RESEARCH TECHNOLOGY TRANSFER SYMPOSIUM

ORGANISING COMMITTEE

2017

Mr.Nkosinathi Jacob Tembe (Chairperson)

Ms. Fikile Qwabe

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Ms. Noxolo Mtumtum

Mr. Sibusiso Radebe

Mr. Vincent Zuma

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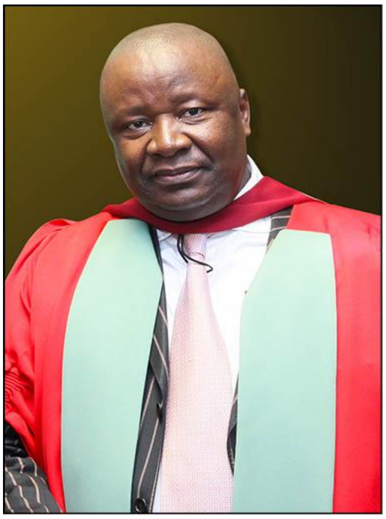
PROVINCE OF KWAZULU-NATAL

FOREWORD FROM THE HOD



Message from the Head of Department: Dr S. F. Mkhize

KwaZulu-Natal Department of Agriculture and Rural Development

The Agricultural sector plays an important role in the South African economy because of the opportunities it offers for sustaining livelihoods, food security and employment. Therefore there are strong linkages between agriculture and the rest of the economy. The Province of KwaZulu-Natal has one of the highest agricultural potential in the Republic, of which 17% of the land surface is arable and 7.5% is high potential. However evidence suggests that during the past decades the sector contribution to the economy of the Province has been declining. A significant decline has been reported in the number of agricultural households (-6, 3% or 180 781 agricultural households). Severe drought conditions have contributed to this large decline in agricultural households.

In KZN high unemployment, poverty and inequality levels and the reliance on income are a major determinant of household food insecurity. Food affordability is becoming a major challenge, because, as we know food prices have risen above inflation during the year 2015/16.

The poorest of the poor are the most affected, who already spend up to 60% of their income on food. Even though involvement in agriculture alone does not address food insecurity challenges, agriculture remains a key method used to supplement food requirements amongst households that are involved in this practice. Due to the above facts, it has been announced by the honourable MEC Mr Themba Mthembu that food security has to be a crucial part of the Departmental mandate. One of our key mandates that emanates from the National Development Plan, is to build an inclusive rural economy. Research needs to be aligned with these mandates, as well as to the strategy of the Department. As Researchers, Scientists and Advisors, if we are not making a dent in the poverty statistics in our Province and if the agricultural sector is still struggling with job creation, we are failing the people of this Province.

All of this, points to the fact that we need to take a long hard look at our current research and see if it addresses the above challenges. We all know that Agriculture is a natural science based on well-defined theories and biological processes. Its production systems are based on science that are affected by the environment where the production takes place. Research and technology plays a very important role to be able to establish new technologies to adapt to this ever changing environment. The extension staff need to take the technology and translate it into an understandable message for farmers so that they are able to incorporate the latest technologies in their farming practises. So, as we are having this gathering today. I am very pleased that both Research and Extension are together to share the results of the tested technologies in different fields of crop production.

The 2016/17 Research Technology Transfer Symposium proceedings booklet contains the summaries of invited papers from research projects conducted by Departmental staff, funded by the KwaZulu-Natal Department of Agriculture and Rural Development on an annual basis.

I wish to take this opportunity to thank institutions such as the Agricultural Research Council, Universities, the Private Sector, NGO's and Commodity Organizations for the research work they do in the Province to contribute to a food-secure Province.

I wish you a fruitful and successful symposium.

DIRECTORATE INFORMATION

The Province of KwaZulu-Natal (KZN) has the second largest population in the country with a total population of 10 267 300 million people. An estimated 3.5 million citizens in KZN, according to Provincial Growth Development Strategy, experience various forms of food insecurity, and in need of assistance. KZN has the highest disease burden in the country with high incident of malnutrition. The National Food and Nutrition Security Programme, through Fetsa Tlala campaign, proposes various initiatives to address the main challenges of food insecurity. Such challenges of addressing food and nutrition insecurity through agriculture intervention, has received global intention.

Agricultural produce is the primary source of nutrients necessary for a healthy life, but agricultural policies and technologies have focused on improving profitability at the farm and agroindustry levels, not on improving nutrition. Agricultural Crop Research Directorate as part of its strategic contribution, focuses on research which addresses both food and nutrition security. The new paradigm shift is able to produce and deliver better quality food (food rich in nutrients). The chemical elements called “nutrients” are key to agriculture in order to deal with food nutrition security. Through the Analytical Services sub-directorate, chemical elements in crops, animal food products, soils and water will be quantified. This will assist to measure the progress before research intervention and thereafter.

The main issues covered under Outcome 7 of the Provincial Growth and Development Plan (PGDP) are:

(i) Develop and promote agricultural potential of KZN
(ii) Increasing land productivity and
(iii) Enhancing sustainable household food security in KZN.

South Africa’s population will reach close to 60 million people by the year 2050. As a result, the country will have to provide for an additional 20% (by volume) in food requirements for its expanded population and diminished productive agricultural land. Climate change could further reduce the productivity of agricultural land, and increase poverty especially in rural areas.

Continuous and substantial investment into a needs-driven research and technology development programme is essential to provide solutions to problems, offset constraints and to offer new and innovative technologies which will ensure sustainable agricultural production in KwaZulu-Natal in the future.

The Directorate: Agricultural Crop Research Services with 285 staff members performs one of the line functions of the KwaZulu-Natal Department of Agriculture and Rural Development. Three Sub-directorates with respective divisions are involved in research and technology development concerning crop production.

1. Analytical Services (Laboratory Analytical Services, Bio-datametrics & Bioinformatics, Biochemistry, Soil Fertility Research),
2. Crop Production Research Services (Agronomy, Horticulture, (Juncao Mushrooms) Crop Protection) and
3. Farming Systems Research

The four pillars of Agricultural Crop Research Services are as follows:

1. Agricultural research on-station and off-station,
2. Laboratory Services: soil, plant, plant health, water and animal feed,
3. Maintenance of research infrastructure,
4. Transfer of technology developed.

As one of the key responsibility areas (four pillars), the Research Technology Transfer Symposium is an opportunity for researchers and their teams to share with colleagues and clients, information emanating from research. Following final and progress report feedback sessions conducted by the Sub-directorates during September 2016, those research projects ready with a clear message or recommendation were identified to be included in the Symposium programme.
For the 2017 Symposium, 16 talks will be presented. This provides a platform for discussion and debate around the subject while simultaneously creating an opportunity to identify further research needs.

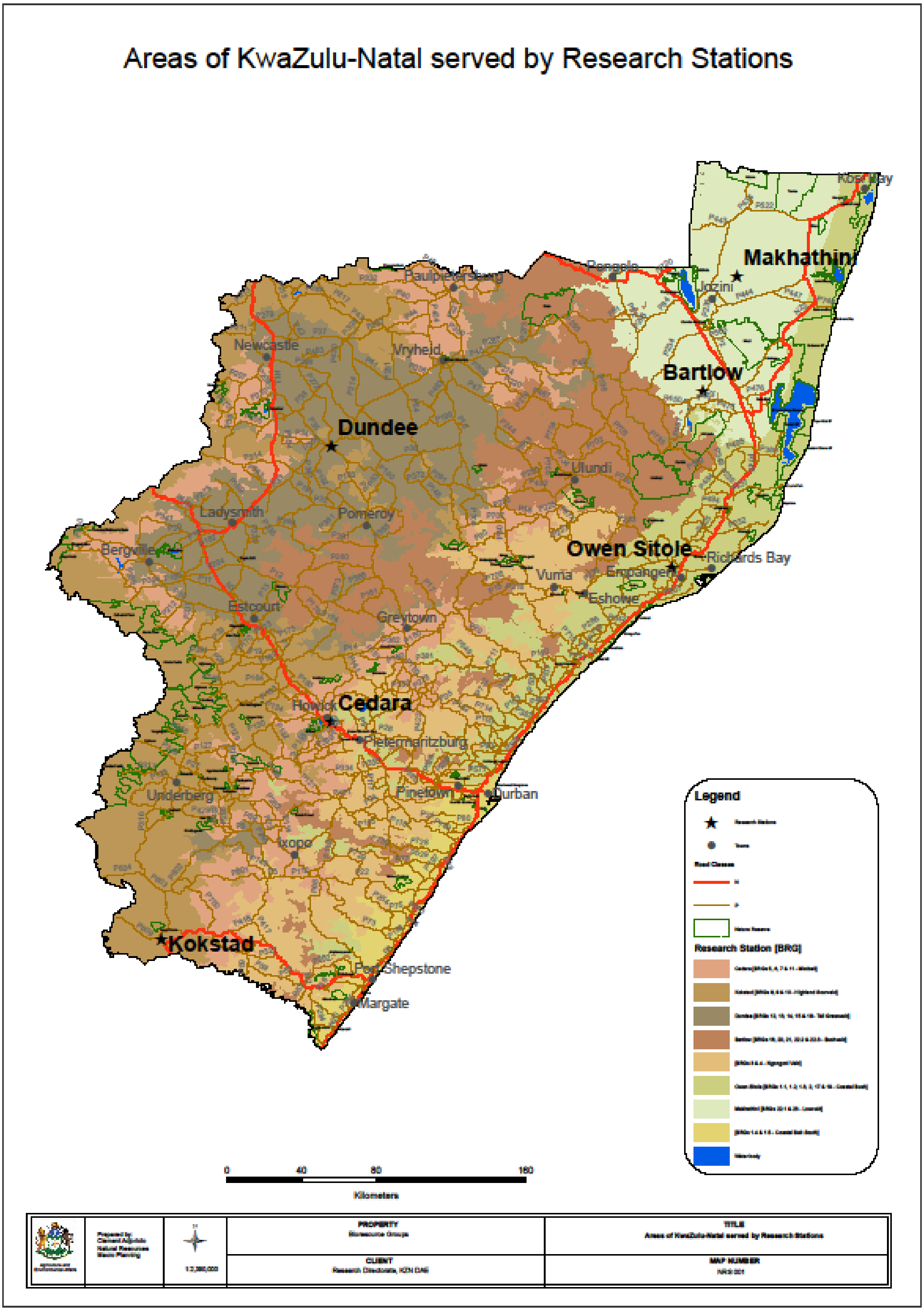
The Research Proceedings records summaries of the talks, a list of the current research projects, as well as the research projects approved during 2016. It also documents a list of staff currently involved in research and technology development.

Thanks are due to the Organizing Committee and to those presenters participating in the Symposium.

You are therefore encouraged to enjoy the Symposium and make full use of the opportunity to engage, to network and to communicate with fellow scientists and colleagues – all to the benefit of those within our Province.

Fikile Qwabe
(Acting Director: Agricultural Crop Research Services)

MAP OF KZN INDICATING RESEARCH STATIONS LOCATIONS



MEMBERS OF THE RESEARCH PROJECT COMMITTEE

Dr Hannes de Villiers: Chairman

Ms Thembeka Mlambo: Secretary

Mrs Michelle Larsen: Administrative Support

Mrs Nomfuzo Mkhize: Director: Agricultural Training Institutes

Ms Fikile Qwabe: Acting Director: Agricultural Crop Research Services

Mrs Les Thurtell: Scientific Manager: Analytical Services

Dr Trevor Dugmore: Acting Scientific Manager: Livestock Production Research

Dr Alan Manson: Professional Scientist (Analytical Services)

Dr Suzette Bezuidenhout: Professional Scientist (Crop Protection)

Mr Thami Mpanza: Professional Scientist: Farming Systems Research

Mr Bright Mashiyana: Liaison between R&TD and Extension and Projects

Mr Francois du Toit: Control Farm Manager: Farm Services

Mr Rob Osborne: Professional Scientist (Horticulture)

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Ms Thembeka Mlambo: Secretary

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RESEARCH TECHNOLOGY TRANSFER SYMPOSIUM PROGRAMME

"Enhancing crop production for the future"

Cedara Centenary Complex, 15th -16th February 2017

15th FEBRUARY 2017		
10h30 - 11h00	**REGISTRATION & TEA**	
SESSION ONE	**Chairperson**	**Dr Hannes de Villiers**
11h00 - 11h05	Opening prayer	Mr. B. Mashiyana *Liaison between R&TD and Extension and Projects*
11h05 - 11h15	Welcome	Ms Fikile Qwabe *Acting Director: Agricultural Crop Research Services*
11h15 - 11h30	Opening address	Dr S.F. Mkhize *Head of Department: KZN DARD*
11h30 - 12h00	Guest Speaker	Prof. UNathi Kolanisi *Head Of Department: Consumer Science, University of Zululand*
SESSION TWO	**Chairperson**	**Dr. Suzette Bezuidenhout**
12h00 - 12h20	Multi-season maize cultivars for KwaZulu-Natal	Ms. N.P. Mtumtum *(Agronomy, Kokstad)*
12h20 - 12h40	Vitamin A sweet potato genotype evaluation	Mr. R. Osborne *(Horticulture, Cedara)*
12h40 - 13h00	Mushroom production for food security and improved nutrition in KwaZulu-Natal	Mr. N.J. Tembe *(Juncao Mushroom, Cedara)*
13h00 - 13h30	**LUNCH**	
SESSION THREE	**Chairperson**	**Mr. Thami Mpanza**
13h30 - 13h50	Monitoring and evaluation of aphid numbers at Cedara	Ms. A. Nunkumar *(Crop Protection, Cedara)*
13h50 - 14h10	Soybean cultivar recommendations for the cool and moderate production areas of KwaZulu-Natal	Mr. A.J. Arathoon *(Agronomy, Cedara)*
14h10 - 14h30	The effects of gypsum and lime application on soil properties and groundnut yields	Mr. S.B. Radebe *(Agronomy, Dundee)*
14h30 - 14h50	How can resource-poor famers improve production on acid and low-phosphorus soils?	Dr. Alan Manson (*Analytical Services, Cedara)*

16th FEBRUARY 2017		
08h00 - 08h30	**REGISTRATION & TEA**	
SESSION ONE	**Chairperson**	**Ms. Noxolo Mtumtum**
08h30 - 09h00	Guest Speaker	Mr. N. Madondo *(Small - scale farmer adopted conservation tillage in the Potshini area, Bergville)*
09h00 - 09h20	The best Mango cultivars for KwaZulu-Natal	Mr. C. Dlamini *(Horticulture, Makhathini)*
09h20 - 09h40	Dry - bean cultivars for KwaZulu-Natal through cultivar evaluation trials	Mr. T. Ntombela *(Agronomy, Cedara)*
09h40 - 10h00	Comparison of fungicide spray frequency and intervals under simulated inoculum pressure on maize yield and grey leaf spot	Ms. A. Nunkumar *(Crop Protection, Cedara)*
10h00 - 10h15	**TEA**	
SESSION TWO	**Chairperson**	**Ms. Archana Nunkumar**
10h15 - 10h35	Land management and soil microorganisms	Mrs S.C. Naidoo *(Analytical Services, Cedara)*
10h35 - 10h55	The response of dry bean cultivar on different planting dates under climatic conditions of Maphumulo District	Mr. F. Khubone *(Farming Systems Research, Cedara)*
10h55 - 11h15	Value adding to processed peach products – case study of Impendle.	Mr. K.M. Mkhathini *(Horticulture, Cedara)*
11h15 - 11h35	The seeding rate of maize for optimum yield in KZN	Mr. A.J. Arathoon *(Agronomy, Cedara)*
11h35 - 11h55	Sweet potato vine multiplication in KZN	Mr. C. Dlamini *(Horticulture, Makhathini)*
11h55 - 12h15	Influence of different weed types on the growth of maize	Dr. S.R. Bezuidenhout *(Crop Protection, Cedara)*
12h15	CLOSURE	Ms F.N.P Qwabe *Acting Director: ACRS*

ABSTRACTS

MULTI-SEASON MAIZE CULTIVARS FOR KWAZULU-NATAL

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Introduction

Cultivar selection is among the factors that have to be considered by producers for successful maize production as cultivars differ in their ability to produce optimally under different environmental conditions. New maize cultivars are developed regularly by breeders to address agronomic challenges and are subsequently introduced into the market. Their performance in specific environments may not have been evaluated before their release. A national maize cultivar evaluation trial is conducted annually in the major grain producing areas of South Africa to evaluate existing and new cultivars for adaptability and agronomic characteristics. The Agronomy Section of the KwaZulu-Natal Department of Agriculture and Rural Development conducts this trial on the Kokstad and Dundee Research Stations.

Materials and methods

Fifty maize cultivars were evaluated during the 2013/14, 2014/15 and 2015/16 growing-seasons to determine their adaptability to the Kokstad (cool climate) and Dundee (warm climate) areas. The trials were planted in 0.75 m wide rows at seeding rates of 44 444 and 55 555 seeds/hectare at Kokstad and Dundee, respectively. The crops were grown under dry-land conditions and were fertilized for a 10 ton/hectare grain yield based on soil analysis recommendations conducted by the Cedara Analytical Laboratory. Weeds, insects and diseases were controlled throughout the growing-season.

Results

The mean yields of the top ten cultivars from the twenty eight (28) cultivars which were evaluated during all three seasons at Kokstad and Dundee are presented in Table 1. DKC 78-87, PAN 6Q-408CB, DKC 78 – 79BR and DKC 80– 40BR had consistently high rankings at both sites, whilst PAN 6R – 680R has a considerably higher ranking at Kokstad than at Dundee. At Kokstad and Dundee the mean yields ranged from 5.71 t/ha to 10.34 t/ha and from 6.20 t/ha to 7.90 t/ha, respectively. The highest yielding cultivars at Kokstad and Dundee over the three seasons were PAN 6Q-408CB (10.34 t/ha) and DKC 78-17B (7.9 t/ha), respectively.

TABLE 1 Mean yields of the top ten cultivars at Kokstad and Dundee over the three seasons

KOKSTAD			DUNDEE		
Cultivar	**Yield (t/ha)**	**Rank**	**Cultivar**	**Yield (t/ha)**	**Rank**
PAN 6Q-408CB	10.34	1	DKC 78-17B	7.90	1
DKC 78-87B	9.68	2	DKC 78-87B	7.80	2
PAN 6P-110	9.66	3	DKC80-40BR GEN	7.87	3
PAN 4B-311B	9.35	4	DKC 73-74BR-GEN	7.70	4
PAN 6R-680R	9.30	5	DKC 78-79BR	7.70	5
DKC 78-79BR	9.29	6	PAN 6Q-245	7.70	6
PHB 33H52B	9.20	7	PAN 6Q-408CB	7.70	7
DKC80-40BR GEN	9.08	8	P2653WB	7.68	8
DKC 78-17B	8.98	9	PAN 6P-110	7.58	9
DKC 73-74BR-GEN	8.97	10	KKS 8410BR	7.50	10
Mean	**8.46**		**Mean**	**7.05**	

Discussion

The cultivars showed both wider and narrower adaptability to specific environments. The mean yields at Dundee were more consistent during the evaluation period than at Kokstad. Although Kokstad had fairly inconsistent mean yields, which resulted from the drought (considerably lower rainfall and higher temperatures than the long-term mean) in the last season (2015/16), higher mean yields (8.46 t/ha) were produced compared to Dundee (7.05 t/ha) due to cooler temperatures and higher rainfall.

Cultivars perform differently at different localities due to environmental conditions and therefore the yield potential and adaptability of cultivars in specific environments are important indicators of cultivar performance.

Recommendations

PAN 6Q-408CB, DKC 78-87B and PAN 6P-110 are recommended for cool production areas such as Kokstad, whilst DKC 78-17B, DKC 78-87B and DKC 80-40BR GEN are recommended for warm production areas such as Dundee.

VITAMIN A SWEET POTATO GENOTYPE EVALUATION

Rob Osborne[1], Paul Shanahan[2]

[1]Horticulture, Cedara; [2]School of Agricultural, Earth and Environmental Sciences, UKZN

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Introduction

Sweet potatoes have been identified as one of the most promising crops for improving household food security in resource-poor communities. No other crop has the potential to produce as high a level of nutrition with as low inputs. Sweet potatoes have been rated as the most nutritious of all vegetable crops. They are an excellent source of vitamin A. In addition they produce high yields with relatively low inputs. They are drought tolerant, disease resistant and can tolerate relatively low fertility soils with high soil acidity.

Materials and Methods

New material was obtained from crossing of the American cultivar "Jewel" with a range of Ugandan genotypes from a polycross. A total of 141 first generation seedlings were grown in order to produce cuttings for field evaluation. These were planted at a commercial farm at Weenen in an un-replicated screening trial. At harvest, each plot was photographed and weighed according to marketable as well as unmarketable roots. In addition, a range of qualitative ratings were made according to a standardised evaluation sheet. These data were used to make selections for the next round of evaluation.

Results

Of the 141 genotypes evaluated, a total of 25 were selected on the basis of yield and quality to be included for further trials. These will be replicated five by five lattice designs and will be planted at Weenen as well as at Cedara.

Discussion

Once the current trials are lifted and evaluated in 2017, final selections can be made which can be taken forward for cultivar registration. Once this registration is complete, the cultivars can be released for commercial multiplication.

Recommendations

No recommendations can be made until the new cultivars are registered.

MUSHROOM PRODUCTION FOR FOOD SECURITY AND IMPROVED NUTRITION IN KWAZULU-NATAL

Tembe J. Nkosinathi, Mncwabe Mlondi, Ngwira Ntombikayise

Juncao Mushroom, Cedara

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Juncao Mushroom Technology was introduced to South Africa with the objective of eradicating poverty, ensuring food security and sustainable job creation in KwaZulu-Natal rural communities. This project has resulted in two satellite bases (Dukuduku and KwaDindi) and generated more than 40 food security gardens producing oyster mushrooms *(Pleurotus ostreatus)*. People interested in being part of the project should send an application letter to their local extension office, from where it will be forwarded to the relevant section.

Mushrooms are favoured for their delicious flavour, high protein content and absence of cholesterol. Their production may be optimized only if their substrate specific requirements are known and well-maintained. Sugarcane bagasse, juncao, hominy chop, wheat bran, maize stover, sawdust and lime (calcitic and hydrated) are the raw materials currently used at Cedara for oyster mushroom substrate pack production. These raw materials are regarded as the nutritional requirements of *P. ostreatus*. Oyster mushroom can grow on any material that contains lignin and cellulose, regardless of the quality, yield and growth rate. The carbon to nitrogen ratio (C:N) is critical for optimizing the yield. Current research done at the Mushroom Section is focusing on optimizing yield and using locally available raw materials.

Some species of *pleurotus* have medicinal properties such as anti-tumour, anti-cancer, anti-inflammatory and anti-nociceptive. In nature there are also poisonous mushrooms. From time to time reports appear in the media that there has been an incident of mushroom poisoning, causing the deaths of ‘wild’ mushroom collectors. Careful and accurate identification is essential for the safe consumption of mushrooms collected in the natural or ‘wild’ state. Eat only mushrooms which have been positively identified as edible, if there is any doubt do not eat them.

MONITORING AND EVALUATION OF APHID NUMBERS AT CEDARA

Archana Nunkumar[1] & Kerstin Krüger[2]

[1]Crop Protection, Cedara, [2]Universtiy of Pretoria

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Introduction

Pathogens such as Potato Virus Y (PVY) and Potato Leaf Roll Virus (PLRV) threaten the quality of seed potatoes in South Africa. In order to efficiently manage the disease in the field, farmers and researchers require a thorough knowledge of the insects responsible for transmitting the virus. Aphid species are widely known to be responsible for transmitting viruses onto plants. Different aphid species can transmit PVY and PLRV with varying success. Potato Virus Y and PLRV are responsible for tuber quality and yield losse, which may be as high as 80%. In South Africa 21 aphid species are known to transmit PVY. Some aphids, such as the peach potato aphid (*Myzus persicae*), are exceptionally efficient in transmitting the virus. However, in contrast, other aphid species are not able to transmit PVY. Potato Virus Y management involves spraying pesticides or using preventative measures, such as making use of aphid monitoring and the determination of vector pressure to aid the timing of desiccant sprays. The aim of this project is to provide seed potato growers with aphid abundance data both to assess virus risk and to serve as an early warning system to assist growers in making management decisions regarding location and timing of aphid control measures.

Materials and methods

Potato South Africa assisted with the erection of an aphid trap on Cedara Research Station. The aphid trap consists of a four metre high metal chamber housing the suction pump, the control and a funnel for directing the trapped insects into a glass Ball-jar containing water, 5 ml of liquid soap and a pinch of benzoic acid. A 12 metre high plastic tube sucks in flying insects. The bottle is replaced daily. The trapped insects are sieved out and placed in 96% ethanol. Aphids are identified, counted and placed into vials containing glycerol. These vials are posted weekly to the University

Results and discussion

Results indicate that a total of 3934 aphids were caught in the suction trap from July 2015 to June 2016. Aphid species were most abundant between August and November 2016. Results indicate an increase in vector pressure for both the Cedara and Underberg areas. This is due to an an increase in *Aphis spp* (vectors of PVY and PLRV) and *Rhopalosiphum padi* and *Sipha flava* (both vectors of PVY). On Cedara data show that there has been an increase in the aphid vectors, *Sipha flava*, *Metopolophium dirhodum* and *Aphis spp* compared to the 2014/2015 year. The distribution of *Rhopalosiphum padi* on Cedara has decreased. This could be due to unfavorable weather conditions. Results show that the cummulative vector pressure was much higher in 2015/2016 compared to 2014/2015 for both PVY and PLRV.

Recommendations

This information can be used to determine flight patterns of the aphid vectors and gives an indication of when to apply insecticides for aphid control. Therefore, it is recommended that potato farmers log into Potato South Africa's website daily for instructions of when to apply insecticides.

SOYBEAN CULTIVAR RECOMMENDATIONS FOR THE COOL AND MODERATE PRODUCTION AREAS OF KWAZULU-NATAL

James Arathoon
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Introduction

Soybean (*Glycine max* (L.) Merrill) cultivar selection is extremely important if production is to be optimized. The cultivars should be adapted to the production area, be high yielding and have few weaknesses, such as susceptibility to lodging and pod shattering or have low bottom pods. A national soybean cultivar evaluation project is conducted annually in the major grain producing areas of South Africa to evaluate existing and new cultivars for adaptability and agronomic characteristics. Due to variations in weather between seasons, reliable cultivar recommendations should be based on the results obtained over three or more seasons.

Materials and methods

In the 2013/14, 2014/15 and 2015/16 seasons cultivars were planted in rows spaced 0.45 m apart in Kokstad and Cedara and either 0.75 m and 0.90 m apart at two sites in Greytown. The seeding rate was 400 000 seeds/hectare. The crops were grown under dry-land conditions and were fertilized for optimum grain yields, based on recommendations from a soil analysis. Registered agro-chemicals were used to control weeds, insects and diseases throughout the growing-season.

Results

The mean yields produced by the fourteen cultivars evaluated during the three seasons at Kokstad (cool production area), Cedara and Greytown (moderate production areas) are presented in Table 1. At Cedara the total rainfall received during the growing-season decreased with each successive season, resulting in mean yields of 4.2 t/ha, 3.6 t/ha and 2.7 t/ha, respectively. Although Cedara and Greytown have fairly similar long-term climatic conditions, Greytown experienced drier conditions during the evaluating period and hence lower yields were produced (mean = 2.6 t/ha). The yields at Kokstad were fairly consistent over the seasons (mean = 2.5 t/ha), but the rankings of most of the cultivars were inconsistent.

TABLE 1 Maturity group and mean yield of the cultivars for the 2013/14, 3014/15 and 2015/16 seasons at the three localities

Cultivar	Maturity group*	Kokstad (t/ha)	Kokstad Rank	Cedara (t/ha)	Cedara Rank	Greytown (t/ha)	Greytown Rank
LS 6240R	4.0	2.68	10	3.25	12	2.26	11
PAN 1454R	4.4	2.65	5	3.47	8	2.05	13
LS 6146R	4.6	2.31	13	3.18	13	2.33	10
LS 6248R	4.8	2.78	3	3.62	6	2.73	6
PHB 94Y80R	4.8	2.58	7	3.42	9	1.92	14
PHB 95Y20R	5.2	2.38	12	3.14	14	2.49	9
PAN 1521R	5.7	2.75	4	3.79	2	2.71	7
PAN 1500R	5.7	2.82	2	3.34	11	2.18	12
LS 6261R	6.0	2.44	11	3.59	7	2.80	4
PAN 1623R	6.1	3.04	1	3.79	2	3.04	1
LS 6161R	6.1	2.64	6	3.83	1	3.01	2
DM 6.2iRR	6.2	2.54	8	3.79	2	2.68	8
LS 6164R	6.4	2.55	9	3.63	5	2.95	3
PAN 1614R	6.4	2.20	14	3.39	10	2.76	5

***** *Maturity grouping is an index for the differentiation of cultivars according to their photoperiod requirements. The higher the maturity group, the longer the growing-season length.*

Discussion

PAN 1623R produced consistently high yields at Kokstad and Greytown over the seasons, indicating that it has the potential to adapt to and yield well with a wide range of climatic conditions. PAN 1500R and LS 6248R performed better in the cool Kokstad climate, whilst LS 6161R yielded consistently well at Cedara and Greytown over the seasons. At Cedara DM 6.2iRR and PAN 1623R had very high yield rankings in some seasons, which, overall, resulted in high mean yields. LS 6161R produced good yields in two seasons at Kokstad, but an uncharacteristically low yield in the 2014/15 season reduced the overall ranking of this cultivar. Short-season cultivars generally yield better in cool production areas than in warmer areas. The longer-season cultivars produced higher yields in the moderate production areas.

Recommendations

PAN 1623R, PAN 1500R and LS 6248R are recommended for cool production areas, whilst PAN 1623R, LS 6161R and LS 6164R are recommended for moderate production areas. DM 6.2iRR and PAN 1521R are also recommended for the KwaZulu-Natal Midlands.

THE EFFECTS OF GYPSUM AND LIME APPLICATION ON SOIL PROPERTIES AND GROUNDNUT YIELDS

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Introduction

Groundnut is one of the most important oilseed crops in the world. It contains 48 – 50% oil, 26-28% protein and is a rich source of dietary fiber, minerals and vitamins. Groundnut yields are dependent on soil calcium content, as it influences pod development. Both lime ($CaCo_3$) and ($CaSO_4$) gypsum contain calcium (Ca) which can increase the calcium levels when applied to the soil. The average yield of groundnut in small-scale production is less than 1.5 t/ha, much lower than yield produced on similar soils with better management of essential nutrient availability. Therefore, the study seeks to improve yields through gypsum and lime applications. KwaZulu-Natal groundnut production areas are mainly on sandy soils, which are generally low in calcium and organic matter. The use of gypsum on groundnut production by small-scale farmers is not documented. Therefore the aim of the study was to determine the effects of lime and gypsum on groundnut yields and on soil properties.

Materials and methods

The experiments were conducted at Bergville (Edukuza) and at the Dundee Research Station in the 2015/2016 growing-season. Four levels of gypsum (0, 500, 700 and 1000 kg/ha) and four levels of lime (0, 250, 500 and 750 kg/ha), however, in this season only gypsum was applied, lime was not required in soil analysis results. The experiments were laid out in a randomized complete block design with three replicates. Soil samples were taken to determine soil pH and electrical conductivity before planting and at harvest. Gypsum application intervals were at planting, flowering and pod-formation. Groundnut leaf and seed samples were taken for element analysis especially for calcium (Ca+), sodium and aluminum (Al). Data were analyzed using the analysis of variance (ANOVA) procedure in the statistical program GenStat.

Results

The initial soil pH ranged from 3.8 – 4.1 which is the lower levels required for optimum groundnut yields. In both experimental sites soil pH at harvest was highly significant. Soil pH levels were increased at 700 kg application rate of gypsum, reaching the highest mean pH of 5.67 at the Dundee Research Station and 6.92 at the Bergville experimental site. Gypsum application rates influenced the electrical conductivity (Ec) of the soil. Plots without applied gypsum had the lowest Ec of 49.22 mS/m; this, suggested that electrical conductivity increased with increasing rates of applied gypsum.

Aluminum and calcium concentrations in the leaves were significantly different between treatments, suggesting that applied gypsum affects the movement and concentration of Al and Ca^{+} in groundnut leaves. Other elements were not significantly affected by gypsum application. This indicates that gypsum only affects Al and Ca^{+} in the leaves of groundnuts, and confirms the availability and absorption of calcium by groundnut plants. Increased soil pH levels also contributed in the balance absorption of all essential elements by groundnut roots. Gypsum at 0 kg/ha and 500 kg/ha had minimum Al concentration, whereas higher rates resulted in high concentrations of Al in the leaves. Calcium percentage was significantly increased at 500 kg/ha of gypsum.

Grain yield showed no significant differences between treatments in both experimental sites. However, the data followed a trend of increasing yield with increase gypsum application rate; the highest rate of applied gypsum (700 kg) resulted in the highest yields of 1.99 and 2.97 t/ha at Dundee and Bergville respectively.

Recommendations

The application of agricultural gypsum increases soil pH and leaf calcium percentage in groundnut plants. While this study did not find significant effects of gypsum on grain yield, literature recommends the application of 200 kg of gypsum per hectare to improve yields. The response of groundnut to applied gypsum will be further investigated in the next season.

HOW CAN RESOURCE-POOR FAMERS IMPROVE PRODUCTION ON ACID AND LOW-PHOSPHORUS SOILS?

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Soil acidity and phosphorus (P) deficiency are important growth-limiting factors for many crops in KwaZulu-Natal soils. Soil acidity is prominent in the high rainfall areas of KZN, whereas P deficiency is widespread, not only in KwaZulu-Natal but throughout Africa.

This can be an overwhelming problem for food security and entrant farmers who are resource-limited. However, there is much that can be done, even on a limited budget. Advisers can: improve their knowledge of the severity of the problem through soil testing; advise the use of the most cost-effective amendments; draw attention to the effect of agronomic practices, especially weed control; and advise the growing of crop varieties that produce most effectively on infertile soils.

Numerous studies have shown that plant species and genotypes within species vary widely in their tolerance to acid saturation and low levels of soil P, although review of literature reveals a lack of recent, locally relevant information allowing for the ranking of species and varieties according to their tolerance of acid saturation and low soil P. Work that has been done on staple food crops includes studies on maize, wheat, dry beans and sorghum.

Examples of maize cultivar effects on response to soil acidity:

In their comprehensive study on the differential tolerance to soil acidity of 48 maize cultivars in South Africa, Mendes *et al*. (1985) reported significant yield differences between the cultivars in the absence of lime, ranging from over 90% to less than 10% yield (relative to yield in limed soils). Similarly, The *et al*. (2006) tested the responses of an acid-tolerant and an acid-susceptible maize cultivar on an acid soil in Cameroon. They found that the yield advantage of the acid tolerant cultivar was evident even after correcting for soil acidity. They concluded that the integration of soil amendments (lime, P and organic fertilisers) together with the use of acid soil-tolerant cultivars offered a solution for the management of acid soils in the tropics.

Examples of maize cultivar effects on response to P deficiency:

Differences in cultivar response to applied P may be due to a) variation between cultivars in terms of internal P requirement, and/or b) differences in P uptake efficiency. Improved P uptake may be due to the exudation of particular chemicals by roots or differences in root architecture (e.g. Nielson and Barber, 1978; Krasilnikoff *et al*., 2003). Liu *et al*. (2004) compared the tolerance to a low P soil of two maize genotypes, which had been previously identified with contrasting P efficiency (measured by grain yield). They concluded that efficient use of P by the P-efficient cultivar was related to its large root system, greater ability to acidify the rhizosphere, and positive response of acid phosphatase production and excretion to low P conditions. Wasonga *et al.* (2008) investigated varietal effects on P utilisation efficiency of maize grown on different soil types in Kenya. They found that the internal P requirements varied with both maize variety and experimental site (soil type). They attributed the varietal effect to sensitivity to Al saturation. Varieties more sensitive to Al saturation experienced decreased root growth, lower yield potential and thus a decreased requirement for P uptake.

Much of this work was, however, done on varieties that are either outdated or are not suited for conditions in KwaZulu-Natal. We have initiated field trials to assess varieties of dryland crops used locally; we thereby hope to assist resource-poor farmers in their decisions regarding food crop choices for low-fertility soils.

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THE BEST MANGO CULTIVARS FOR KWAZULU-NATAL

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Introduction

Mango *(Mangifera indica L)* is widely grown in tropical and subtropical region of the world. It is reported to be one of the top five fruit crops in terms of global production. Mango yield are generally poor ranging from 4 to 9 tonnes ha[1]. This variation is partly due to wide tree spacing's, population and orchard management. Currently mango farmers in the Makhathini area grow mangoes with spacing of 10 m x 10 m (100 trees/ha) under dry-land conditions with a subsequently low yield and return ha[1]. There is little information for small-scale farmer's o recommendations for mango cultivars suitable for dry-land and irrigation conditions. This study aimed to evaluate mango cultivars for production performance under irrigation and dry-land conditions in Makhathini area.

Materials and methods

Nine commercial cultivars and two landrace cultivars were planted at Makhathini Research Station in 1997 to be evaluated for adaptation and yield performance. The trees were planted at a standard high density spacing of 6 m x 3 m (555 trees/ha) under irrigation and dry-land conditions. The following parameters were measured: field weight, average number of fruit per tree, average yield per tree and yield per hectare for each cultivar.

Results

Table 1: Showing yield performance results from irrigated block

Cultivar	2014	2014	2015	2015
	Field weight in kg/ plot	Estimate yield in tonnes/ha	Field weight in kg/plot	estimated yield in tonnes/ha
Keitt	75.5	25.10	46.67 c	15.22
Nedica	72.9	24.30	40.30 bc	13.33
Kensington	64.17	21.3	33.10 b	11.03
Tommy Artkins	60.90	20.3	34.87 b	11.26
Joa	55.93	18.64	40.00 bc	13.33
Shene	54.40	18.13	40.43 bc	13.48
Kent	44.65	14.9	40.87 bc	11.25

Table 2: Showing yield performance results from dry-land block

Cultivar	2014	2014	2015	2015
	Field weight in kg/ plot	Estimate yield in tonnes/ha	Field weight in kg/plot	estimated yield in tonnes/ha
Keitt	15.50 bcd	5.16	20.30 abcd	6.76
Nedica	13.84 abcd	4.61	26.30 d	8.76
Kensington	11.86 abc	3.95	23.20	7.73
Tommy Artkins	15.80 bcd	5.05	22.37 bcd	7.46
Joa	17.77 bcd	5.16	16.57	5.50
Shene	20.83 d	6.53	16.43	5.48
Kent	19.31 cd	6.13	14.57 a	5.53

The observed result showed significant differences in yield performance between cultivars and sharp decline in yield per tree as tree age increased. Drought effects also influenced the yield significantly during the past two years. Yield were considerable higher under irrigation compared to dry-land, this was expected due to moisture effects under dry-land. The cultivar Keitt out-performed, followed by Neldica and Kensington under irrigation whilst other cultivars shows significant difference in production performances.

Discussion

During 2014 to 2016, drought occurrence resulted in decline in yield per cultivar, both under irrigation and dryland conditions. Most cultivars that perform satisfactory over years was affected. This inconsistent yield performance can be occulated to alternate fruit bearing which affects all fruit bearing trees, this natural occurrences can be managed by spraying trees during dormancy period with 5% KCL.

Recommendations

Based on the observed result, Keitt, Neldica, Kensington and Tommy Artkins can be recommended for Makhathini Area. 555 plant per hector gives good result under good management, but intra-row spacing of 3 m is not enough and farmers can be advised to use 4 m instead of 3 m. Irrigation or moisture supplementation is suggested during critical growth stages such as flowering and bearing stages under dry land condition to avoid flower and fruit drop. The best time to supplement your moisture under dry-land conditions is from July to November.

DRY BEAN CULTIVARS FOR KWAZULU-NATAL THROUGH CULTIVAR EVALUATION TRIALS

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Introduction

A national dry bean cultivar trial is conducted annually to evaluate commercially available and new cultivars for a) adaptation to a variety of environmental conditions, e.g. yield and disease resistance, and (b) acceptability for canning, packaging and export purposes. The cultivars need to be evaluated over a number of seasons to provide reliable information on their adaptability to different production areas.

Materials and methods

Cultivar evaluation trials were conducted at Kokstad (cool production area) and at Cedara and Loskop (moderate production areas) under dry-land conditions. The trials at Kokstad and Loskop were conducted during the 2013/14, 2014/15 and 2015/16 growing-seasons, whilst at Cedara the trials were conducted during the 2012/13, 2014/15 and 2015/16 seasons. At Cedara and Loskop fungicides were applied fortnightly from flowering to control leaf diseases. No fungicides were applied at Kokstad due to a low disease pressure. An unsprayed trial was also conducted at Cedara to determine disease tolerance. Fertilizer was applied to obtain a 3 t/ha yield. The number of cultivars evaluated each season ranged from 22 to 30. The seed was hand-planted at a seeding rate of 180 000 seeds/ha in rows spaced 0.75 m apart. Weeds and insects were controlled throughout the season.

Results

The climatic conditions experienced at Kokstad and Loskop were more variable between the seasons than at Cedara. The mean yields obtained for all the cultivars evaluated over the past three seasons at Kokstad, Cedara and Loskop were 2.47 t/ha, 3.14 t/ha and 2.68 t/ha, respectively. The yields of the top ten highest producing cultivars at each site are presented in Table 1. A mean yield reduction of 28% was obtained when no fungicides were applied at Cedara.

TABLE 1 Mean yields of the highest producing cultivars at each locality

KOKSTAD		CEDARA		LOSKOP	
Cultivar	**(t/ha)**	**Cultivar**	**(t/ha)**	**Cultivar**	**(t/ha)**
		Small white bean			
TEEBUS RR1	2.62	TEEBUS RR1	3.33	SW 1	3.34
SW 1	2.56	PAN 123	3.18	TEEBUS RR1	2.94
PAN 123	2.44			PAN 123	2.83
		Red speckled sugar bean			
KAMIESBERG	3.15	SEDERBERG	3.59	TYGERBERG	3.07
RS 5	2.79	DBS 840	3.50	PAN 9216	2.86
DBS 310	2.77	OPS-RS4	3.49	RS 6	2.84
WERNA	2.73	TYGERBERG	3.48	SEDERBERG	2.82
DBS 840	2.59	PAN 9213	3.47	PAN 9213	2.82
DBS 830	2.59	RS 6	3.47	KRANSKOP HR1	2.76
PAN 148	2.57	RS 5	3.44	KAMIESBERG	2.75
OPS-RS4	2.51	DBS 830	3.43	PAN 9292	2.73
RS 7	2.51	PAN 9292	3.33	RS 7	2.72
SEDERBERG	2.50	PAN 148	3.30	RS 5	2.71

Discussion

Teebus RR1 yielded better at Kokstad than SW 1, which preferred the warmer conditions experienced at Loskop. SW 1 was only evaluated at Cedara during two seasons and the yields were comparable with Teebus RR1. Both cultivars are suitable for canning purposes. Kamiesberg, DBS 310 and Werna yielded better under the cool Kokstad conditions than at Cedara and Loskop, where Sederberg, Tygerberg, RS 6 and PAN 9213 yielded well. RS 5 gave acceptable yields at all three sites. DBS 840 and DBS 830 responded better to the climatic conditions at Kokstad and Cedara than at Loskop.

Recommendations

Fungicides must be applied from flowering for all the cultivars planted in the moderate production areas. The small white cultivars, Teebus RR1 and SW 1, are recommended for all three areas. Kamiesberg, RS 5, DBS 310 and Werna are recommended for the cool production areas. Sederberg, Tygerberg RS 6 and PAN 9213 are recommended for the moderate production areas.

COMPARISON OF FUNGICIDE SPRAY FREQUENCY AND INTERVALS UNDER SIMULATED INOCULUM PRESSURE ON MAIZE YIELD AND GREY LEAF SPOT

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Introduction

Few diseases of major crops have risen from relative obscurity to general recognition as a threat to economical production as suddenly as gray leaf spot (GLS) of maize (*Zea mays* L.). Gray leaf spot was first reported in Illinois (United States of America) by Tehon and Daniels (1925). This disease is caused by *Cercospora zeina* and has become the most important foliar disease of maize worldwide. In South Africa yield reductions range from 29% to 65% depending on the hybrid susceptibly to *C. zeina*. Currently the KwaZulu-Natal Department of Agriculture and Rural Development recommends that spraying fungicide should commence when disease is evident on the lower five leaves (2-3% disease) and further spray applications may be necessary to provide control until the crop is physiologically mature. This has been considered sufficient for disease control as it gives a period of control lasting from 29-32 days, with two to three sprays required during the season. However, it has been noted that farmers have shifted away from disease resistant cultivars to higher yielding susceptible cultivars. These susceptible cultivars rely on the producer to provide protection against disease and this requires greater inputs. Input costs are covered by the higher yield obtained and therefore many producers have switched to these high-performance hybrids in search of higher yields and increased profit margins. The objectives of this project are to determine the optimum fungicide application time for disease control on susceptible and resistant cultivars, assess the economic benefits of well-timed preventive fungicide spray applications, and determine the best spray timing intervals for resistant and susceptible maize cultivars and to determine the effect of differing inoculum levels on diseased epidemics.

Materials and Methods

The effect of timing and frequency of fungicide treatments for the management and control of grey leaf spot was quantified. Resistant and susceptible maize cultivars were hand-planted in a split plot design with three replications. The inoculum level was the main plot with cultivars and spray timing as sub plots. The fungicide (Azoxystrobin) was applied at 21 and 30 day intervals. The timing of fungicide application commenced at the different leaf stages: V3, V5, V8 and V12.

Results and Discussion

Control of grey leaf spot was effective when the fungicides was applied at the early leaf stages and at a spray interval of 21 days. The highest grain yield was achieved with fungicides spray treatments applied at the early leaf growth stage. The fungicide application timing significantly affected disease severity and maize yield. Resistant and susceptible cultivars inoculated with a spore suspension of 2 x 10^6 spores/ml showed higher disease severity and a decrease in yield compared to the non-inoculated cultivars, which had lower disease and a higher yield.

Recommendations

Early application of fungicide at the V3 to V5 leaf stage is essential and spray intervals should be at 21 days and not 30.

LAND MANAGEMENT AND SOIL MICROORGANISMS

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Land management practices (LMP) for soil conservation in agricultural systems are essential for sustainable productivity of these systems. LMP have an impact on the physical, chemical and biological properties of cultivated soils. In terms of the impact on soil biology, these practices not only influence the population densities of beneficial microflora and fauna but also those of soil borne pathogens. The effects of different LMP on soil borne pathogens are important to understand to enable the implementation of effective soil and crop management systems that are suppressive to these soil borne pathogens and their root diseases. In this review we focus on the impacts of tillage and organic and inorganic sources of nitrogen (N) on microbial diversity and soil borne pathogens.

Conventional tillage practices incorporate crop residues from the surface into deeper layers of the soil, in this way burying associated plant pathogens where they cause less or no disease. However, tillage practices can also indirectly spread plant pathogens, while implements can widely disperse some forms of pathogen inoculum (Ogle and Dale, 1997). Conservation tillage systems are reported to increase microbial biomass, functional diversity (especially that of profitable bacterial species), as well as enzyme activity. These increases seem to occur due to the presence of the mulch and minimal soil disturbances, which enhance favourable conditions for microbial activity in the rhizosphere (Correa-Galeote *et al*., 2016; Wang *et al*., 2016). However, no-tillage practices also allow certain fungal pathogens to increase inoculum to damaging levels, potentially infecting crops in the next season.

The application of green manure (incorporation of crop residues into the soil), animal manure and other organic materials are cultural practices that are recommended to decrease the incidence of disease caused by soil borne pathogens. One proposed mechanism for the enhancement of the suppressive capacity of organic amendments is the improved biomass, diversity and activities of antagonistic microbes resulting in increased competition against pathogens for resources. While manures generally enhance functional diversity in soils (measured using the Shannon diversity index), a combination of organic and inorganic fertilisers seems to yield the best results (Diallo-Diagne *et al*., 2016).

The form of nitrogen supplied to the plant and pathogen is an important factor influencing disease severity or resistance and this can be manipulated based on the choice of crop residue applied (Huber and Watson, 1974). In general, increasing nitrogen application rates creates a shift in the microbial communal balance from bacterial to fungal dominated communities with increasing soil acidity (Jian-Gang *et al*., 2016). However, this physiological pattern cannot be applied to all fungal species. For example, G*aeumannomyces graminis*, responsible for take-all disease on wheat, requires alkaline conditions to survive and residues that create an accumulation of the ammoniacal form of nitrogen as opposed to the nitrate form inhibits the growth of this pathogen (Bockus and Shroyer, 1998). Organic amendments can also exacerbate disease severity by providing a suitable substrate for saprophytic growth or by releasing phytotoxic compounds that could damage plant roots and predispose them to pathogen attack (Bonanomi *et al*., 2007).

Crop rotation, cover crops and intra-cropping are some of the oldest and most widespread cultural practices that increase functional diversity and biomass of beneficial organisms and control soil borne diseases (Florence, 2016). Avoiding disease build-up by rotation with a non-susceptible crop, thereby reducing pathogen levels, can break this cycle. The beneficial effects of allelopathy observed in cereals in rotation with *Brassica* crops are most likely derived from the release of fungicidal compounds, isothiocyanates, known to suppress fungal growth. Isothiocyanates have been reported to cause death in several fungal root pathogens of cereals (Bailey and Lazarovits, 2003). Pathogen control using crop rotation may also be achieved by employing intervals between susceptible crops that are longer than the known survival period of pathogens. Rotations are most effective in controlling pathogens that only survive in the presence of a specific host or its residues. They are less likely to be effective in controlling damping-off and root-rot fungi such as *Pythium* and *Fusarium* spp., which can survive for prolonged periods in the soil as saprophytes (Ogle and Dale, 1997).

The use of environmentally benign practices in controlling soil borne plant pathogens and stimulating microbial diversity may be promising and the introduction of these practices in an integrated pest management program could also aid in maintaining soil organic matter, thereby improving soil quality.

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THE RESPONSE OF DRY BEAN CULTIVAR ON DIFFERENT PLANTING DATES UNDER CLIMATIC CONDITIONS OF MAPHUMULO DISTRICT

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Introduction

Dry bean (*Phaseolus vulgaris)* is an important legume that contains high levels of protein and adequate levels of vitamins and minerals. The trial was planted at Emambedwini in the Maphumulo district which is in the coastal region of KwaZulu-Natal. In this area planting dates for dry beans are spread over a period of time from spring to summer. Therefore, it is essential to identify the ideal planting date for this area.

Materials and methods

The trial was laid out in a randomised complete block design with three replicates. The trial consisted of four planting dates: Mid-November, Mid-December, Mid-January and Mid-February in 2013/14, 2014/15 and 2015/16 seasons. Four dry bean cultivars were planted namely PAN 116, PAN 148, Gudra, Ukulinga. Farmers own seed Ijuba which is a small greyish haricot bean was used in the 2014/15 & 2015/16 seasons, due to the discontinuation of PAN 116 which was originally planned for the trial.

Fertilizer was applied for an optimum yield based on soil analysis conducted by Soil Analytical Services at Cedara. At planting a row spacing of 75 cm and an intra- row spacing of 7.5 cm was used, giving a plant population of 177 000 plants per hectare. A fungicide spray program using Punch C alternated with Score was applied at two weeks intervals from flowering to control leaf diseases. The problem pests were boll - worms and locusts which were controlled with the use of an insecticide called Kemprin. Weeding was done by the farmers from an early stage.

Results

During the 2015/16 season, low rainfall and extremely hot temperatures were experienced. Consequently, there were no yields recorded for December and January planting dates (Table 1).

Table 1: Yield of the four cultivars at the four planting dates

Season	Planting Date	PAN 116	GUDRA	PAN 148	UKULINGA	MEAN
2013/14	November	1.263	1.197	1.204	1.204	**1.2168 b**
	December	0.805	0.668	0.819	0.819	**0.7776 a**
	January	0.737	0.323	0.58	0.55	**0.5475 a**
	February	0.523	0.54	0.69	0.72	**0.6183 a**
	MEAN	**0.8321 a**	**0.6819 a**	**0.8231 a**	**0.8231 a**	
Season	**Planting Date**	**IJUBA**	**GUDRA**	**PAN 148**	**UKULINGA**	**MEAN**
2014/15	November	1.27	1.01	1.18	1.097	**1.1392 c**
	December	1	0.553	2.043	0.873	**1.1175 c**
	January	0.97	0.627	0.383	0.927	**0.7267 b**
	February	0.644	0.343	0.529	0.129	**0.4117 a**
	MEAN	**0.9711 b**	**0.6333 a**	**1.0340 b**	**0.7565 a**	
Season	**Planting Date**	**IJUBA**	**GUDRA**	**PAN 148**	**UKULINGA**	**MEAN**
2015/16	November	1.420	1.047	0.907	0.373	*
	December	*	*	*	*	*
	January	*	*	*	*	*
	February	0.517	0.373	0.700	0.373	*
	MEAN	**0.9683 b**	**0.7100 b**	**0.8033 b**	**0.3733 a**	

Discussion

The dry bean yields from the mid-November plantings were significantly different from the other planting dates in both 2013/14 and 2014/15 seasons, with one exception in the 2014/15 season where mid-November yields were not different from the mid-December yields. Mid-February yields in 2014/15 season were significantly lower than the yields from all other planting dates. There were no significant differences between the yields from all four dry bean cultivars in the 2013/14 season. In the 2014/15 season, Ijuba and PAN 148 gave comparable yields and their yields were significantly different from the yields of the other two cultivars (Gudra & Ukulinga).

Recommendations

It is recommended that the planting dates for optimum dry bean yields in Maphumulo are from mid - November to mid - December. The recommended cultivars are PAN 148 and Ijuba.

VALUE ADDING TO PROCESSED PEACH PRODUCT- CASE STUDY OF IMPENDLE

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Abstract: The aim was to investigate the relationship between relative humidity (RH) and ambient temperature (T) to assess whether the KwaZulu-Natal Midlands mist belt is suitable for solar drying of food as most food crops are harvested but unfortunately lost by those lacking proper storage and processing facilities. Tunnel dryer data and ambient day and night relative humidity and temperatures were collected. The daily ambient temperature averaged at 25 °C and tunnel temperature remained below 45°C during the day. High ambient RH (70%) and tunnel humidity (above 40%) during the day, reaching 90% and 80% respectively at night, in year one (2014/2015 December – February) suggested that drying was not possible. Different results were obtained in year two (2015/2016 December – February) as drying experiments were all succesful, when the peach leather and dried slices were processed and dried.

Introduction

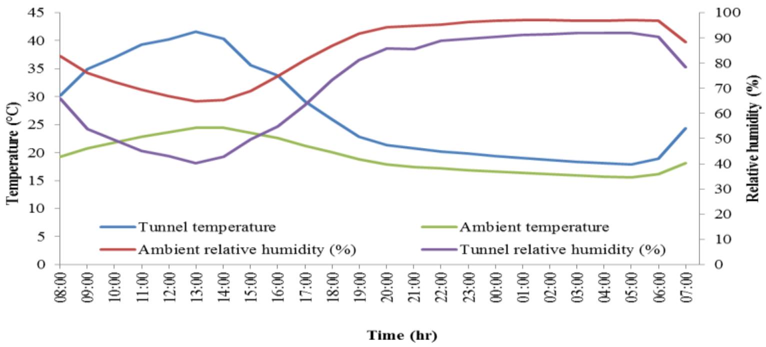
Horticultural postharvest food losses in developing countries are major problems that can be addressed by value adding techniques. Food drying is one of a number of methods of value adding that can be used. Valipour (2014) stated that the most important weather parameters are relative humidity, temperature and wind speed for evapotranspiration models. Banout *et al.*, (2011) reported that, in artificial solar food drying with improved dried product quality as opposed to open sun drying air velocity, temperature (Jain and Tiwari, 2004) mass transfer, evaporation of water and a requirement of high heat energy during evaporation are some of the drying condition requirements that play an important role in ensuring that the product is dried effectively. Clearly, in order for the product to be dried, the ambient relative humidity, which is weather dependant, must be lower than the moisture content of the product to be dried in a tunnel using solar energy.

Materials and Methods

Tunnel (of 432 m^3 volume) temperature and RH were determined using four HOBOs Pro v2 onset installed and located at various positions in a tunnel according to Nishizaki and Carrington (2014). Ambient temperature and RH were measured using a Campbell Scientific CR10 Data Logger according to Gush (2008) at a weather station located on Cedara Research Station in KwaZulu-Natal, South Africa.

Results and Discussion

The variation of ambient temperature from 08:00 AM to 19:00 PM affects the tunnel temperature (Fig. 1). The increasing ambient temperature results in an increase in the tunnel temperature. A similar relationship is observed from 20:00 PM to 07:00 AM, whereby ambient temperature decreases and is followed by a decrease in tunnel temperature.



At about 05:00 AM, the ambient temperature starts to increase, with a subsequent increase in tunnel temperature. The ambient and tunnel RH also appeared to be dependent on ambient temperature. The increasing ambient temperature causes a decrease in ambient RH accompanied by a sharp decrease in the tunnel RH. In addition, the ambient RH was always higher than the tunnel RH.

Recommendations

The first year of drying coincided with heavy rains, however, the recent dry spells have shown that drying is one of the postharvest possibilities that can be used for food preservation. That is based on a repeat of the same experiment for similar periods. Further information is available at the above details.

THE SEEDING RATE OF MAIZE FOR OPTIMUM YIELD IN KWAZULU-NATAL

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Introduction

For the high-potential KwaZulu-Natal Mist Belt areas, seeding rates between 60 000 and 70 000 seeds/ha are recommended for ultra-early maturing maize (*Zea mays*) cultivars and between 40 000 and 45 000 seeds/ha for later maturing cultivars. A research project was implemented to determine if higher seeding rates would result in greater yields by cultivars with a range of growing-season lengths.

Materials and methods

Three ultra-early (UE), one early (E), two medium-early (ME) and three medium (M) maturing maize cultivars were hand-planted into a no-till land at seeding rates of 40 000, 60 000, 80 000 and 100 000 seeds/ha at the Cedara Research Station on 3 November 2014 and 10 November 2015. The inter-row spacing was 0.76 m. Fertilizer was applied for a 10 t/ha yield based on recommendations from a soil analysis. Agro-chemicals were applied to control weeds, insects and diseases.

Results

In the 2014/15 season, two severe hailstorms during the vegetative growth stages reduced the plant stand by 3.9% up to 21.7% as seeding rate increased. The plant stands of DKC 61-94BR (UE) and LG 3607Y (UE), were reduced by 24.7% and 19.7%, respectively, which resulted in significantly low yields (4.5 t/ha and 5.8 t/ha, respectively). Plant height, cob height and the number of cobs/plant were significantly lower in the 2014/15 season, but 100-kernel mass and grain mass/cob were significantly higher. Two hailstorms during the reproductive growth stages in the 2015/16 season caused 35.5% lodging. Minimal lodging occurred in the 2014/15 season. The total rainfall received from pollination onwards was fairly similar in both seasons. However, the temperatures were considerably warmer in the 2015/16 season, and all the cultivars, apart from DKC 61-94BR (UE) and LG 3607Y (UE), produced lower yields. Nevertheless, no significant difference in mean yield was measured between the two seasons (7.47 and 7.37 t/ha, respectively).

Plant height was significantly shorter at 100 000 seeds/ha than at the other seeding rates, whilst cob height and percentage lodged plants increased significantly as seeding rate increased from 40 000 to 80 000 seeds/ha. Significantly more *diplodia* infected cobs were observed at 40 000 seeds/ha than at the higher seeding rates in the 2015/16 season. The number of cobs/plant, grain mass/cob and 100-kernel mass decreased significantly with increasing seeding rate. No significant interaction was measured for yield between the cultivars and seeding rates in both seasons. In the 2014/15 season yield was significantly higher at 80 000 seeds/ha than at the other seeding rates, whilst in the 2015/16 season and overall, no significant difference in yield was measured between 60 000 and 80 000 seeds/ha. Yield was significantly lower at 40 000 seeds/ha in both seasons.

Mean cob height, percentage lodged plants, grain moisture percentage at harvest and yield were considerably lower for the ultra-early cultivars than for the other cultivars. However, the yields of DKC 61-94BR (UE) (7.8 t/ha) and LG 3607Y (UE) (7.6 t/ha) in the 2015/16 season were not significantly lower than the yield of the highest producer, PAN 4A-111(E) (8.1 t/ha). Overall, DKC 73-74BR (M) produced the highest mean yield (8.5 t/ha), which was not significantly higher than the mean yields of PAN 4A-111 (E) (8.2 t/ha) and DKC 71-44B (M-E) (8.1 t/ha).

Discussion

In the 2014/15 season, the desired plant populations were not obtained at the higher seeding rates. In the 2015/16 season the ultra-early maturing cultivars did not produce significantly higher yields at seeding rates above those generally recommended (60 000 to 70 000 seeds/ha). Interestingly, in both seasons the later maturing cultivars produced significantly higher yields at seeding rates above those usually recommended (40 000 to 45 000 seeds/ha). The trial will be repeated in the 2016/17 season to confirm the results obtained.

Recommendations

All the evaluated cultivars can be planted at 60 000 seeds/ha in the high-potential areas of the KwaZulu-Natal Mist Belt. PAN 4A-111, DKC 71-44B and DKC 73-74BR are recommended as suitable early, medium-early and medium maturing cultivars. No reliable recommendation can be given for an ultra-early cultivar at this stage.

SWEET POTATO VINE MULTIPLICATION IN KWAZULU-NATAL

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Introduction

In 2014, Vitamin A Deficiency (VAD) prevalence was estimated at 42 per cent among children under five in Africa, which represents approximately 78 million affected children. It is also particularly severe among pregnant and/or lactating women. The deficiency increases children's vulnerability to common illnesses and impairs growth, development, vision, and immune systems. In severe cases, it results in blindness and death. Up to 500,000 preschool children go blind from VAD every year in Africa, and two-thirds die within a month of being blind. VAD also increases the risk of dying during pregnancy and the likelihood of giving birth to low weight babies and is believed to facilitate the spread of HIV/AIDS.

Humans produce Vitamin A when there is sufficient beta-carotene in their bodies. Most people cannot afford expensive Vitamin A rich foods—fish oils, liver, milk, eggs and butter—that contain retinol (Vitamin A) that the body can use directly when it doesn't produce its own. Supported by the World Health Organization and UNICEF, African governments have responded by distributing vitamin capsules and fortifying food. These efforts have had little effect on the prevalence of VAD, possibly because poor rural families cannot access facilities where supplements and food are distributed. The biotechnology industry has been promoting genetically modified crops, such as rice and banana, to synthesize Vitamin A. However, none of these genetically modified crops is yet commercialized. Furthermore, there are significant biosafety, socioeconomic and regulatory issues with biotechnological solutions. Other approaches are safer, cheaper, and more appropriate, especially those rooted in diet diversification.

Materials and methods

The aim of this project is to ensure that every household has beta carotene from orange fresh sweet potato and specific objectives include:

- Establish sweet potato nursery for pilot project
- To multiply sweet potatoes planting material for distribution to farmers
- To establish demonstration trial at different localities
- Conduct presentation and provide awareness of malnutrition of vitamin A
- To promote planting of orange flesh sweet potato through famers days and training

Results

The following quantities of sweet potato vines were distributed during the 2015 planting season.

Table 1 Quantities of sweet potato vines of four cultivars distributed from Makhathini Research Station in 2015

Cultivar	Number of vines
A 40	105 000
A 45	117 000
1990.62.1	51 000
Beauregard	6 000
Total	**279 000**

Discussion

Distribution of vines to farmers is on-going and farmers are planting more of the white-fleshed cultivar A40 and selling them at informal markets, the two orange fleshed cultivars, 1990.62.1 and A45 are also receiving good acceptance. The value adding section has made a great contribution in the training of farmers about the importance of beta carotene vitamin A in the food dishes, as well processing of sweet potato to various products.

In the 2015 season a total of 279 000 vines were distributed which equates to a total of over seven hectares of crop or over 400 tonnes of sweet potatoes. This would have a conservative value of over two million rand at a retail price of five rand a kilogram. Furthermore the distributed vines could be multiplied and distributed further making an even bigger impact.

Recommendations

The multiplication and distribution of sweet potato vines as planting material has been shown to have a significant impact on rural communities. The orange fleshed cultivars are an excellent source of beta carotene which can alleviate vitamin A deficiency. This programme should continue and should be supported with the establishment of tissue culture facilities in order to maintain virus-free nursery plants.

THE INFLUENCE OF DIFFERENT WEED TYPES ON THE GROWTH OF MAIZE

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Introduction

One of the key factors to obtain good yields is adequate weed control. If weeds are allowed to grow with the crop, a portion of the growth resources will be used by them, causing a reduction in growth and subsequent yield loss. The weed spectrum usually consists of various annual and perennial, broadleaf and grass weed species depending on the production history of the field. Certain weeds will be dominant and it is assumed that they have the biggest influence on crop growth. The weed management strategy must therefore focus on reducing their influence on crop growth. If the influence of the different weed species on maize and sunflower production can be established, a weed management strategy can be formulated, targeting those weed species that have the greatest influence during the critical growth stages of the crop.

Materials and methods

A field experiment was carried out from 2010 to 2015 at the Cedara Research Centre using conventional tillage. Five weed treatments were applied in order to achieve the objectives. In three of the treatments only broadleaf weeds, grass and sedges were grown, while the fourth consisted of a mixture of naturally-occurring weeds. In the control treatment, no weed growth was permitted. To obtain the same weed species in a treatment, registered herbicides were applied to omit other weed types required for each treatment. Maize planting lines were drawn with a no-till planter and the fertilizer was applied with the planter 0.05 m to the side and below the seed. Maize was hand-seeded at 53 333 seeds ha^{-1}. The date of final emergence was the last day emergence was measured and expressed as the percentage of seeds planted. Each plot was divided into four quarters to record the accruement of maize seedling dry weight after maize emergence. At about 21 days after emergence (DAE), 21 maize seedlings in the first quarter of each plot were cut above the soil surface and their dry weights recorded. This was repeated in the second and third plot quarters, at about

28 and 35 DAE. Weed growth was only visually assessed in the same plot quarters used for the maize measurements. Harvesting was done by hand and yield was determined at 14% moisture content.

Results

Despite the differences in climatic conditions from planting to final emergence, different planting dates and cultivars used, final emergence for the treatments was similar across the six seasons. Overall, despite differences in climatic conditions, planting date and weed quantities, maize seedling dry mass at 21 DAE for the different treatments was similar. From 28 DAE onwards, seedling dry mass was higher in the control and broadleaf treatment compared to the grass, sedges and mixture treatments. Overall, the grass, sedges and mixture treatment had significantly more weeds present compared to the broadleaf treatment. Overall, maize yields were significantly higher in the control treatment with the lowest yield obtained in the mixture treatment. Despite the differences in weed growth, no significant differences in yield were measured amongst the broadleaf, grass and sedge treatments.

Conclusions

Maize seedling growth at 21 DAE was not affected by the different weed treatments despite the quantity and species of weeds present in each plot. From 28 DAE, differences in maize seedling dry mass were becoming evident. The reduction in seedling growth in the weed treatments compared to the control did translate into significant yield reductions. Results from this experiment indicate that it is essential that weeds are controlled from 28 DAE. Herbicide applications must control both broadleaf and grass weeds as it is seldom that only one species will dominate.

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RESEARCH PROJECTS APPROVED IN 2016

Researcher	Short title	Location	Period
K Mbotho	Maize planting date trial	Cedara	2016-2020
N Mtumtum	Response of indigenous watermelon (*citrullus lanatus*) to nitrogen (n) treatments, applied either as inorganic fertilizer or as manure	Kokstad	2016-2018
NN Manyoni	Weed management strategies for pumpkin (*curcurbita maxima*)	Cedara	2016-2017
NSH Gumede	Management of nematodes and scab on potatoes	Dundee	2016-2020
P Ndayi	The effects of irrigation frequency on growth and yield of selected potato cultivars	Cedara	2016-2017
S Ngcobo	The effects of nitrogen levels and cutting length on the yield and taste of two sweet potato cultivars (A40 & 199062.1)	Bergville, Potshini	2016-2019
SB Madiba	A survey of equipment availability among small-scale farmers	Creighton, Hlanganani	2016-2017
SC Zulu	Effect of bark and grass mulch on tomato (*lycopersicon esculentum mill*.) growth, yield and post-harvest quality	Cedara	2016-2018
SG Zuma	Effect of phosphorus fertiliser application on growth and yield of bambara groundnuts (*vigna subterranea L. Verdc*) landraces under rainfed conditions	Cedara, Makhathini	2016-2018

ONGOING RESEARCH AND DEMONSTRATIONS PROJECTS IN 2016

Researcher	Short Title	Location	Period
MF Msomi	Plant Introductions (Block A)	Empangeni	2013-2017
AJ Arathoon	Effect of seeding rate on maize production	Cedara, Kokstad, Dundee	2014-2017
N Mtumtum	Integrations of soybean (Glycine max (L) Merrill) into small-holder maize production system in KwaZulu-Natal	Cedara	2014-2017
SB Radebe	The effect of gypsum and lime application on soil properties and groundnut yields	Bergville	2015-2018
N Mtumtum	Effect of intercropping with a forage legume on maize forage yield and quality	Kokstad	2015-2018
SG Gumede	The response of three grain sorghum cultivars to chemical, bird netting and control treatments	Makhathini & Dundee	2016-2019
LS Zulu	The effect of added nitrogen through a legume-maize rotation on maize yields		2015-2020
N Mtumtum	Evaluation of quinoa (*Chenopodium quinoa, Willd*) as alternative crop for food security and proverty alleviation in KwaZulu-Natal	Kokstad, Makhathini, Dundee	2016-2019
SG Zuma	Effect of phosphorus fertiliser application on growth and yield of bambara groundnuts (*Vigna subterranea L. Verdc*) landraces under rainfed conditions	Cedara, Makhathini	2016-2018
N Mtumtum	Response of indigenous watermelon (*Citrullus lanatus*) to nitrogen (N) treatments, applied either as inorganic fertilizer or as manure	Kokstad	2016-2018
TE Ntombela & MP Sikhakhane	National dry bean cultivar trial	Cedara, Kokstad Dundee, Loskop, Makhathini	- 2020

M Naidoo	Elite potato cultivar trial	Cedara	- 2020
SG Zuma	Long season maize cultivar trial	Kokstad, Loskop, Dundee	- 2020
N Mtumtum	Maize Silage cultivar evaluation Trial	Kokstad	2009-2013
M Naidoo	Potato Production Demonstrations	Umthentweni, Harding, Ixopo	2009-2015
AJ Arathoon	National soybean cultivar trial	Cedara, Kokstad, Dundee	- 2020
AJ Arathoon	Influence of different phosphorus and potassium rates on the production of three vegetable soybean cultivars	Cedara	2012-2015
AJ Arathoon	Vegetable soybean cultivar versus seeding rate trial	Cedara	2012-2014
SR Bezuidenhout	The management of cover crop residues to reduce weed growth in maize	Cedara	2011-2015
M Khanyile	Indigenous knowledge on fish harvesting and utilization in the Umhlabuyalingana District Municipality (KZN)	Umhlabuyalingana Local Municipality	2014-2015
DI Nash	A survey on the energy status of newly calved cows at Cedara Dairy	Cedara	2015-2017
J Mann	DEMO: The grazing of beef breeding cows on kikuyu for 12 months of the year	Cedara	1989-ongoing
PA Oosthuizen	An investigation into the effect of different breeding strategies on an Nguni herd’s performance	Dundee	2008-2020
M Magawana	The effect of night time kraaling on cow productivity and fertility of cattle at Kokstad Research Station	Kokstad	2008-2011
S Ngcamu	The effect of different management / breeding strategies has on Nguni performance	Bartlow Combine	2012-2022
PA Oosthuizen	Small scale dairying in an integrated farming system	Dundee	2003-2020

DI Nash	The effect of accelerated calf rearing and managing of Friesland dairy heifers on future milk production potential	Nottingham Road	2014-2019
M Magawana	Establish the effect of having an unrestricted breeding season on animal fertility and productivity in a system with no fencing vs a restricted breeding season	Kokstad	2008-2015
PA Oosthuizen	Genetic conservation and characterization of indigenous sheep	Dundee	2007-2020
E van Zyl	Investigate the potential of Sericea lespedeza as summer grazing for sheep and establish production norms for NW KZN	Dundee	2010-2015
SC Moodley	Use of Essential Oils on the control of Agricultural Pathogens	Cedara, KZN	2009-2015
SC Moodley	Establishment and maintenance of an essential oil trial for demonstration purposes	Cedara	2007-2020
A Nunkumar	Evaluation of soybean, dry bean and sunflower cultivars for tolerance to different strains of *Sclerotinia sclertiorum*	Cedara	2014-2016
SR Bezuidenhout	Different weed control methods to reduce *Ipomoea purpurea* (common morning glory) emergence and growth	Cedara	2015-2022
A Nunkumar	Studies on *Pyricularia grisea* the casual organism of Grey Leaf Spot on Ryegrass	Cedara	2016-2021
NSH Gumede	Management of Northern corn leaf blight on green mealies using planting time and crop rotation	Makhathini	2016-2021
K Mbotho	Maize planting date trial	Cedara	2016-2020

NN Manyoni	Weed management strategies for pumpkin (*Curcurbita maxima*)	Cedara	2016-2017
NSH Gumede	Management of nematodes and scab on potatoes	Dundee	2016-2020
P Ndayi	The effects of irrigation frequency on growth and yield of selected potato cultivars	Cedara	2016-2017
A Nunkumar	Controlling Aphid and viruses in potatoes	Cedara	2006-2020
A Nunkumar	Epidemiology and control of *Phaeosphaeria* leaf spot in maize	Cedara, UKZN PMB campus	2009-2016
J Sibiya	Co-operative breeding trials with ACCI – UKZN	Cedara	2006-2020
M Relihan	Cedara Plant Disease (Plant Health) Clinic	Cedara	1998-2030
SR Bezuidenhout	Influence of cover crops and crop rotations on weed density and Zea mays(maize) competitiveness	Dundee	2013-2023
ST Gcumisa	The untold story of the pig farming sector of rural KwaZulu-Natal: A case study of Uthukela District	Ladysmith area	2009-2013
FZ Khubone	Dry bean production in the Ilembe District	Ndwedwe	2008-2013
SB Madiba	Plant spacing under no-till in maize production in rural communities of KZN	Potshini, Bergville	2010-2015
FZ Khubone	An overview of cucurbits production in Umnambithi and Indaka local municipalities	Umnambithi & Indaka Municipality	2014-2015
TP Mpanza	Effects of Row Intercropping Orange Fleshed Sweet Potatoes (OFSP) & Maize on Soil Moisture, land Use Efficient and the Yield Under Different Row Spacing	Ndwedwe Training Centre	2014-2014

CSZ Qwabe	Improving ruminants production in KwaZulu-Natal Rural areas (winter nutrition)	KZN	2015-2015
SB Madiba	A survey of equipment availability among small-scale farmers	Creighton, Hlanganani	2016-2017
S Ngcobo	The effects of Nitrogen levels and cutting length on the yield and taste of two sweet potato cultivars (A40 & 199062.1)	Bergville, Potshini	2016-2019
DI Nash	Evaluation of *Festuca arundinacea* (Tall Fescue) varieties, herbage quality and grazing management to determine suitability as a lower input pasture for dairy systems	Cedara	2014-2019
DI Nash	Evaluation of the effect of Glyphosate, soil temperature and soil moisture on the establishment of ryegrass oversown into kikuyu	Cedara	2014-2017
DL Berjak	Evaluation of medium and long duration forage cereal varieties to be grown in a mixture with forage legumes	Cedara	2016-2020
CF Luthuli	Performance of goats supplemented with sweet potato vines	OSCA	2015-2019
SD Househam	Lucerne cultivar evaluation at Kokstad Research Station	Cedara, Kokstad	2014-2018
CF Luthuli	Manure as alternative fertilizer for pastures (Pastures Block)	OSCA	2010-2015
SD Househam	Control of Senecio species in the Dry Highland Sourveld of KwaZulu-Natal	Kokstad	2013-2025
SD Househam	The effect of cattle to sheep ratio and stocking rate on veld condition (Simulation trial) on KRS	Kokstad	1989-2014

SD Househam	The effect of a two-camp "blaze and graze" system on sheep performance, veld condition and soil loss	Kokstad	1992-2014
M Relihan	In depth research on diseases associated with infection by *Lagena* sp on pepper & other crops	University of KZN	2009-2015
RE Osborne	Sweet Potato cultivar evaluation	Cedara, OSCA	2009-2020
KM Mkhathini	Postharvest handling and value adding to peach fruit	Impendle, UKZN	2013-2019
VAD Gcabashe	Effect of Potassium on days to spoilage of Beauregard Sweet potato (*Ipomea batatas*) Tubers	Makhathini, OSCA	2015-2016
C Dlamini	The effect of intra-row spacing, row spacing and planting date on green maize ear size	Makhathini	2014-2016
D Naicker	Evaluation of indigenous pumpkins for use in sustainable agriculture (Indigenous crops)	Cedara	2015-2018
KM Mkhathini	Improvement of tomato spacing and fertilizer application rate at Umsinga Irrigation Scheme	Umsinga	2015-2017
RE Osborne	Control of downy mildew in brassica seedlings	Cedara, Sunshine Seeds, Top Crop	2015-2017
SE Zulu	Effect of bark and grass mulch on tomato (*Lycopersicon esculentum Mill*.) growth, yield and post-harvest quality	Cedara	2016-2018
VAD Gcabashe	Citrus cultivar demo	OSCA	1997-2015
FNP Qwabe	Improving productivity and quality of green maize: Green maize potential of Orange Pro-Vitamin A and Yellow Quality Protein maize	Makhathini, Tugela Ferry, Vryheid	2012-2015
C Dlamini	Demonstration - High density Litchi cultivar evaluation	Makhathini	1997-2025

C Dlamini	Mango cultivar & mango grafting and pruning demo	Makhathini	1997-2020
VAD Gcabashe	Mango cultivar Demo	Makhathini	ongoing
D Naicker, C Dlamini & VAD Gcabashe	Sweet Potato demo	Cedara, Makhathini, OSCA	2004-2018
NC van Rij	On farm trials to research an alternative pasteurization technique to prepare substrates for Oyster mushroom production	Dlondlobala Co-op, Inchanga, Dukuduku	2015-2017
NC van Rij	Identification and Management of Factors affecting Oyster Mushroom Spawn Production	Cedara	2014-2017
NJ Tembe	Optimizing substrate requirement in production of Oyster mushroom-	Cedara	2012-2013
NC van Rij	Effectiveness of six different fungal storage procedures in maintaining the viability of mushroom cultures	Cedara	2013-2014
NC van Rij	Using spent mushroom substrates (SMS) of Oyster mushroom (*Plueurotus ostreatus*) to produce vegetables	Cedara	2013-2014
CN Mchunu	Impact of Land Management on microbial functional diversity (in relation to the N biochemical cycle) and N mineralization rates	Cedara, Loskop, Karkloof	2015-2018
NJ Findlay	Cultivar effects on yield response of selected staple agronomic crops to soil acidity and P deficiency	Cedara	2016-2026
BK Mashiyana	Comparison of phosphorus analysis in South African soil laboratories	Cedara	2015-2017
AD Manson	Cover crops for maize silage system production	Cedara, KZN	2011-2020
CN Mchunu	The improvement of FERTREC nitrogen recommendations	Cedara, KZN	1999-2019

NJ Findlay	Catalysis of phosphodieterase by manganese dioxide	Cedara, Danesfort Farm, Kambert	2013-2014
VG Roberts	Soil P requirements of vegetables	Dundee	2011-2016
AD Manson	Nitrogen Use Efficiency for Vegetables	Cedara	2013-2023
GR Thibaud	Soil acidity interactions with no-till	Karkloof, KZN	2001-2015
GR Thibaud	Tillage effect on N requirements	Loskop, KZN	2005-2015
NJ Findlay	Improving N-use efficiency in pastures	Rosetta	2010-2012

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