁻¹ was included while all the top-dressed treatments also received 25 kg N ha⁻¹ at planting time. Cropping systems included wheat after canola (CW), wheat after medic (MW) and wheat after lucerne (LW). The chlorophyll meter values of the flag leaf of wheat were recorded using a CCM-200 plus chlorophyll meter from Opti-Sciences. The chlorophyll content of 5 randomly selected plants per treatment was recorded, the same leaves were sampled, dried and total N (Leco N-analyser) determined.

Results and Discussion

Scatter charts of the trial mean (all systems and sites) showed that the predictability of flag leaf N from CCI values was relatively low with $R^2 = 0.5653$ and described by $y = 0.0906x + 1.7581$. The predictability of grain yield from CCI at flag leaf was even worse ($R^2 = 0.2129$) and described by the equation $y = 149.77x + 146.03$. Predictability is however more site specific. Predictability at Riversdale (CW) was high with R^2 values of 0.8892 (CCI vs flag leaf N) and 0.8325 (flag leaf N vs grain yield), Porterville (CW) 0.7957 (CCI vs flag leaf N) and 0.5867 (flag leaf N vs grain yield) and Darling (CW) 0.6876 (CCI vs flag leaf N) and 0.0533 (flag leaf N vs grain yield).

Conclusions

Preliminary results show that CCI can be a good indicator of flag leaf N content. The variation in flag leaf N content and grain yields between sites can possibly be ascribed to climatic conditions, such as rainfall and temperature, between flag leaf and physiological maturity.

References

EFFECT OF COVER CROPS AND SOIL MANAGEMENT ON COMMON COUCH (CYNODON DACTYLON)

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Introduction

This perennial spreading grass grows actively from grapevine bud break (September) to post harvest (April/May) and has the ability to spread vegetatively. The objective of the study was to determine the effect of different weed management treatments on the stand of common couch.

Materials and Methods

Twelve treatments were applied in a full-bearing seven year old drip irrigated Shiraz/101-14 Mgt vineyard established on a sandy to sandy clay loam soil near Stellenbosch (33o58'S, 18o50'E). Five cover crop species and a treatment in which no winter growing cover crop was sown (Weeds) were evaluated. Two management practices were applied to each of these winter treatments namely, full surface, post-emergence weed control (CC) and slashing of cover crops/weeds which was immediately mechanically incorporated into the soil (MC). The dry matter production (DMP) of common couch was determined end of August (winter growth), end of November (grapevine berry set) and the beginning of April (post-harvest).

Results and Discussion

Pallinup oats (CC) proved to be most effective in controlling/suppressing the common couch stand throughout the trial. Pallinup oats (MC) could not control the common couch initially, but did suppress it during rest of the trial. Weeds (CC) effectively controlled the common couch stand for the duration of the trial, while Weeds (MC) was only effective during the first three seasons. White mustard (CC) and (MC), as well as Canola (CC) suppressed the common couch during winter and eventually reduced the stand compared to the pre-treatment stand. Caliente 199 (CC) and (MC) controlled the common couch in the winter but Caliente 199 (MC) was more effective in reducing the common couch stand over the trial period.

Conclusions

Pallinup oats (CC) proved to be most effective in controlling/suppressing the common couch and should therefore be the preferred treatment where this weed dominates.

References

SOIL ALTERATION RESPONSES FOLLOWING IRRIGATION WITH DILUTED WINERY WASTEWATER IN SOILS OF DISSIMILAR TYPES

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Introduction

Microbially-secreted soil enzymes, which is responsible for the decomposition of organic matter and cycling of nutrients in soil, are said to be stimulated through the supply of easily decomposable organic material in wastewater. Even supposing this to be true, exactly how soils of dissimilar textures may be altered by winery wastewater, remains uncertain. In soil, enzymes typically bind to humus in organic matter through various mechanisms. A large portion also adsorb to clay minerals. Since, organic matter also bind with clay minerals, this clay-humus complex further supports enzyme stability. Therefore, it is likely that enzyme activity responses following irrigation with winery wastewater, will differ between soils of dissimilar types. The aim was to investigate the impact of irrigation with diluted winery wastewater, and of irrigating with good quality (municipal) water, on differently textured vineyard soils, using an enzyme-based alteration index (AI3).

Materials and Methods

Soils originating from four vineyard areas were irrigated, in pots, over four simulated seasons with municipal water, and with winery wastewater diluted to a chemical oxygen demand of 3000 ml/L. The soils were: alluvial sand (3.3% clay; 1.0% organic carbon), aeolian sand (0.4% clay; 0.2% organic carbon) as well as shale (21% clay; 1.2% organic carbon) and granite (13%; 1.2% organic carbon) derived soils. Pot soil samples were taken from the 0-10cm and 10-20cm layers after each season. AI3 indices were generated using the formula by Puglisi et al. (2006). The pot trial followed a statistical design.

Results and Discussion

A positive enzyme activity response, following irrigation with water containing winery wastes, compared with quality water containing no winery wastes (irrespective of season and of sampling depth), was noticed to be most prominent in the Stellenbosch shale, followed by the Stellenbosch granite, and the Lutzville sand; the Rawsonville sand remained unaltered. Stimulation in enzyme activity was in accordance with the different clay and organic matter contents of the different soils; the heavier soils being able to sustain better overall soil fertility than sandy soils.

Conclusions

Soil alteration responses following irrigation with water containing winery wastes differ between vineyard soils of dissimilar types. Soils of higher clay and organic matter contents will be better able to sustain soil fertility when subjected to multiple irrigation cycles with diluted winery wastewater.

References

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THE RELATIONSHIP BETWEEN CONSERVATION TILLAGE PRACTICES FOR POTATO PRODUCTION AND SOIL BIOLOGICAL ACTIVITY IN THE SANDVELD REGION OF SOUTH AFRICA

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Introduction

Tillage plays a major role in modification of soil structure as it influences the distribution of energy rich organic matter within the soil profile and thus impacts on the energy flow and the dynamics of soil geo-chemical functions. The aim of this study was to investigate the effect of conservation tillage on the levels of biological activity in the soil.

Materials and Methods

The trial was conducted in Aurora, South Africa, in the Sandveld region under a centre pivot from 2013 to 2106. The trial layout was randomised complete block. Three tillage treatments were investigated on soil respiration rates and consisted of a conventional tillage treatment with a mouldboard plough to a depth of 350 mm combined with a rip treatment 600 mm deep between planting rows, a conservation rip treatment to a depth of 600 mm between planting rows and a conservation paraplow treatment over two planting rows to a depth of 600 mm. The soil respiration (CO₂) samples, as indicator of biological activity, were taken in February of each year before commencement of treatments and then again ten weeks after emergence of plants. Samples were weighed (20.00-20.01g); thereafter the vials were closed, after 30min the gas was drawn through septa in the lid. Agilent's gas chromatography was used in this procedure which was fitted with a thermal conductivity detector to measure CO₂ and O₂

Results and Discussion

The soil respiration ten weeks after emergence, was significantly higher in all the paraplow treatments from year 1 to 4 when compared to the other two treatments which indicates that the paraplow treatment enhances biological activity in the soil probably due to less soil disturbance and optimal aeration of the soil profile due to the lifting of the entire profile. During the growing season, up to 10 weeks after emergence, the soil respiration in the paraplow treatment in year 4 rose from 5.760 mg/kg/h to 8.062 mg/kg/h. Soil respiration however dropped in the other treatments from 5.760 mg/kg/h to 5.526 mg/kg/h for the rip treatment and to 3.736 mg/kg/h for the conventional mouldboard treatment. The results of the last four seasons show that the paraplow treatment led to significantly higher levels of soil respiration and it is thus evident that the paraplow treatment enhances biological activity.

Conclusions

Due to the less aggressive nature of the conservation paraplow tillage action it is evident that it leads to more soil biological activity in relation to the other treatments.

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THE INTERACTIVE EFFECT OF THE PRODUCTION ENVIRONMENT, GENOTYPE AND SEED AGEING ON GERMINATION AND VIGOUR OF CHICKPEA (*CICER ARIETINUM* L.)

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Introduction

The production of chickpea (*C. arietinum* L.) is often limited by poor seed quality; this may vary with genotype, seed production environment and storage conditions. For example, water stress during seed production may cause alterations in the seed morphological and chemical properties and affect seed vigour during storage as well as the imbibition process during germination. This study evaluated the effect of the production environment, genotype and seed ageing on germination and vigour of chickpea seeds that were harvested from plants grown under two production environments.

Materials and Methods

The experiment consisted of a factorial combination of 2 production environments (stress and non-stress), 3 chickpea genotypes (Desi-K, Saina and ICCV-K) and 2 seed ageing treatments (aged and unaged) arranged in a CRD. The seeds were artificially aged for 0, 1, 3, 5 or 7 days at 41 °C and 100% relative humidity. Electrical conductivity (EC), tetrazolium chloride test (TZ), germination percentage (GP) and mean germination time (MGT) were determined.

Results and Discussion

Desi-K had lower EC ($\mu\text{S cm}^{-1}\text{g}^{-1}$) (3.24) compared to Saina (4.08) and ICCV (4.13). Unaged seeds had greater seed viability (according to TZ test) (81.7%) compared to aged seeds (79.2%, 75.8%, 67.5% and 58.3% for 1, 3, 5 & 7 days, respectively). The production environment x genotype x seed ageing interaction was highly significant. Water stress did not affect GP of unaged seeds. In contrast, there were genotypic differences in GP among the cultivars after ageing for 7 days; Saina showed a 7% reduction (93 to 87%) compared to 29% (93 to 67%) in ICCV-K and 45% (73.3% to 40.0%) in Desi-K. The results were consistent with the observations on MGT (1.6, 1.7 and 1.9 days for Saina, ICCV-K and Desi-K, respectively). The decrease in GP by accelerated ageing may be due to progressive loss of seed viability and vigour (Hussein et al., 2011). Moreover, high EC of ICCV-K and Saina resulted from imbibition damage caused by the rapid entry of water into the cotyledons during imbibition (Matthews and Powell, 2006).

Conclusions

These findings suggest that there are genetic differences among chickpea genotypes with respect to response to the production environment which could affect storage potential and consequently seed quality.

References

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Comparison of commonly employed local and international soil P extraction tests on South-African soils

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Introduction

INTRODUCTION Numerous soil P tests have been developed which provide an estimate of plant available P under different soil conditions. However, critical soil threshold levels of extractable P for specific crops are not available for all test methods, and thus it is necessary to be able to convert values between these different methods. Thus the aim of this study was to compare the efficiency and relationship between 7 different soil P tests (Bray I and II, Mehlich3, Olsen, citric acid, Colwell, and 1:2 water extractable) that are currently used in South Africa.

Materials and Methods

MATERIALS AND METHODS Fifty soils, varying in physiochemical properties and P content, were collected from across South Africa. Soil pH, EC, ECEC, total C, organic C, CBD Fe and Al, oxalate Fe and Al, soil texture, Bray I P, Bray II P, Mehlich 3 P, Olsen P, Colwell P, Citric acid P, 1:2 water extractable P and total P through acid digestion was determined. The correlations between the various P extraction tests, as well as, the effect of soil properties on % of total P extracted were assessed using Pearson test.

Results and Discussion

RESULTS AND DISCUSSION Bray II and Mehlich 3 extractable P correlated most strongly to total P with R²-values of 0.79 and 0.77 ($p < 0.01$) respectively. Mehlich 3, Bray II and Bray I correlated most strongly linearly to each other ($R^2 = 0.96-0.99$, $p < 0.01$). Olsen correlated most strongly with Bray I and II ($R^2 = 0.91$) and Mehlich 3 ($R^2 = 0.88$). Citric acid correlated most strongly with Mehlich 3 and Bray II ($R^2 = 0.86$). The Mehlich 3 test extracted on average the highest percentage of total P of 43.8%, followed by Citric acid (41.8%) and Bray II (40.7%) tests. The 1:2 water and Colwell tests extracted on average the least amount of total P (7.7% and 28.8 %, resp.) and did not correlate significantly with total P. The 1:2 water test correlated most strongly with Olsen ($R^2 = 0.75$), while Colwell correlated most strongly with citric acid ($R^2 = 0.75$). Soil pH or other soil properties did not significantly correlate with % of total P extracted by each test.

Conclusions

CONCLUSIONS We can conclude that it is possible to most accurately directly convert between Mehlich 3, Bray I, Bray II and Olsen P extraction tests soil P values. The relative amount of P extracted by each test did not significantly correlate with any soil properties.

References

Thank you for attending the congress.