TANZANIA AGRICULTURAL RESEARCH INSTITUTE
KIBAHA SUB-CENTRE

ANNUAL PROGRESS REPORT 2018-2019

TIME TABLE FOR ANNUAL SUGARCANE RESEARCH TECHNICAL MEETING
DATES: 30th May 2019
TARI Kibaha

TIME	**EVENT**	**RESPONSIBLE**
	S. I: Rapporteur (Baraka, Beatrice)	
08.00-08.30	Registration	Julieth
08.30-08.45	Welcome Note and Introduction	Sub Centre Manager
08.45-09.00	Opening remarks	Chairperson
09.00-09.15	TARI overview	Director TARI HQ
09.15-09.30	Research highlights	Coordinator
09.30-09.40	Discussion	All
09.40-09.55	Breeding	Andrew
09.55-10.00	Group Photo	All
10.00-10.30	**TEA BREAK**	**All**
	S II: Rapporteur (January, Kinyau)	
10.30-10.45	Breeding	Nsajigwa
10.45-10.55	Discussion	All
10.55-11.15	Agronomy	Leyla
11.15-11.25	Discussion	All
11.25-11.45	Entomology	Amri
11.45-11.55	Discussion	All
11.55-12.20	Pathology	Minza/Margareth/Beatrice
12.20-12.30	Discussion	All
12.30-12.50	Technology Transfer	John
12.50-13.00	Discussion	All
13.00-14.00	**LUNCH**	**All**
	S. III: Rapporteur: (Mziray, Amri)	
14.00-14.10	Kilombero Estate	Agronomist
14.10-14.20	Mtibwa Estate	Agronomist
14.20-14.30	Kagera Estate	Agronomist
14.30-14.40	TPC Estate	Agronomist
14.40-14-50	Discussion	All
14.50-15.10	Other stakeholders	
15.10-16.00	Lab, screenhouse, field visits	All
16.00-16.30	Refreshments	All
	S. IV: Rapporteur: (Minza, Nsajigwa, Andrew)	
16.30-17.30	Recommendations 2019/20 projects	All
17.30-17.45	Closing Remarks	Director TARI HQ
17.45……………	**Departure**	**All**

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ACRONYMS AND ABBREVIATIONS

MN	Malawi/Natal
N	Natal
R	Reunion
ANOVA	Analysis of Variance
B	Barbados
CG	Contract growers
CG	Guatemala
CP	Canal Point
DUS	Distinctiveness Uniformity Stability
FP	Farmers Practice
GC	Genetic Combinations
GENSTAT	General Statistics
K1	Kilombero one factory
K2	Kilombero two factory
KSC	Kilombero Sugar Company
KSL	Kagera Sugar Limited
LSD	Least Significant Difference
M	Mauritius
MSE	Mtibwa Sugar Estate
NPT	National Performance Trials
OGs	Out Growers
PC	Plant Cane
POCS	Per cent Obtainable Cane Sugar
Q/KQ	Queensland
R1	Ratoon cane
RCBD	Randomized Complete Block Design
RT	Recommended Technology
SBT	Sugarbord of Tanzania
SPF	Sugar Processing Factories
TCH	Tonnes Cane per Hectare
TOSCI	Tanzania Official Seed Certification Institute
TPC	Tanganyika Planting Company
TPRI	Tropical Pesticides Research Institute
TSH	Tonnes of Sugar per Hectare
WICSCBS	West Indies Central Sugar Cane Breeding Station

1.0 SUGARCANE RESEARCH HIGHLIGHTS 2018/19

Figure 1. 1 Sugarcane

1.1 Introduction

The Tanzania Agricultura Research Institute (TARI, Kibaha) is working on demand driven research to solve problems hindering sugarcane production. Due to limited area good for sugarcane production and limitations of being closer to sugar factory, hence production has to be with improved practices and varieties. However, sugar production is still low to meet country requirements. They are several factors that are limiting including Biotic and abiotic such as lack of enough improved varieties which are tolerant to drought and resistance to pest and diseases, Poor management of pests and diseases and lack of knowledge on good agronomic practices. Being the only Research institute with national mandate for sugarcane research, TARI-Kibaha has been implementing a five years strategic plan which aims to improve researches related to sugarcane.

In order share research outputs archived, TARI Kibaha organizes Technical Committee Meetings for the researchers and other sugarcane stakeholders to present their results. Hence in 2017/18 the meeting was held on 8th June 2018 at TARI Kibaha conference room and researchers presented progress reports related to sugarcane breeding, agronomy, entomology, pathology and technology transfer. The main purpose of this meeting was to review the results and progress of research activities implemented in year 2017/18 and propose research activities for 2018/19. In this meeting, we invited different stakeholders including; representatives from sugarcane out growers, agronomist from estates

(Kilombero, Mtibwa, Kagera sugar and TPC), DAICOs (Kilombero, Kilosa, Misenyi, LAOs, Mkulazi project, SBT, SIDTF, AWF-SUSTAIN, YARA Fertilizer Company, Bagamoyo Sugar Estate, Essoco, DEDs, Abood Radio and Representatives from Researches (Ilonga and Mlingano).

During the meeting participants came up with recommendations for the purpose of improving sugarcane researches. The recommendations discussed and agreed to be part of action plan include; establish collaboration between TARI Kibaha (formerly SRI) and TOSCI in establishment of quality control standards for seed cane, form task force to sensitize LGA's to give financial support in order to support sugarcane productivity based on ASDP II Program, establish a study on factor that will improve efficiency along sugarcane value chain for out growers (Farm to Weigh bridge), review the MoU between LGA,s and SBT for extension services, Government to support ARI-Mlingano to upgrade their soil laboratories to ISO standards (Accreditation of laboratories is important) and last is to initiate the study on the control of *Striga* i.e. by using catch crops.

1.1.1 Weather

1.1.2 Staffs

Researches under the commodity of sugarcane has been divided by discipline which are breeding, agronomy, entomology, pathology, nematology and technology transfer. However, starting from new financial year researchers will be working based on where they have been allocated following new TARI structure which divides researchers into their specialization. The system of working under discipline of specialization will allow researchers from root and tuber crops to work on sugarcane when we have shortage of research staffs. Aim is to fully utilize available skills and identify gaps within institution. The TARI structure wants to make sure all researches are conducted by specialized people. In addition, in the new structure, there is emphasis on transfer of developed technologies to end user. Hence this section is separated from research section and will concentrate on reaching farmers with improved technologies through trainings, awarenesses, shows etc.

Sugarcane research comprised of 25 staffs (Table 1.1) where six are technicians or field officers and nineteen are scientists. Among 19 scientists, 17 are fulltime scientists and two are working under contracts. One field officer is on study leave taking her BSc agronomy at SUA. Due to restructuring of TARI, sugarcane has received new staffs where three from internal transfer from root and tuber crops and other two from TARI HQ. However, some staffs have been transferred to other institutions or given new appointments. Among them are Drs Mtunda and Ngailo who were appointed as Director for TARI center and Director General for TFRA respectively.
In the last meeting we presented problem of Entomologist. But recently we have been given permit from TARI to continue with recruitment of Entomologist who will be working in contract bases and paid from SIDTF funds.

Table 1. 1 Research staffs responsible for sugarcane researches at TARI Kibaha

No	Name	Education	Specialization	Duty
1	Dr H. Msita	PhD	Bioscience engineering	Centre Manager
2	Dr Nessie Luambano	PhD	Plant Nematology	Coordinator
3	Ambilikile Mwenisongole	MSc	Agricultural Economics	Technology transfer
4	Herman Kalimba	MSc	Agronomy	Agronomy
5	Leyla Lwiza	MSc	Soil Science	Agronomy
6	Minza Masunga	MSc	Molecular Pathology	Pathology
7	Beatrice Kashando	MSc	Nematology	Nematology
	Magreth Mziray	MSc	Water Management	Pathology and nematology
8	Andrew Kachiwile	MSc	Molecular Breeding	Breeding
9	George Mwasinga	MSc	Breeding	Breeding
10	Amri Yusuph	MSc	Environmental and Natural resource Economics	Entomology
11	Margareth Kinyau	MSc	Agricultural Economics	Technology transfer
12	John Msemo	MSc	Rural Development and Marketing	Technology transfer
13	Diana Nyanda	MSc	Agric. Education and Extension	Technology transfer
14	Baraka Ernest	MSc	Climate Change	
15	Nsajigwa Mwakyusa	BSc	Agriculture General	Breeding
16	Fadhila Urasa	BSc	Agriculture General	Entomology
17	Rose Pachi	BSc	General Science	Agronomy
18	Mohammed Mwinjumah	Diploma	Fields Officer	Field Officer
19	Stanley Kajiru	Diploma	Field Officer	Field Officer
20	Robert Mlimi	Diploma	Field Officer	Field Officer
21	Renifrida Polini	Diploma	Laboratory Technician	Technician
22	Yeremiah Mbaga	Diploma	Laboratory Technician	Technician
23	Dr Juma Katundu	PhD	Entomology	Contract
24	Bonaventura Minja	MSc	Entomology	New-Entomologist
25	Judith Setebe	Diploma		Study leave

1.2 Research Activities

In the financial year 2018/19 a total of 49 project activities (appendix 1) were approved by 37th sugarcane research steering committee meeting held on 13th July 2018. The projects are from breeding, agronomy, entomology, pathology and technology transfer and percentage projects distribution are shown in Figure 1.2.

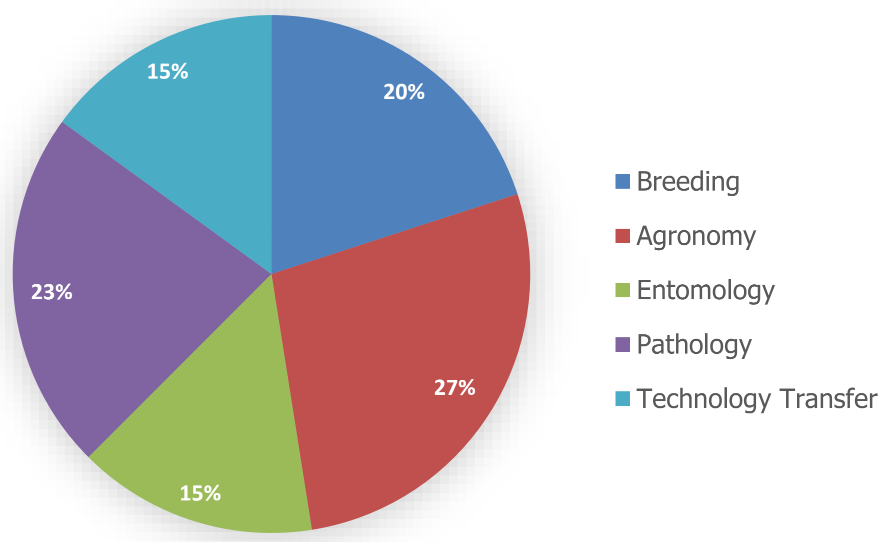

Figure 1. 2 Percentage of project distribution funded in 2018/19

Total budget approved for these activities was 426, 062, 870/=. In addition to this, the committee approved funds for research coordination and station upkeep which are Tsh 68,971,700 and 197,424,000/= respectively. Below in Figure 1.3 are projects and outputs achieved by each discipline for 2018/19.

1.2.1 Sugarcane Breeding

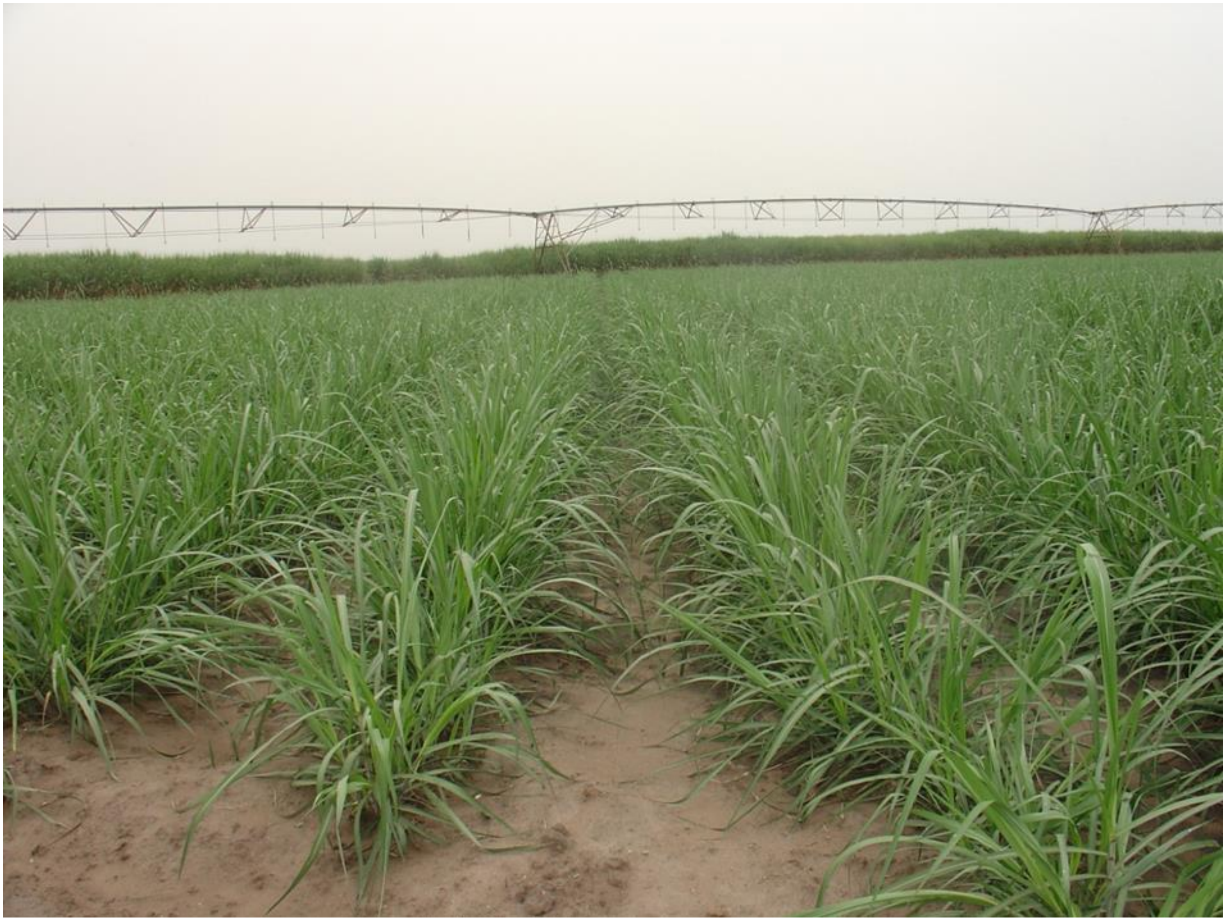

Figure 1. 3 Multiplication of clean sugarcane planting materials

Importation of New Varieties (Quarantine and distribution of newly imported sugarcane varieties)

- Five varieties (CPCL05-1102, R 01/0277, GT18, GT 5 and GT 3) were imported from CIRAD and planted in the closed quarantine
- Eight varieties (R98/4146, GT 15, R 58, CP 062042, R00/2460, R00/8180, FR 89-746, & R 6221) are under open quarantine at Kilombero
- Thirteen varieties (N35, N40, N42, N48, N57, R97/0478, R96/0020, R00/2129, R96/6396, NA8-1090, FR 92394, FR 90881 & BO 3572) were released from open quarantine and planted in four estates (KSC, MSE, KSL & TPC) for seedcane bulking.

Smut Screening Trials (Selection of smut resistant sugarcane varieties)

- 12 varieties (N35, N40, N42, N48, N57, R97/0478, R96/0020, R00/2129, R96/6396, NA891090, FR 92394 & FR 90881) were planted at TARI Ifakara for smut screening.
- Evaluation of 107 varieties is at TARI Ifakara in five sub-experiments
- Among 107 varieties, 10 are promising candidate for smut resistance

Preliminary Yield Trials (Preliminary evaluation of new varieties/clones in different sugarcane estates)

- A total of 5 trials have been established at KSC, KSL and MSE in 2018/19 season.
- 25 on-going preliminary variety trials at KSC, KSL, MSE and TPC have been harvested at different crop stage
- Among these, 15 promising sugarcane varieties have been identified

National Performance Trials (NPT)

- Four varieties which include rainfed (R 570 & N47) and irrigated (N36 and R 85/1334) varieties were planted in KSC, KSL, MSE and TPC.
- 5 NPTs established at TPC and 2 KSC, KSL and MSE
- Data on performance of plant cane planted at TPC, KSC and KSL will be presented in detail by breeding team

Advanced Sugarcane Fuzz Evaluation and Selection

- A total of 31 promising clones of sugarcane were selected from imported fuzz.
- Selected clones were planted at KATRIN, KSC, TPC and KSL for further evaluation and selection

Rapid seedcane multiplication (Evaluation of sugarcane seed cane production methods)

- Eleven sugarcane varieties (NCo376, R579, N41, R570, R575, N25, N30, N19, N36, N47 and R85/1334) have been mass multiplied in screenhouses at TARI Kibaha using single node multiplication technique
- Total of 34,111 seedlings have been multiplied and ready for commercial production

Germplasm Conservation and Maintenance (sugarcane germplasm conservation for sustainable sugarcane sector development)

- A total of 279 sugarcane varieties have been collected, planted and are maintained at TARI Kibaha
- Also, 41 local sugarcane cultivars have been collected from different regions of Tanzania, planted and maintained at TARI-Kibaha

1.2.2 Sugarcane Agronomy

Figure 1. 4 Selection of planting materials

Under sugarcane agronomy, the following have been conducted;
Evaluation of existing agronomic package to selected sugarcane varieties in outgrowers fields of Kilombero sugar mill area.

- Trials established at Kilombero Mill area with aim of assessing three promising varieties (N47,N12, and R570) against NCo376 on recommended sugarcane agronomic practices.
- The key output for the trial is two varieties (N47, R 570) were selected for evaluation in large blocks.

Evaluation of different levels of fertilizers for improved sugarcane productivity at Kagera Mill Area

- Fertilizer trials comprised of different rates of NPK were established in OG fields of Kagera mill area
- Among 12 fertilizer combinations tested, three ($N_{100}P_{75}K_{100}$ tested at Kyaka, $N_{150}P_{25}K_{150}$ tested at Nsunga and $N_{100}P_{25}K_{100}$ at tested at Kasambya were promising

Baseline survey on the status of *Striga* spp in sugarcane fields in Tanzania

- Survey was done in 100 sugarcane fields in Kagera Mill area.
- No field was infested in estate while one field was infested at out growers.
- In this study, *Striga* spp is not a serious weed of sugarcane at Kagera mill area.

Evaluation of different herbicide for use in sugarcane fields at Kagera Mill area

- Trials were conducted to evaluate efficacy of different combination rates of herbicides namely Acetochlor, Metribuzine, Chlorimuron and Paraquat
- Assessment of herbicides action was based on direct comparison between treated and untreated plots
- Results shows that all herbicides combinations were effective in controlling weeds for more than nine weeks

1.2.3 Sugarcane Entomology

Figure 1. 5 Sugarcane stalks infested by white scale

Study of seasonal insect population fluctuations influenced by weather changes and crop management practices in all estates and out growers fields.

- Surveys were conducted in selected fields of Kagera, Mtibwa and TPC, Kilombero and Manyara to assess the status of infestation of sugarcane Stem borer, Yellow Sugarcane Aphids and White scale.
- The sugarcane fields assess were 121 from estates and 56 from out growers.
- Sugarcane stem borer, the white grub and the sugarcane white scale were found in all estates and out growers fields

- Except for white grab which was only at TPC and MSE estates.
- Sugarcane stem borer attack has been a common problem at TPC and KSL estates.
- Generally, white scale infestation in surveyed fields were low which could be due to the use of less susceptible varieties like R579.

Evaluation of white scale damage and sugar loss in selected varieties

- The objective was to develop protocol for an artificial inoculation technique and later adopt for screening of new sugarcane varieties.
- This was conducted in Kilombero Sugar company on the following varieties TZ 93KA - 120, TZ 93KA - 122, R 85/1334, B80689, KQ228 and EA70-97 as tolerant standard and MN1 or N25 as susceptible controls

Production of White scale predator, *Rhyzobius lophanthae,* in screen house for field releases

- The objective is to produce *R. lophanthae* for release in sugarcane fields infested with white scales.
- The surveys conducted at TPC showed both White scale and predators were not available because they use varieties which are less susceptible to white scale
- Other results not yet

The Effectiveness of Prophylactic Soil Treatment and Foliar Applications of locally available insecticides for Yellow Sugarcane Aphids control at Kilombero Estate

- Study was conducted at Kilombero Sugar Estate fields to evaluate efficacy of Attackan, Actara, Drone, Pirimicarb and Abamectin in the control of YSA.
- These insecticides are in Neonicotinoids (Attackan, Drone and Actara) and carbamide (Pirimicarb) and microbial (Abamectin) groups.
- Neonicotinoids insecticides (Attackan, Drone and Actara) were highly effective in reduction of YSA population and damage on sugarcane by 55.2% to 75.5%.

Impacts of predators on Population dynamics of Yellow Sugarcane Aphid in Kilombero and Kagera Estates

- The study aimed at studying the impacts of the resident adults and larvae of Coccinellid and Syriphid predators in reducing populations of the *YSA* in sugarcane by field surveys and partial exclusion cages and open plots
- Also, to assess the impact of insecticides on of reduction of predator and YSA populations.
- Results of the exclusion method have shown that the YSA population have increase three to five times in the absence of predator.
- The regular surveys data have supported evidence for predation as a major regulating factor of YSA population development in sugarcane fields.
- Chemical exclusion shown that the both YSA and predators were susceptible to all insecticides
- The impact of insecticides on reduced abundance of predators caused the YSA resurgence in treated plots.
- However, insecticides must be thoroughly tested to determine their impact on predators.

Evaluation of resistance of sugarcane varieties to Yellow Sugarcane Aphid infestation in cages

- The study aimed to asses level of YSA infestation on different sugarcane varieties
- Different varieties of sugarcane plantlets have been planted on pots in screenhouse at TARI Kibaha.
- Results not yet

1.2.4. Sugarcane Pathology and Nematology

Figure 1. 6 Symptoms of sugarcane affected by smut disease

Status of Ratoon Stunting Disease at Kilombero Sugar Company, Tanzania
A capacity was built to 13 staffs trained in relation to identification of Ratoon Stunting Diseases (RSD)
20 fields were surveyed at KSC which had 6 sugarcane varieties (N19, N25, N41, N30, R570 & R579)
Results showed no RSD infestation in all field surveyed
Assessment on the incidence of sugarcane smut on estate and outgrowers fields in Tanzania

113 fields consisting of 20 sugarcane varieties were assessed for smut infestation both on estates and out-growers fields
Results showed higher smut infestation on out-growers fields (86 %) as compared to estates (51 %).

Factors influencing disease spread on sugarcane outgrowers fields in Tanzania
The survey was conducted to assess knowledge and factors contributing to disease spread in outgrowers fields in Kagera, Kilombero and Mtibwa.

A total of 276 farmers interviewed
Four major factors; source of planting materials, high price of seedcane, inadequate knowledge related to sugarcane diseases and long distance from seedcane source were identified

Monitoring of Plant Parasitic Nematode in sugarcane growing area of Tanzania

Figure 1. 7 Plant parasitic nematode which affect sugarcane plants

- Nematodes monitoring was done in Kagera sugar, Kilombero sugar, Tanganyika Planting Company limited and Mtibwa Sugar Estate. The aim was to know the status and key nematodes of sugarcane
- Total of 129 samples were collected from 43 fields
- At least 12 key plant parasitic nematode were identified to genus level
- Lesion nematodes (*Pratylenchus* spp) are widely spread in all estates surveyed while Reniform (*Rotylenchulus* spp), was only at TPC limited

Screening for the best control of nematodes in sugarcane production using integrated pest management

- This study aimed to develop integrated pest management using organic amendments (Filter cake, Mucuna beans and Lablab and sunn hemp).
- The experiment was done at Kagera sugar limited.
- Before setting 24 soil samples were collected to know the status of nematode
- The trial consist of 5 treatments and a control

Study on yield losses associated with key plant parasitic nematodes affecting sugarcane in Tanzania

- The study intend to assess yield losses associated with key plant parasitic nematodes (Pratylenchus spp and Meloidogyne spp) of sugarcane on varieties R570, R579 and Co 617.
- The experiments will be conducted in screenhouse at TARI Kibaha
- We have started with mass multiplication of inoculum in the laboratory

1.2.5 Technology Transfer

Figure 1. 8 Leaflets produced for sugarcane awareness on recommended practices

Strategies to Improve Extension Services to Sugarcane Farmers Through FFS in Kilombero Sugarcane Mill Area

- The FFS established at Kilombero and Mtibwa whereby and 55 farmers were trained on the use of clean seedcane from nursery B, fertilizer recommendation (N_{100}, P_{25}, K_{100}) and herbicides application.
- Gender distribution was 33 males and 22 females

Establishment of Demonstration plots in Mvomero, Kilosa and Kilombero District

- Nine demonstration plots established at Kilombero mill area and Mtibwa mill area.
- Three packages were demonstrated which are the use of clean seedcane from B nursery, recommended fertilizer packages (N_{100} P_{25} K_{100}), herbicides volmuron 4 liters/hectare and good agronomic practices.
- The yields of 9 demonstration plots were higher (87-111 TCH) as compared to the yield from farmers practice (63-75 TCH)
- A total of 782 sugarcane farmers learned through demonstration plots.

The multiplication of clean seedcane at Kilombero, Kagera and Mtibwa Mill Area

- Multiplication of nursery B was established at sugarcane mill areas with a total area of 38.5 acres planted with Co617, NCo376, N47 and R570 varieties.
- The seedcane multiplication fields are managed and owned by farmers.
- TARI-Kibaha provided clean seed cane from A nursery and inputs, also and local extension officers support in field observation and monitoring.

Scaling up sugarcane production technologies through training and development of extension material

- A total of 13 were trained on sugarcane production
- Designed and developed 1 poster (350 copies), 7 flyers (7000 copies), 7 Brochure (7000 copies) and 1 book (200 copies) Swahili version.
- Total of 2820 fliers, 2300 brochures and 328 posters have been distributed to cane growers and other stakeholders during nanenane exhibition, farmers' day in Kilombero and Kilosa district, at TARI office to parliament committees for agriculture livestock and fisheries.
- In nanenenane exhibition total of 4676 peoples visited sugarcane pavilion

Promotion of Sugarcane Production Technologies to Sugarcane Growers Through Mass Medial

- The promotion of sugarcane technologies was done through Abood FM.
- Total of 26 episodes which covered production to harvesting were aired.
- As a result we received about 96 calls and 3175 messages from listerners.
- Percentage farmers interest were on new seedcane variety (39%), pests and diseases (19%), planting pattern (14%), fertilizers type and application (13%), herbicides (8%).
- This shows that radio is one of the important tools in dissemination technologies to sugarcane growers.

1.3 General Achievements

Papers, reports and thesis

Juma Katundu, Amri Yusuph, Nassoro Abubakari, Yona Kalinga (2019). Impacts of predators on yellow sugarcane Aphids population in Kilombero and Kagera. Paper submitted to the 8th Annual national Workshop of Tanzania Society of Sugar and Cane Technologist (TSSCT), held on 26th -27th April 2019 at Kilombero Sugar Company.

Lwiza L, Kalimba H, Kajiru S, Merumba S, , Nyanda D, Msita H (2019). Improved sugarcane vertical productivity through optimum fertilization; case study of Kagera mill area, Misenyi district, Kagera, Tanzania.

Beatrice Kashando (2018). Morphological and Molecular characterization of plant parasitic nematodes from sugarcane plantations in the Kilimanjaro region of Tanzania. MSc Thesis.

George Mwasinga (2018). Effects of Nitrogen Fertilizer on yield and quality of introduced sugarcane (*Sacchurum Officinurum* L.) varieties in commercial field at Kilombero, Morogoro Region.

Annual progress report 2018-2019 compiled for sugarcane research technical committee meeting

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Awareness materials and training Manuals
7 banners, 350 posters, 7000 flyers, 7000 Brochures and 200 training manuals were printed and distributed to;

- Sugarcane farmers in sugarcane mill areas (Kilombero, Kagera and Mtibwa),
- August 2018 Agriculture show (Nanenane exhibition) in Morogoro,
- Different visitors including members of parliament committees for agriculture livestock and fisheries.

Training
Two researchers who were on study leave have been gradated as follows;

- Beatrice Kashando graduated September 2018 in International Master of Science in Agro and Environmental Nematology. Ghent University, Belgium.
- George Mwasinga graduated December 2018 in MSc of Crop Science, Sokoine University of Agriculture, Morogoro, Tanzania.

Proposal development and submission
As researchers with national mandate for sugarcane researches we are responsible mobilizing resources to support sugarcane research and development.

1.4 Proposal in plans for submission

- Sustain-Africa phase ii submitted to Dutch government with title crop variety research and multiplication of clean seed-cane in Kilombero and Kilosa.
- The nutritional, sensory quality and the microbial contamination of chewing sugarcane juice consumed in Tanzania, to be submitted end of May 2019 to Innovate UK/DFID call

The following proposal drafts have been prepared and we are looking for the call to submit;

- **Breeding:** Sustainable Sugarcane Seed System in Tanzania
- **Entomology:** Evaluation of Yellow Sugarcane Aphid resistance among commonly grown sugarcane varieties in Sugarcane growing areas in Tanzania
- **Agronomy +Agric. natural resources management**: Assessment of environmental and social impacts of sugarcane industry in Tanzania.
- **Pathology**: Development of diagnostic tools for detection of sugarcane diseases in Tanzania

1.5 Challenges

- Need of more funds for building capacity through teller made courses from different countries
- Old irrigation pump
- Getting funds from other donors out of SIDTF
- Few vehicles and drivers for field work
- Leakage of building
- Few field officers for succession those expected to retire within 2 years

2.0 SUGARCANE BREEDING SECTION

2.1 Importation of New Varieties (Quarantine and Distribution of Newly Imported Sugarcane Varieties)

Project code: **SCB 2017/01**
Investigators: **A. Kachiwile, N. Mwakyusa G. Mwasinga and R. Mlimi**
Collaborators: **TPRI**
Duration: **2017/18**
Completion: **Ongoing**

Project summary

Sugarcane varieties are fundamentals for sugarcane sector development. Varieties with improved traits to resist pests, diseases and tolerate drought in harsh environment providing more protection against crop failure. The purpose of the project was to introduce new sugarcane germplasm, monitoring and selection of superior varieties. The selection is based on their performance in closed and open quarantine before they are released to sugar estates in Tanzania. Five (5) new varieties (CPCL05-1102, R 01/0277, GT18, GT 5 and GT 3) were imported from France and planted in the closed quarantine in February 2019. Eight (8) varieties (R 98/4146, GT 15, R 58, CP062042, R 00/2460, R 00/8180, FR89-746, & R 6221) planted in November 2018 originally from France are under open quarantine at Kilombero. Thirteen (13) newly varieties (N35, N40, N42, N48, N57, R 97/0478, R 96/0020, R 00/2129, R 96/6396, NA8-1090, FR92394, FR90881 & BO3572) were released from open quarantine distributed to four estates: KSC, MSE, KSL & TPC for seedcane bulking.

2.1.1 Introduction

Plant breeding is defined as the art and science of changing plants genetically (Allard, 1960). Therefore, it is crop evolution directed by man through conscious decision to keep the progeny of certain parents in preference to others in diverse genetic population (Simmonds, 1978). The introduction of new sugarcane varieties is among of the activities in the breeding section. The introduced varieties were from South Africa, Mauritius, United States, Australia, Reunion and Brazil. Evaluation of the varieties in major sugarcane growing areas is done in collaboration with sugarcane estates so as to identify superior genotypes with improved agronomical performance and tolerance to biotic and abiotic stresses.

Objective

To introduce new germplasm of sugarcane, monitor and select superior varieties based on their performance in closed and open quarantine before they are released to the sugarcane estates.

Specific Objectives

i. To introduce new sugarcane varieties in sugarcane estates of Tanzania
ii. To evaluate the performance of the new sugarcane varieties
iii. To select the superior sugarcane varieties for commercialization

Outputs

i. 5 new varieties imported and planted in closed quarantine
ii. 8 new varieties graduated to open quarantine

iii. 18 new varieties released from open quarantine for seedcane bulking in the four sugarcane estates

2.1.2 Materials and methods

Importation of 5 new varieties from France was done in February 2019. These materials were planted in closed quarantine screen house at TARI-Kibaha. The plant materials were inspected by National Plant Quarantine Services from Tropical Pesticides Research Institute (TPRI) before planting and released to Cane growers in Tanzania. Each variety consisted 6 setts with one eye bud each. Prior to planting, the cutting knife was sterilized by washing with sodium hypochloride solution 3.5/v; before using it for cutting another variety. Setts were dipped into mixed solution of Baleyton 250 WP (*Triadimefon 250g*) fungicide with Diazinon (*Neucidol 50 EC*) insecticide for 10 minutes for a ratio of 1ml of Baleyton and 1g of Diazinon to 1 litre of water. The setts were planted into 20 dm^3 baskets containing sterilized soil, one variety per basket. Irrigation of setts planted was done by using tape water. After planting, 20mls of insecticide per 20 litres of water (Karate 500 EC *lambda-cyhalothrin*) was sprayed to control insect pests inside the screen house.
Sugarcane varieties imported before the five varieties planted in 2018/2019 are in nurseries for seedcane multiplication. They are in the stages to attain preliminary variety trials for 2019/2020 planting season. The varieties are N35, N40, N42, N48, N57, R 97/0478, R 96/0020, R 00/2129, R 96/6396, NA89-1090, FR 92394, FR 90881 and B 03572.

2.1.3 Results

Imported varieties in closed quarantine:

Five (5) new varieties, CPCL05-1102, R 01/0277, GT18, GT 5 and GT 3 were imported from France in February 2019 and planted in closed quarantine at TARI - Kibaha (Table 2.1). All varieties germinated and are in good condition.

Table 2. 1 Varieties planted in closed quarantine at TARI – Kibaha

S/N	Variety	No of setts & eye buds	Germination (%)	Remarks
1	GT 3	6 setts 1 eye bud each	100	Very Good
2	CPCL05-1102	6 setts 1 eye bud each	50	Good
3	R 01/0277	6 setts 1 eye bud each	17	Poor
4	GT 18	6 setts 1 eye bud each	17	Poor
5	GT 5	6 setts 1 eye bud each	17	Poor

Varieties under open quarantine

- Eight (8) new varieties (R98/4146, GT 15, R 58, CP 062042, R00/2460, R00/8180, FR 89-746, & R 6221) are under open quarantine at Kilombero.

Varieties released from open quarantine

- Thirteen (13) newly varieties (N35, N40, N42, N48, N57, R97/0478, R96/0020, R00/2129, R96/6396, NA8-1090, FR 92394, FR 90881 & BO 3572) were released from open quarantine distributed to four estates: KSC, MSE, KSL & TPC for seedcane bulking.

2.1.4 Discussion

Introducing new varieties and clones to the sugarcane industry in the country have high impact towards commercialization by sugarcane estates. The performance of the planted varieties in the closed quarantine depends on genetically adaptability to new environment that are subjected. The better performing varieties are typically adapted to the environmental condition resulting to promising commercial elite varieties for sugar industry development in Tanzania

EVALUATION OF NEW VARIETIES

2.2 Smut Screening Trials (Selection of Smut Resistant Sugarcane Varieties)

Project Code: **SCB 2017/02**
Investigators: **A. Kachiwile, N. Mwakyusa, Mwasinga, G and R. Mlimi**
Collaborators: **Sugarcane Estates and TARI-Ifakara**
Duration: **2 years (2017/18 – 2019/20)**

Project summary

Sugarcane smut resistance is influenced by three major factors: sugarcane genotype, the pathogen, and the environment. Assessment on the reaction of varieties to smut was done by exposing candidate varieties to high smut pressure by artificially inoculating seedcane with fresh smut spores and planting in a nursery. All test varieties were planted between infester rows of an artificially infected susceptible variety (NCo376). The experiment design was a Randomized Complete Block Design (RCBD) replicated three times. Plot sizes were two rows 1.2 m apart and 8 m long. Total numbers of stalks were counted and number of infected stalks were calculated as percentages and subjected to analysis of variance. The reaction of test varieties in the form of numbers of infected stalks was compared with the most susceptible (NCo376) and resistant (EA70-97) varieties. A total of 10 sugarcane varieties showed to be promising in resisting smut disease.

2.2.1 Introduction

Sugarcane smut disease, caused by *Sporisorium scitamineum*, can cause significant yield loss when susceptible cultivars are planted. There is 0.6 to 0.7% yield loss for every 1% increase in diseased plants. (Magarey *at al.,* 2014). Sugarcane smut can cause any amount of loss to susceptible varieties from 30% to total crop failure .Sugarcane smut managed effectively when resistant cultivars are planted, which is the most economical and effective measure for disease prevention and control (Xing, 2013). Infected plants show a profound metabolic modification resulting in the development of a whip-shaped structure (sorus) composed of a mixture of plant tissues and fungal hyphae. Within this structure, *ustilospores* develop and disseminate the disease. Resistant varieties grown in all areas

regularly and show some smut infection but not suffering with cane yield loss (Magarey *et al.,* 2014).
In Tanzania, sugarcane smut disease has been causing problem in all estates and to outgrowers (OGs) where growers use clean seedcane as means of managing the disease. However, the management techniques used are not effective and hence this project aimed to evaluate new imported sugarcane varieties for their resistance to this disease.

Objective
To determine the reaction of newly imported varieties to smut infections so as to identify resistant varieties
Specific objective
To evaluate new imported sugarcane varieties for their resistance to smut disease.
Achieved Output
A total of 10 sugarcane varieties showed to be promising in resisting smut disease

2.2.2 Materials and methods
A total five experimental trials comprised of fifteen (7N and 8R), nineteen (4CP and 15R), twenty four (7B and 17R), twenty five (B) twenty four (23B and 1M) varieties and 3 check varieties were evaluated in ratoon crop (R1). Susceptible check variety was NCo376, while R 579 and EA 70-79 included as resistant varieties. The treatments were planted in Randomized Complete Block Design and replicated 3 times, having a spacing of 1.2 m and length of 8 m, each plot was planted with 40 setts containing two eye buds inoculated with 2 grams of smut spores in 1litre of water per plot stayed overnight. Data on diseases incidences were collected by counting number of infested stools per plot and later percentage infection calculated from the total plants.

Statistical analysis

Data on percent disease incidence were square root transformed before subjecting into ANOVA using GENSTAT statistical package version 14. Means were compared using LSD at P=5%

2.2.3 Results
Experiment No. 1
A total of fifteen (7N and 8R) varieties were evaluated for smut resistant and compared to NCo376 and EA70-97 in smut screening trial. Results for R1 are shown in (Table 2.2).The level of mean percent smut infection varied among test varieties, however there were not significantly different ($p \leq 0.05$). Test varieties N29, N38 and R96/2454 had smut infection lower than resistant check EA70-97, while varieties N50, R95/2100, R97/2168 and R99/4065 had smut infection higher than susceptible check NCo376.

Table 2. 2 SCB Smut infection rate

Variety	Smut (%)	Arc sine
N29	0.0	5.7
N38	1.6	8.5
N43	7.3	15.0
N50	27.6	31.4
N51	11.1	15.8
N52	7.2	16.4
N53	7.1	16.0
R95/2100	24.6	25.2
R95/2204	9.2	17.0
R96/2454	0.0	5.7
R96/8149	16.2	20.2
R97/2168	30.1	30.4
R98/2431	21.4	27.6
R98/6092	20.0	26.0
R99/4065	26.8	31.3
EA 70-97	**6.5**	**14.6**
NCo 376	**23.3**	**26.5**
MEAN	14.1	19.6
LSD (0.05)		21.9
CV (%)		67.0
P-Value		0.389

Experiment No. 2

Nineteen (4CP and 15R) varieties were assessed for smut reactions in comparison with NCo376 and EA70-97 susceptible and resistant varieties, respectively. Results for R1 are presented in Table 2.3. Varieties CPCL02-6848, CPCL051791, R004055, R94/2129-1 and R95/2202 had significant ($P<0.05$) lower smut infection than resistant check EA70-97, while varieties R95/2202, R95/4065 (R586), R97/2225 and R97/6177 scored significant ($P<0.05$) higher smut infection than susceptible check NCo376.

Table 2. 3 SCB Smut infection rate

Variety	Smut %	Arc sine
CPCL02-6848	2.7	9.6
CPCL05-1102	8.5	15.6
CPCL05-1791	3.6	10.4
CP04-1566	9.7	18.1
R004055	3.8	12.4
R93/4541	12.1	18.6
R94/2129	14.1	14.4
R94/2129-1	3.1	10.0
R95/2087	7.0	11.4
R95/2202	23.3	24.5
R95/4065 (R586)	24.9	28.4
R95/4216	1.9	9.5
R96/2281	10.1	18.4
R97/0391	17.0	23.7
R97/2225	20.9	26.8
R97/6177	24.2	27.8
R98/2310	7.6	15.9
R98/4001	12.2	20.4
R98/8115	12.9	21.1
R99/4064	10.7	17.7
R99/4065	14.6	19.7
EA 7079	**6.2**	**12.3**
NCo 376	**14.4**	**21.5**
MEAN	11.6	17.7
LSD (0.05)		15.7
CV (%)		53.6
P-Value		0.314

Experiment No. 3

Twenty four (7B and 17R) varieties were evaluated in smut screening trial against R579 and NCo376. Results are presented in Table 2.4, indicated that mean percent smut infection varied among test varieties, however there were not significantly different ($p \leq 0.05$) in reaction to smut among test varieties. However, susceptible check had lower smut infection compared to test varieties except varieties R94/0142 and R96/8299 which had the lowest infection rate.

Table 2. 4 SCB: Smut infection rate

Variety	Smut %	Arc sine
B001250	4.0	11.9
B00167	24.0	26.9
B03110	11.5	18.6
B77602	32.2	3 5.1
B80689	4.5	12.5
B89447	3.6	11.6
B98235	4.9	12.7
R580	16.7	19.0
R581	6.6	14.3
R585	18.5	23.5
R91/2200	7.0	15.1
R92/4246	2.0	9.0
R93/6480	6.9	15.2
R94/0142	0.0	5.7
R94/2129	2.1	9.0
R94/6113	3.3	10.3
R94/6447	3.7	11.7
R95/0017	12.4	20.5
R96/2116	1.5	8.4
R96/2569	10.1	17.7
R96/6538	6.7	12.9
R96/8299	0.0	5.7
R97/4029	7.4	13.4
R98/4162	26.1	30.2
R579	**1.5**	**8.5**
NCo376	**13.9**	**17.4**
MEAN	8.8	15.3
LSD (0.05)		17.6
CV (%)		70.3
P-Value		0.164

Experiment No. 4

A total of twenty five **(B)** varieties were assessed for smut reaction against NCo376, N41 and R579. Results for R1 are presented in Table 2.5, indicated that were not statistically significant difference ($p \leq 0.05$). However, varieties B99186, BBZ951049 and BR93017 scored significant higher ($p<0.05$) smut infection than susceptible check NCo376.

Table 2. 5 SCB: Smut infection rate

Variety	Smut %	Arc sine
B991037	1.1	7.8
B991114	18.9	26.0
B99186	37.4	38.2
BBZ92653	7.6	15.1
BBZ951034	0.0	5.7
BBZ951049	25.3	30.5
BJ78100	5.6	13.2
BJ8231	1.1	7.8
BJ8534	14.2	22.5
BJ8897	9.5	18.8
BR030003	0.0	5.7
BR041001	0.0	5.7
BR08004	14.6	22.2
BR08012	4.1	12.9
BR93017	20.4	27.5
BR96013	11.7	20.0
BR971007	2.6	10.4
BR971011	8.2	16.1
BR971014	1.7	8.6
DB8203	15.1	19.7
DB94177	5.5	14.6
DB9436	10.1	17.7
DB9526	6.8	15.8
M700/86	8.2	17.2
N41	**6.8**	**16.0**
NCo376	**18.5**	**23.5**
R579	**0.0**	**5.7**
MEAN	9.4	16.5
LSD (0.05)		12.1
CV (%)		44.9
P-Value		0.001

Experiment No. 5

Twenty four (23B and 1M) varieties were assessed for smut reaction against NCo376 and R579. Results are presented in Table 2.6, indicated that there were highly significant differences ($p \leq 0.05$) among tested varieties. Test varieties had varying levels of reaction to smut infection; however, varieties B41291 and KNb9180 scored significant ($p<0.05$) higher smut infection than the susceptible check NCo376, while other varieties had smut infection statistically ($P>0.05$) similar to resistant check R579.

Table 2. 6 SCB: Smut infection rate

Variety	Smut %	Arc sine
B00111	0.0	5.7
B00279	12.6	17.7
B00713	1.0	7.7
B0072	9.0	16.4
B01218	19.5	23.1
B041291	28.9	27.8
B991110	4.9	12.5
B99907	2.6	9.5
BBZ8257	8.3	14.8
BJ82156	7.3	16.2
BJ8820	3.0	9.9
BR00010	2.2	9.1
BR021002	1.7	8.5
BR96013	9.8	18.2
BR971004	3.2	11.1
BR972001	1.7	8.5
BT7782	0.0	5.7
BT88404	4.5	11.1
DB7869	9.5	14.3
DB8113	3.5	11.4
DB9633	8.3	13.6
KNB9180	28.9	31.4
KNB9211	5.1	11.6
KNB9218	10.0	17.0
KNB9252	18.4	22.4
NCo376	**15.8**	**23.4**
R579	**4.8**	**12.7**
MEAN	8.3	14.5
LSD (0.05)		15.3
CV (%)		64.4
P-Value		0.117

2.2.4 Discussion

From these results it is obvious that NCo376 have high infestation rate than the tested varieties, however, some tested varieties shows high infestation rate than NCo376 (Table 2.2). Variety N29, N38 and R96/2454 proved more resistant to smut infestation rate than other varieties, this might be attributed by genetic makeup of these varieties (Xing, 2013). Variety R95/2202, R95/4065 (R586), R97/2225 and R97/6177579 showed that they are not stable resistant to smut infestation than other varieties. The tillering rate has been reported to progressively decrease in the field infected sugarcane cultivars (Caleb, 2008).

Varieties CPCL02-6848, CPCL051791, R004055, R94/2129-1 and R95/2202579 (Table 2.3) shows stable resistant to smut infestation than other varieties. Varieties R95/2202, R95/4065 (R586), R97/2225 and R97/6177 proved that they are not resistant to smut infection rate. Magarey *et al* (2014) reported that, the infection rate of smut in a variety is mainly dependent on the races of the pathogen present and the environmental conditions. For highly susceptible variety, indicating that if the planting material is fully infected, it may result in a total failure of the crop because incidence of smut increases in the ratoon crop due to the infection of subterranean buds, which germinates to from the ratoon tillers (Xing, 2013).

Variety R94/0142 and R96/8299 (Table 2.4) shows stable resistant to smut infestation than other varieties, however, other varieties were intermediate resistant to smut, this might be attributed by timing of inoculation between smut spores growth and susceptibility of a variety to smut spores or genetic makeup of the variety to resist against smut spores (Xing, 2013).This implies that smut resistant cane cultivars should be planted in areas where smut is known to be common.

Variety BBZ951034, BR030003, BR041001 and BT7782 (Table 2.5) proved to be highly resistant to smut, while variety B991037, BJ8231, and BR971014 shows high ability to resist to smut infection. The variation in the reactions of smut among varieties might be associated with resisting to inoculation pressure (Singh et al., 2014). Cultivars with a high level of field phenotypic resistance to smut disease had relatively little pathogen proliferation after smut infection (Caleb, 2008)

Variety B00111, B00713, BR972001, BT7782 proved that they are highly resistant to smut infestation rate. The variation in reactions to smut might be associated with variety environments occurrence of difference strains of smut (Xing, 2013). The susceptible reactions of some varieties in respective of whether they are inoculated or not during the varietal screening and the series of field infection contributed to variation of varieties infection rates. Magarey et al (2014) reported that the extent of the yield and economic losses exerted on sugar cane by smut are dependent primarily on the percentage of seed cane infected and by the yield loss of each infected plants. The contrast between the disease resistance percentage for test varieties it might be the differences were due to the presence of different races of sugarcane smut (Caleb, 2008),

2.3 Preliminary Yield Trials (Preliminary Evaluation of New Varieties/Clones in Different Sugarcane Estates)

Project Codes:	**SCB 2013/04, SCB 2015/03, SCB 2016/04, SCB 2016/05 2017/4, SCB 2017/03, SCB 2017/06**
Principle investigator	**A. Kachiwile, N. Mwakyusa, G. Mwasinga and R. Mlimi**
Collaborators	**Sugarcane Estates**
Duration	**2013/14/15/16/17**
Date of Completion	**Ongoing**

Project summary

Commercial sugarcane production in Tanzania is done in rainfed and irrigated conditions. The attainable yield of 70 – 80 TCH and 45 - 50 TCH are being experienced in the country under irrigation and rainfed conditions respectively (Chambi & Issa, 2010). This is generally very low productivity that actually translate to actual sugar production of less than 7 tonnes per hectare.

The key factors leading to low productivity include the use of old varieties which have lost vigour and have succumbed to insect pests and diseases and further unfavorable weather and soil conditions. The aim of this project is to evaluate performance of newly introduced varieties in sugarcane estates of Tanzanian sugarcane. A total of 5 trials have been established: 3 at KSC, 1 at KSL and 1 at MSE in 2018/19 season. 25 on-going preliminary variety trials at KSC, KSL, MSE and TPC have been harvested at different crop stage and out of those 15 promising sugarcane varieties have been identified.

2.3.1 Introduction

Development of sugarcane varieties involve a series of stages. It starts by generating the population with genetic variability (either by crossing contrasting individuals or introduction of new varieties of known qualities) followed by evaluations across locations and selection of genotypes with superior qualities (Gazaffi, Oliveira, Souza, Augusto, & Garcia, 2014). In Tanzania, preliminary variety trial is the second stage in sugarcane variety release pipeline after germplasm introduction and/or improvement. The stage involves three crop cycles: one plant cane (PC) and two ratoons (2R). At this stage candidate varieties are compared with commercial varieties for important traits such as per cent pure obtainable cane sugar (POCS), cane-yield (tons of cane per hectare - TCH), sugar yield (tons of sugar per hectare - TSH) and tolerance/resistance to biotic and abiotic stresses. Identified superior genotypes are then passed to advanced stages until official variety release.

Objective

To evaluate performance of newly introduced varieties in sugarcane estates of Tanzanian sugarcane.

Output achieved

- 5 new preliminary variety trials established at different sugarcane estates
- 15 promising sugarcane varieties have been identified

2.3.2 Materials and Methods

The experiments were conducted in sugarcane estates fields of Kagera, Kilombero, Mtibwa and TPC. Varieties planted in Randomized Complete Block Design (RCBD) with three to five replications. Plot size and spacing differed from one sites to another. Parameters collected during evaluation are number of millable stalks, plant height, plant weight, sugar yield and quality parameters (brix, pol and purity cane). Sucrose content was calculated (TCH X %Sucrose).

Statistical analysis

Data collected at different crop growth stage was subjected to analysis of variance using GenStat statistical package version 15.

2.3.3 Results

Kilombero Sugar Company (KSC) - Irrigated variety trials

Variety trials were established at KSC estate to test performance of candidate varieties under irrigated conditions. Results are reported below in different parameters: Sucrose content, Polarization (POL), Purity, Tons Cane per Hectare (TCH), Tons Sugar per Hectare (TSH), percentage brix, number of millable stalks and stalks population per hectare.

Field 410

Fourteen B varieties were evaluated against N25 and R 579 in field 410 at KSC during the reported period. Results indicated highly significant differences in TSH (P< 0.001) and high significant difference on TCH (P<.001) among tested varieties (Table 2.7). Varieties B001250 followed by BR971004 and DB9526 had the highest TSH. Contrarily, varieties BJ8256, BR0812 and BR96013 had the lowest TSH. In terms of TCH, candidate varieties BR971004, DB9526 and B001250 had highest TCH whereas BJ8256, BR0812 and BR96013 had lowest TCH.

Table 2. 7: Preliminary sugarcane variety trial (Field 410)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
BJ8256	13.3	85.6	10.6	33.0	3.5
BR0812	13.4	89.9	11.0	34.8	3.8
BR96013	13.1	83.2	10.1	38.4	3.9
BJ78100	13.1	89.3	10.8	45.0	4.8
BJ8820	12.6	85.9	10.1	48.6	4.9
B98235	13.3	85.4	10.5	48.6	5.1
DB8113	13.2	85.6	10.5	51.0	5.3
BR041001	13.6	84.7	10.7	52.2	5.6
BR971014	12.5	81.8	9.5	63.6	6.1
BJ8534	12.9	85.7	10.2	60.0	6.1
B80689	13.1	88.2	10.6	67.2	7.2
DB9526	12.3	84.9	9.8	74.4	7.3
BR971004	13.2	90.7	11.0	70.8	7.8
B001250	13.5	87.5	10.9	76.8	8.4
N25	**13.3**	**89.4**	**10.9**	**55.2**	**6.0**
R579	**12.6**	**85.7**	**10.0**	**69.6**	**6.9**
MEAN	13.1	86.5	10.4	55.6	5.8
LSD (0.05)	1.0	5.4	1.3	20.3	2.2
CV (%)	4.8	3.7	7.3	21.9	23.0
P-Value	0.392	0.092	0.400	<.001	0.001

Planting date: 12/08/2015 previous harvest date: 28/08/2017

Harvest date: 20/7/2018 Crop cycle: R2

Field 411

Twenty six varieties (15 CP and 11 Q) were tested against N25 and NCo376. Results of selected parameters are presented in Table 2.8. There was no significance differences among tested varieties in all parameter. However, in absolute terms, variety Q219 followed by Q96 and CPO4-1367 had higher TSH. Contrariwise, varieties CPO4-1844, CPO4-1258 and CPO4-1252 had the lower TSH. For TCH, the highest performer was candidate Q96 followed by Q219 and CPO4-1367. Perversely the lowest performer was CPO4-1844 followed by CPO4-1258 and CPO4-1252.

Table 2. 8: Preliminary sugarcane variety trial (Field 411)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
CPO4-1844	14.8	86.6	11.8	14.4	0.5
CPO4-1258	14.4	92.1	12.1	16.2	0.6
CPO4-1252	14.8	93.1	12.6	16.2	0.6
Q199	14.9	91.5	12.5	18.0	0.6
CPCLO2-0843	15.0	89.7	12.4	19.8	0.7
CPO4-1619	15.0	97.9	13.3	18.0	0.7
Q190	14.3	88.4	11.6	21.6	0.7
CPO4-1321	14.6	87.8	11.8	21.6	0.7
Q183	15.0	96.5	13.1	19.8	0.7
CPCLO2-2273	14.8	90.4	12.4	21.6	0.7
Q200	14.4	88.3	11.7	23.4	0.8
CPCLO2-0926	14.5	88.7	11.9	25.2	0.8
CPO4-1566	14.6	90.6	12.1	23.4	0.8
CPO4-1426	14.8	97.4	13.2	21.6	0.8
Q177	14.9	89.3	12.2	23.4	0.8
CPCLO2-1295	14.5	93.4	12.4	23.4	0.8
CPO4-1935	14.9	94.8	12.9	23.4	0.8
Q151	15.3	89.8	12.7	25.2	0.9
Q155	15.2	93.7	13.1	23.4	0.9
Q99	14.3	90.2	11.9	28.8	1.0
CPCL95-2287	14.8	83.5	11.4	30.6	1.0
CPO4-1374	15.4	89.2	12.6	28.8	1.0
Q171	15.4	93.9	13.2	27.0	1.0
CPO4-1367	14.3	89.9	11.8	30.6	1.0
Q96	14.0	85.2	11.0	34.2	1.0
Q219	15.0	95.6	13.0	32.4	1.2
N25	**14.4**	**95.6**	**12.5**	**23.4**	**0.8**
NCo376	**14.6**	**94.0**	**12.5**	**19.8**	**0.7**
MEAN	14.7	91.3	12.3	23.4	0.8
LSD (0.05)	1.1	12.6	2.2	14.8	0.5
CV (%)	3.6	6.7	8.5	30.8	28.7
P-VALUE	0.655	0.809	0.867	0.539	0.502

Planting date: 12/09/2015 previous harvest date: 06/09/2017
Harvest date: 25/7/2018 Crop cycle: R3

Field 417

Fifteen varieties (4 B, 6 CG and 5 R) were tested against N25. Results are presented in Table 2.9. There was highly significant differences (P<0.001) in TSH and TCH among varieties tested.

The test candidate R96/2569 was the highest in terms of TSH and TCH followed by BR9701011 and N25. To the contrary, varieties DB8203, CGSP98-12 and CG99-125 had the lowest TSH. Whereas varieties DB8203, CGSP98-12 and B99114 had the lowest TCH.

Table 2. 9: Preliminary sugarcane variety trial (Field 417)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
B03110	14.8	77.3	10.5	60.0	6.3
B041291	14.6	78.1	10.5	51.9	5.5
B99114	15.7	77.8	11.2	44.6	5.1
BR9701011	15.1	77.3	10.7	69.1	7.4
CG00-092	13.2	77.3	10.4	61.9	6.4
CG96-52	14.8	74.7	10.2	50.4	5.2
CG99-087	14.8	76.0	10.3	52.4	5.4
CG99-125	15.1	77.5	10.8	45.7	4.9
CGSP98-12	14.0	76.8	9.9	33.3	3.3
DB8203	14.1	77.8	10.1	29.3	3.0
R94/6447	14.5	77.3	10.3	49.4	5.1
R96/2569	14.7	77.5	10.7	80.6	8.6
R96/6538	14.4	80.9	10.8	62.0	6.7
R97/4029	14.3	81.0	10.7	58.9	6.3
R580	14.9	76.6	10.5	55.6	5.8
N25	**14.0**	**80.8**	**10.4**	**65.9**	**6.9**
MEAN	14.6	77.8	10.5	54.4	5.7
LSD (0.05)	1.3	3.6	0.8	14.4	1.6
CV (%)	5.4	2.8	4.5	15.9	17.0
P-VALUE	0.150	0.060	0.220	<.001	<.001

Planting date: 25/09/2015 previous harvest date: 06/12/2017
Harvest date: 16/11/2018 Crop cycle: R2

Field 511

Fourteen varieties (12B and 2R) were evaluated against N25 and R579. The means for parameters studied are presented in Table 2.10. Results indicated non-significant differences in all the selected parameters: polarization, purity, sucrose, TCH and TSH. Nevertheless, candidates BT88404, BR93017 and B00167 were the best in terms of TSH whereas checks N25 and R579 were the least for the parameter.

Table 2. 10: Preliminary sugarcane variety trial (Field 511)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
B0072	20.5	87.6	13.6	33.9	4.3
R96/2116	22.3	90.6	15.1	29.5	4.5
B89447	21.7	91.4	14.8	29.8	4.5
B991037	20.6	91.4	14.1	43.5	5.9
BJ8231	22.8	91.6	15.6	39.9	6.3
DB7869	21.2	90.0	14.3	47.2	6.8
BR030003	20.7	89.7	14.0	56.4	6.8
R94/0142	23.0	93.6	15.9	46.1	7.3
KNB9211	19.2	88.3	12.8	58.9	7.7
BR96013	22.1	91.3	15.0	52.1	7.9
BBZ92953	21.7	90.2	14.7	64.4	9.4
B00167	21.2	89.3	14.3	65.5	9.7
BR93017	23.5	92.4	16.2	64.5	10.5
BT88404	19.8	88.8	13.3	83.8	11.3
R579	**21.0**	**91.1**	**14.3**	**24.1**	**3.5**
N25	**22.5**	**92.3**	**15.4**	**23.6**	**3.7**
MEAN	21.5	90.6	14.6	47.7	6.9
LSD (0.05)	3.7	6.2	3.0	50.3	7.2
CV (%)	10.5	4.1	12.4	63.2	62.7
P-VALUE	0.625	0.887	0.660	0.498	0.513

Planting date: 28/07/2015 previous harvest date: 05/07/2017
Harvest date: 12/06/2018 Crop cycle: R2

Field 219

Field 219 was planted with fifteen varieties (7 N and 8 R) that were tested against N25 and R579. The results for the selected traits at PC stage are presented in Table 2.11. Results showed significant differences ($P<0.010$) only in Purity and TCH. The highest TSH was recorded in variety R98/6092 followed by N25 and N51. To the contrary, lowest TSH was recorded in variety R94/2129 followed by R96/8149 and R95/2204.
More so, varieties N25, N51 and R579 had the highest TCH. Similar to TSH, the lowest TCH was recorded on candidate varieties R94/2129, R96/8149 and R95/2204.

Table 2. 11: Preliminary sugarcane variety trial (Field 219)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
R94/2129	13.9	77.9	10.0	68.3	6.8
R96/8149	14.1	76.7	10.0	71.7	7.1
R95/2204	14.1	77.6	10.1	80.2	8.1
N52	13.6	75.9	9.5	97.4	9.2
N50	14.5	76.2	10.1	92.8	9.4
R99/4065	13.4	78.3	9.7	98.0	9.5
R98/2431	14.5	76.5	9.8	99.4	9.8
N53	12.8	72.6	8.5	116.1	9.8
N29	13.9	75.5	9.7	103.1	9.9
N38	13.8	75.5	9.8	102.6	10.1
R96/2454	13.5	77.7	9.7	108.9	10.6
R97/2168	14.2	75.3	9.8	110.0	10.8
N43	14.5	76.3	10.1	108.0	10.9
N51	13.3	77.7	9.6	121.1	11.3
R98/6092	13.8	77.8	9.9	118.5	11.7
N25	**13.4**	**76.2**	**9.3**	**122.0**	**11.4**
R579	**13.3**	**73.7**	**8.9**	**120.6**	**10.7**
MEAN	13.8	76.3	9.7	102.3	9.8
LSD (0.05)	1.1	2.7	1.1	29.8	2.9
CV (%)	4.9	2.1	6.8	17.5	17.9
P-VALUE	0.150	0.010	0.240	0.010	0.060

Planting date: 27/11/2017 previous harvest date: NONE
Harvest date: 16/10/2018 Crop cycle: PC

Field 332

Table 2.12 summarizes performance of 10 R varieties and tested against N25 and R579 in field 332 at PC stage. Results for the selected parameters showed significant differences ($P < 0.001$) only in TCH. The highest TCH was recorded in variety R97/6177 followed by R99/4064 and N25. However, on comparative terms, varieties R99/4064, R97/6177 and N25 had the highest TSH and varieties R99/4065, R95/2202 and R98/8115 had the lowest TSH.

Table 2. 12: Preliminary sugarcane variety trial (Field 332)

VARIETY	PURITY	POL	SUCROSE	TCH	TSH
R99/4065	82.3	13.1	9.9	97.0	9.7
R95/2202	79.0	12.9	9.4	103.9	9.8
R98/8115	75.1	13.4	9.2	108.1	10.1
R00/4045	82.2	14.0	10.6	108.7	11.5
R93/4541	79.7	13.7	10.1	116.7	11.7
R98/4001	80.7	13.9	10.3	119.3	12.3
R98/2310	81.9	14.0	10.6	118.7	12.6
R95/4216	79.5	14.2	10.4	123.0	12.8
R97/6177	76.6	12.5	8.9	161.1	14.3
R99/4064	80.0	13.9	10.3	146.7	15.0
N25	**80.5**	**13.1**	**9.8**	**133.5**	**13.1**
R579	**80.5**	**14.0**	**10.8**	**112.4**	**12.1**
MEAN	79.8	13.6	10.0	120.8	12.1
LSD (0.05)	4.9	1.3	1.3	22.2	2.8
CV (%)	3.6	5.5	7.9	10.9	13.7
P-VALUE	0.143	0.189	0.133	<.001	2.810

Planting date: 27/11/2017 previous harvest date: NONE
Harvest date: 16/10/2018 Crop cycle: PC

Field 257

Performance of fourteen varieties (11 B and 3 R) that were tested against N25 and R579 in field 257 at PC stage is presented in Table 2.13.

Results for the selected parameters showed significant differences ($P < 0.001$) only in TCH and TSH. The highest TSH was observed in variety R99/4064followed by R97/6177 and N25. In the other way around, the lowest TSH was observed in varieties R99/4065, R95/2202 and R98/8115. For TCH, the highest performers were varieties R97/6177, R99/4064 and N25 whereas lowest ones were R99/4065, R95/2202 and R98/8115.

Table 2. 13: Preliminary sugarcane variety trial (Field 257)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
BR021002	23.1	93.6	15.8	7.3	1.1
BR00010	22.6	90.6	15.4	19.1	2.9
BBZ951034	20.8	89.5	14.0	28.2	3.8
R98/4162	21.3	90.2	14.4	28.1	4.0
DB94177	21.5	88.9	14.5	29.1	4.3
B00713	21.0	90.8	14.3	30.8	4.5
KNB9252	22.4	91.3	15.3	31.5	4.8
BR08004	21.1	90.7	14.3	37.9	5.6
R94/2129	22.2	91.6	15.2	35.9	5.7
B991110	18.1	85.6	11.9	59.4	7.2
BBZ8257	22.0	92.7	15.4	50.9	7.8
R96/8299	22.6	90.6	15.4	69.6	10.6
B99907	22.5	92.5	15.5	77.1	11.9
BJ8897	21.2	89.1	14.3	87.5	12.1
R579	**20.8**	**91.3**	**14.2**	**64.2**	**9.0**
N25	**20.2**	**90.2**	**13.7**	**106.6**	**14.6**
MEAN	21.5	90.6	14.6	47.7	6.9
LSD (0.05)	3.7	6.0	3.0	25.9	4.0
CV (%)	10.3	4.0	12.2	32.5	35.1
P-VALUE	0.568	0.699	0.591	<.001	<.001

Planting date: 06/08/2018 previous harvest date: 16/08/2017
Harvest date: 31/08/2018 Crop cycle: R2

Kilombero Sugar Company (KSC) - Rainfed variety trials

Variety trials were established at KSC estate to test performance of candidate varieties under rainfed conditions. The varieties tested included R 570, R 581, R 583, R 92/4246, N12, N47, TZ93-KA-120 and TZ93-KA-122. They were evaluated against NCo376.

Field 103

The means for parameters studied are presented in Table 2.14. Results for R2 indicated no significant differences for all parameters except purity at ($P<0.05$). In general, varieties R570, R583 and TZ93-KA-122 had the highest TCH and TSH while varieties with lowest TCH and TSH were R92/4246, R581and NCo376.

Table 2. 14: Preliminary sugarcane variety trial (Field 103)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
R92/4246	14.72	80.1	10.9	51.8	5.6
R581	14.29	74.9	10.0	63.6	6.3
N47	15.49	79.4	11.2	82.9	9.2
TZ93KA-122	15.05	81.6	11.3	89.9	10.1
N12	15.07	79.1	11.0	95.0	10.3
TZ93KA-120	15.14	80.6	11.1	95.3	10.6
R583	15.15	76.4	10.4	108.9	11.3
R570	14.78	79.4	10.8	109.3	11.8
NCo376	**15.03**	**78.8**	**10.9**	**66.9**	**7.3**
MEAN	14.97	78.9	10.8	84.8	9.2
LSD (0.05)	0.9	3.0	0.9	41.9	4.4
CV (%)	4	2.6	5.6	33.9	33.0
P-VALUE	0.316	0.003	0.101	0.092	0.066

Planting date: 30/12/2015 previous harvest date: 12/10/2017
Harvest date: 08/11/2018 Crop cycle: R2

Field 124

Eight varieties (2 TZ, 4 R and 2 N) were planted in field 124 and evaluated against NCo376. The means for parameters studied are shown in Table 2.15. Results showed no significant differences (P<0.05) among tested varieties for all parameters. Nonetheless, varieties R94/6113, TZ93-KA-120 and N12 had the highest TCH and TSH. Contrarily, the lowest TCH and TSH were recorded in varieties R570, N47and R 581.

Table 2. 15: Preliminary sugarcane variety trial (Field 124)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
R570	7.5	38.9	5.4	29.5	3.2
N47	7.8	38.5	5.5	30.0	3.3
R581	10.9	58.0	7.6	37.8	3.7
TZ93-KA122	7.4	40.4	5.5	40.4	4.4
R583	7.7	39.3	5.6	48.2	5.4
N12	7.6	39.5	5.6	50.4	5.6
TZ93-KA120	11.3	59.8	8.3	51.3	5.7
R94/6113	11.0	58.1	7.8	72.0	7.5
NCo376	**11.3**	**59.1**	**8.2**	**49.2**	**5.4**
MEAN	8.9	46.5	6.4	44.9	4.9
LSD (0.05)	11.8	61.0	8.5	72.9	8.0
CV (%)	87.9	87.2	88.0	110.0	110.8
P-VALUE	0.986	0.978	0.987	0.969	0.973

Planting date: 16/12/2014 previous harvest date: 9/10/2017
Harvest date: 27/11/2018 Crop cycle: R3

Field 622

The means for traits studied in this field 622 are presented in Table 2.16. Results in R2 did not show significant differences (P>0.05) in selected parameters among tested varieties. Nevertheless, the highest TSH was recorded in control variety NCo376 followed by TZ93KA-120 and R581. Conversely the lowest TSH was observed in TZ93-KA-122, R 92/4246 and R570.

In terms of TCH, the highest TCH was also recorded in control variety NCo376 followed by R583 and R581. The lowest TCH was observed in TZ93-KA-122 followed by R 92/4246 and N47.

Table 2. 16: Preliminary sugarcane variety trial (Field 622)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
TZ93KA-122	14.9	90.0	12.4	26.7	3.3
R92/4246	14.4	88.3	11.8	31.1	3.7
R570	14.7	86.7	11.8	33.9	4.0
N47	15.0	88.7	12.3	32.9	4.1
N12	15.1	88.0	12.3	33.9	4.1
R583	14.6	87.0	11.7	39.4	4.6
R581	14.8	88.9	12.2	38.1	4.6
TZ93KA-120	15.2	88.6	12.5	37.2	4.7
NCo376	**14.9**	**90.4**	**12.4**	**39.6**	**4.9**
MEAN	14.8	88.5	12.1	34.8	4.2
LSD (0.05)	0.6	4.5	0.9	8.6	1.1
CV (%)	2.7	3.5	4.9	16.9	18.4
P-VALUE	0.166	0.750	0.451	0.073	0.114

Planting date: 06/12/2015 previous harvest date: 17/01/2018

Harvest date: 19/12/2018 Crop cycle: R2

Field 670

Field 670 was planted with nine varieties (2 N, 5 R and 2 TZ) that were tested against NCo376. The results for the traits measured are presented in Table 2.17. Results showed significant differences only in POL (P = 0.008), TCH (P<0.001) and TSH (P = 0.001) for varieties tested. The highest TSH was recorded in variety R 94/6113 followed by TZ93KA-120 and NCo376. To the contrary, the lowest TSH was recorded in TZ93-KA-122, N47 and R92/4246.

On the other hand, highest TCH was observed in variety R 94/6113 followed by TZ93KA-120 and R581 and the lowest was observed in TZ93-KA-122, N47 and N12.

Table 2. 17: Preliminary sugarcane variety trial (Field 670)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
TZ93KA-122	15.2	79.8	11.2	32.5	3.6
N47	15.5	81.1	11.6	34.4	4.0
R92/4246	14.7	80.6	10.9	37.8	4.1
N12	15.4	79.0	11.2	37.5	4.2
R570	15.5	79.0	11.0	39.4	4.4
R583	15.2	78.3	11.1	41.2	4.6
R581	15.3	78.3	11.0	42.8	4.7
TZ93KA-120	15.5	79.3	11.3	49.0	5.6
R94/6113	15.0	78.2	10.7	67.2	7.2
NCo376	**15.2**	**78.1**	**11.1**	**42.6**	**4.8**
MEAN	15.3	79.2	11.1	42.5	4.7
LSD (0.05)	0.4	2.4	0.6	12.9	1.4
CV (%)	1.8	2.1	3.8	21.0	20.8
P-VALUE	0.008	0.151	0.302	<.001	0.001

Planting date: 27/09/2016 previous harvest date: 11/11/2017
Harvest date: 21/11/2018 Crop cycle: R1

Field 692

Field 692 was planted with thirteen varieties (1 N, 1 Q, 2 TZ and 9 R) that were tested against NCo376. The results for the selected traits at PC stage are presented in Table 2.18. Results showed significant differences only in purity (P = 0.031), TCH (P = 0.008) and TSH (P = 0.023). The highest TSH was recorded on variety N47 followed by R94/6113 and the check variety NCo376. To the contrary, lowest TSH was recorded in variety R94/2129 followed by R96/8149 and R95/2204.

Further, varieties N47, R97/4004 and TZ93-KA120 had the highest TCH. Oppositely lowest TCH was observed in variety R92/4246 followed by R97/4029 and R98/4162.

Table 2. 18: Preliminary sugarcane variety trial (Field 692)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
R98/4162	14.5	80.0	10.7	75.2	8.1
R97/4029	14.2	77.0	10.1	85.6	8.6
R92/4246	14.4	77.8	10.3	90.9	9.3
Q99	15.0	77.0	10.6	94.6	10.0
R583	14.6	79.1	10.7	98.3	10.5
R95/4065(R586)	15.2	77.9	10.9	97.0	10.6
R570	14.7	75.2	10.2	110.6	11.3
R581	15.0	77.2	10.6	106.9	11.3
TZ93-KA120	14.6	76.0	10.1	112.0	11.4
TZ93-KA122	14.7	76.5	10.8	107.8	11.6
R97/4004	14.1	74.6	9.9	118.1	11.7
R94/6113	14.9	80.4	11.1	111.3	12.4
N47	15.0	77.5	10.5	120.6	12.7
NCo376	**15.2**	**78.8**	**11.0**	**110.9**	**12.2**
MEAN	14.7	77.5	10.5	102.8	10.9
LSD (0.05)	0.7	3.2	0.9	21.6	2.6
CV (%)	2.9	2.5	5.2	12.5	14.1
P-VALUE	0.058	0.031	0.228	0.008	0.023

Planting date: 06/09/2017 previous harvest date: NONE
Harvest date: 12/10/2018 Crop cycle: PC

Field 664

Field 664 was planted with eight varieties (2 N, 2 TZ and 4 R) that were tested against NCo376. The results for the selected traits at PC stage are shown in Table 2.19. Among the quality parameters with significant differences exhibited in pol (P = 0.009). The highest TSH was recorded on varieties R92/4246, TZ93-KA122 and R583 whereas lowest value on R570, N41 and N47. Correspondingly, varieties R92/4246, R583 and TZ93-KA120 had highest TCH while the lowest TCH was on varieties R570, N41 and N47.

Table 2. 19: Preliminary sugarcane variety trial (Field 664)

VARIETY	POL	PURITY	SUCROSE	TCH	TSH
R570	16.0	86.5	12.2	31.0	3.7
N41	15.2	89.2	13.2	31.9	4.3
N47	20.1	90.3	13.6	39.0	5.3
R581	16.4	86.3	12.3	51.4	6.4
TZ93-KA120	18.4	87.5	12.5	51.7	6.4
R583	17.8	87.9	12.3	52.1	6.6
TZ93-KA122	17.0	90.0	13.2	50.2	6.7
R92/4246	16.8	87.0	12.7	60.7	7.9
NCo376	**15.8**	**88.1**	**12.1**	**46.2**	**5.7**
MEAN	17.1	88.1	12.7	46.0	5.9
LSD (0.05)	2.4	3.8	1.8	20.1	2.7
CV (%)	9.7	2.9	9.5	30.0	31.6
P-VALUE	0.009	0.303	0.626	0.075	0.105

Planting date: 29/12/2017 previous harvest date: NONE
Harvest date: 14/01/2019 Crop cycle: PC

Tanganyika Planting Company (TPC) - Irrigated variety trials

Field VT31

Twelve varieties (7R and 5CG) were tested against N25 and R 579 in field trial 31 at TPC in the second ratoon (R2). The information on statistical analysis are presented in Table 2.20. The results indicates that, statistically, there was a significant differences when you compare control and test varieties at (P<0.05) The results indicates that, the highest TCH was recorded in control varieties N25 and R579 followed by test variety R 94/6113 while the lowest TCH was recorded in test varieties CG98/32, R 92/4246, 189.9. With respect to TSH, results indicates that, control variety N25 had the highest TSH followed by test varieties R580 and R 94/6113 while test varieties CG98/32, R 92/4246, and CG98/46 were found to have lowest TSH.

Table 2. 20: Results for Variety Trial 31 (VT31R2)

Variety	Weight	Stalks	Stalks Pop Ha	Pol (%)	Purity (%)	TCH	TSH
R579	**2292.0**	**21.5**	**223454.0**	**15.2**	**87.7**	**318.3**	**48.3**
R580	2019.0	25.1	168697.0	17.7	90.8	280.4	49.5
R581	1752.0	26.8	136316.0	16.7	89.9	243.4	40.6
CG-SP98/12	1736.0	29.0	126231.0	15.8	87.9	241.1	38.1
CG98/10	1658.0	23.1	155141.0	15.3	88.8	230.3	35.2
CG98/32	1173.0	26.7	91656.0	15.3	87.3	162.9	25.0
CG98/46	1368.0	22.6	128591.0	17.7	90.9	189.9	33.5
CG98/47	1535.0	25.9	123603.0	16.4	89.6	213.2	35.1
N25	**2367.0**	**25.6**	**194123.0**	**15.7**	**89.3**	**328.8**	**51.2**
R 92/4246	1292.0	27.0	99446.0	17.1	90.5	179.4	30.6
R 93/6480	1831.0	25.0	152819.0	17.3	91.3	254.4	43.9
R 94/6113	2290.0	31.5	154710.0	15.2	87.3	318.1	48.5
R 94/6447	1755.0	28.7	127838.0	17.4	91.0	243.8	42.4
R 95/0017	1849.0	29.7	130303.0	14.5	86.5	256.8	36.9
MEAN	1780.0	26.3	143781.0	16.2	89.2	247.2	39.9
LSD (0.05)	283.7	3.6	33615.0	1.4	2.2	39.4	5.9
CV (%)	11.1	9.6	16.3	6.1	1.7	11.1	10.3
P-Value	<.001	<.001	<.001	<.001	<.001	<.001	<.001

Date planted: January 16, 2016 Previous harvested: February 9, 2017 Date harvested: July 10, 2018 Age at harvest: 17 Months
Crop cycle: R2

Field VT35

Ten varieties (1B, 1BJ, 1BR, 1CGPS, 2CPCL, 3DB and 1R) were tested against N25 and R579 in field trial 35 of plant cane at TPC. The information on statistical analysis are presented in (Table 2.21). Statistically, there was significant differences in TCH when you compare control and test varieties at ($P<0.05$), except for TSH parameter which indicated no significant differences ($P>0.05$) among the control and test varieties. The highest TCH was recorded in control variety R579 followed by test variety CGPS98-09 and control variety N25 while the lowest TCH was recorded in test varieties DB7869, BJ78100 and CPCL97-0393. Although, there were no significant differences in TSH parameter among the control and test varieties, significantly, control varieties R579 and N25 were found to have highest TSH while test varieties DB7869, BJ78100 and R98/4162 had lowest TSH.

Table 2. 21: Results for Plant Cane Variety Trial 35 (VT35PC)

Variety	Weight	Stalks	Stalks Pop Ha	Pol (%)	Purity (%)	TCH	TSH
R579	**1530.0**	**26.6**	**121437.0**	**15.4**	**86.8**	**212.5**	**32.7**
B991037	1139.0	27.5	86421.0	16.1	83.8	158.2	25.7
BJ78100	998.0	20.7	101228.0	15.7	86.4	138.6	21.7
BR93017	1304.0	26.4	103308.0	13.8	86.4	181.1	24.9
CGPS98-09	1418.0	19.7	153379.0	15.8	85.7	197.0	31.2
CPCL00-6131	1169.0	21.5	114891.0	17.7	90.8	162.4	29.1
CPCL97-0393	1015.0	17.2	126591.0	17.9	91.5	140.9	25.3
DB7869	937.0	24.9	78158.0	15.8	87.2	130.2	20.7
DB9436	1134.0	24.9	95490.0	15.9	87.4	157.4	24.9
DB9526	1317.0	30.8	89441.0	14.9	89.4	182.9	27.1
N25	**1384.0**	**21.8**	**133770.0**	**16.6**	**90.8**	**192.3**	**32.1**
R98/4162	1089.0	20.4	111276.0	15.8	87.5	151.3	23.9
MEAN	1203.0	23.5	109616.0	15.9	87.8	167.1	26.6
LSD (0.05)	318.5	4.2	34320.3	2.2	7.0	44.2	8.2
CV (%)	18.4	12.5	21.8	9.6	5.6	18.4	21.3
P-Value	0.01	<.001	0.004	0.044	0.532	0.010	0.073

Date planted: July 21, 2017
Date harvested: August 10, 2018
Age at harvest: 12.7 Months
Crop cycle: in PC

Field VT37

Ten varieties (1B, 1BJ, 1BR, 1CGPS, 2CPCL, 3DB, 1R) were tested against N25 and R579 in field trial 37 of plant cane at TPC. The information on statistical data analysis are presented in (Table 2.22). The results indicates that, statistically, there was significant differences in TCH among of the control and test varieties at ($P<0.05$) while TSH indicated no significant differences among the control and test varieties. The highest TCH was recorded in control variety R579 followed by test variety CGPS98-09 and control variety N25 while the lowest TCH was found in test variety DB7869, BJ78100 and CPCL97-0393. Although there was no significant differences in TSH parameter among the control and test varieties, significantly, the highest TSH was recorded in control varieties N25 and R579 and test variety CGPS98-09, while the lowest was recorded in DB7869, BJ78100, and R 98/4162.

Table 2.22: Results for Plant Cane Variety Trial 37 (VT37PC)

Variety	Weight	Stalks	Stalks Pop Ha	Pol (%)	Purity (%)	TCH	TSH
R579	**1530.0**	**26.6**	**121437.0**	**15.4**	**86.8**	**212.5**	**32.7**
B991037	1139.0	27.5	86421.0	16.1	83.8	158.2	25.7
BJ78100	998.0	20.7	101228.0	15.7	86.4	138.6	21.7
BR 93017	1304.0	26.4	103308.0	13.8	86.4	181.1	24.9
CGPS98-09	1418.0	19.7	153379.0	15.8	85.7	197.0	31.2
CPCL00-6131	1169.0	21.5	114891.0	17.7	90.8	162.4	29.1
CPCL97-0393	1015.0	17.2	126591.0	17.9	91.5	140.9	25.3
DB7869	937.0	24.9	78158.0	15.8	87.2	130.2	20.7
DB9436	1134.0	24.9	95490.0	15.9	87.4	157.4	24.9
DB9526	1317.0	30.8	89441.0	14.9	89.4	182.9	27.1
N25	**1384.0**	**21.8**	**133770.0**	**16.6**	**90.8**	**192.3**	**32.1**
R 98/4162	1089.0	20.4	111276.0	15.8	87.5	151.3	23.9
MEAN	1203.0	23.5	109616.0	15.9	87.8	167.1	26.6
LSD (0.05)	318.5	4.2	34320.3	2.2	7.0	44.2	8.2
CV (%)	18.4	12.5	21.8	9.6	5.6	18.4	21.3
P-Value	0.01	<.001	0.004	0.044	0.532	0.01	0.073

Date planted: February 21, 2018 Harvest date: February 16, 2019

Kagera Sugar Ltd (KSL) - Irrigated variety trials

Four irrigated variety trials testing varieties MN1, R 579, R 92/6545, N41, N47, N49, R 570, N19, N25 and Co617 were harvested at KSL. While one variety trial was in plant cane, two trials were in first ratoon and one trial was in second ratoon. The data from harvested trials showed varieties MN1, R92/6565, N47 and N49 to be promising similar to N25.

Field GP6D

Ten varieties (6N and R) were evaluated against N19, N25 and Co617. The trial was in second ratoon at KSL. There were highly significant differences (P<0.05) among the candidate varieties for all traits measured. However, with regards to TCH the highest performance was observed in MN1, followed by N47 and N12 (Table 2.23). On the other hand, varieties R 570 and N39 performed lower similar to control variety N25 and Co617.

Table 2. 23: Preliminary sugarcane variety trial (Field GP6D)

Varieties	Stalk/Ha	Stalk height (Cm)	Brix %	TCH
Co617	181342.0	227.6	21.5	114.3
MN1	166008.0	213.9	21.6	165.3
N12	153341.0	222.8	22.5	141.8
N19	146007.0	209.1	23.0	134.4
N25	139340.0	208.4	22.5	136.3
N39	162008.0	176.7	22.5	101.4
N41	140674.0	216.4	23.5	123.5
N47	140007.0	237.2	23.0	151.7
N49	143340.0	226.8	22.8	123.6
R570	147341.0	203.9	22.3	105.1
MEAN	151941.0	214.3	22.5	129.8
LSD (0.05)	35250.0	21.1	0.7	33.3
CV (%)	18.1	7.7	2.5	20.0
P-Value	0.287	0.001	0.001	0.008

Growth start date: 26/10/2017 Harvest date: 15/01/2019

Age at harvest: 14.7 Months Crop cycle: R2

With regard to stalk population, Test varieties did not differed significantly.

Field TP8a

Seven varieties (4N and 3R) were evaluated against N19, N25 and Co617 in field TP8a in first ratoon for the reported period. There was significant difference ($P<0.05$) in TCH among tested varieties. Variety R579 performed better followed by N41 and N49 (Table 2.24). Conversely, varieties N25 and R570 had lowest yield.

Table 2. 24: Preliminary sugarcane variety trial (Field TP8a)

Varieties	Stalks/Ha	Stalk height(cm)	Brix %	TCH
Co617	154674.4	257.7	21.7	125.8
MN1	154674.4	221.5	22.6	138.6
N19	185342.6	239.7	22.4	142.0
N25	130673.2	274.3	21.7	112.0
N41	166675.0	250.0	21.8	163.3
N47	149340.8	245.7	22.7	147.7
N49	160008.0	246.0	22.4	156.9
R570	134673.4	231.7	22.9	116.9
R579	173342.0	257.0	22.0	167.0
R92/6545	164008.2	242.6	22.0	144.5
Mean	157341.0	246.6	22.3	141.5
LSD	57028.0	36.7	1.3	35.2
CV %	28.3	11.6	4.4	19.4
P-Value	0.379	0.267	0.385	0.036

Growth start date: 14/06/2017 Harvest date: 30/08/2018

Age at harvest: 14.5 Months Crop cycle: R1

With regards to stalk population, the difference among varieties tested was not statistically significant ($P \leq 0.05$).

Field AP12A

Ten varieties (6N and R) were evaluated against N19, N25 and Co617. The trial was in first ratoon for the reported period. There were highly significant differences ($P<0.001$) among the candidate varieties for all traits measured except TCH. However, with regards to TCH the highest performance was observed in R92/6565, followed by N25 and N47 (Table 2.25). On the other hand, control variety N19 and Co617 performed lower.

Table 2. 25: Preliminary sugarcane variety trial (Field AP12A)

Varieties	Stalk/Ha	Stalk height (cm)	Brix%	TCH
Co617	134066.0	114.3	20.1	108.1
MN1	136955.0	73.4	20.5	117.9
N19	143918.0	59.6	21.6	100.4
N25	142881.0	66.0	21.4	131.6
N41	144022.0	72018.5	21.6	119.0
N47	143844.0	126.9	21.6	126.9
N49	144259.0	63801.3	21.6	114.5
R570	144126.0	126.5	21.6	126.5
R579	143311.0	124.6	21.5	124.6
R92/6545	127488.0	135.0	19.1	135.0
MEAN	140487.0	217.7	21.1	120.5
LSD (0.05)	4461.9	24.0	0.7	28.9
CV (%)	2.5	8.6	2.5	18.7
P-Value	0.001	0.001	0.001	0.372

Growth start date: 15/02/2017 Harvest date: 12/03/2018

Age at harvest: 12.8 Months Crop cycle: R1

With regards to stalk population, the difference among varieties tested was highly statistically significant ($P<0.001$). N49, R570 and N41 had the highest stalk population as opposed to R92/6565 which had the lowest.

Field TP13a

Nine varieties (6N and R) were evaluated against N19 and N25. The trial was in plant cane for the reported period. There were significant differences ($P<0.05$) among the candidate varieties for TCH. However, Highest TCH was observed in N25, followed by MN1 and N36 (Table 2.26). On the other hand, varieties N46 and N41 record lowest TCH.

Table 2. 26: Preliminary sugarcane variety trial (Field TP13a)

Varieties	Stalks/Ha	Stalk height	Brix %	TCH
MN1	140007.0	200.6	19.4	172.5
N19	121673.0	212.8	21.0	156.3
N25	131673.0	207.2	19.8	180.8
N36	123340.0	211.8	21.0	167.9
N41	128340.0	213.6	21.3	136.5
N46	143340.0	199.6	20.5	131.4
N47	131673.0	211.3	20.9	162.9
N49	126673.0	240.1	21.3	152.7
R579	118339.0	216.5	20.2	143.0
MEAN	141744.0	212.6	20.6	156.0
LSD (0.05)	161681.0	24.3	1.0	31.0
CV (%)	7.8	7.8	3.4	13.6
P-Value	0.088	0.088	0.007	0.040

Growth start date: 24/01/2017 Harvest date: 4/01/2018

Age at harvest: 11.3 Months Crop cycle: PC

With regards to stalk population, the difference among varieties tested was not statistically significant (P ≤ 0.05).

Kagera Sugar Ltd (KSL) - Rainfed variety trials

Results of two rainfed trials (PC and first ratoon) established at KSL in 2019 are reported. The varieties evaluated include N12, MN1, N41, N47, R 570 and the check Co617. Varieties were tested in different field (IR4E & LR6a).

Field IR4E

Five varieties (4N and R) were evaluated against Co617 in field IR4E in first ratoon in the reported period. Results indicated no significant differences (P<0.05) among the tested varieties in TCH. However, Variety N47, followed by MN1 had the highest TCH (Table 2.27). Alternatively, R 570 and Co617 performed least. With regard to Stalk population test varieties also did not differed significantly (P=0.11).

Table 2. 27: Preliminary sugarcane variety trial (IR4E)

Varieties	Stalk/Ha	Stalk height(cm)	Brix %	TCH
Co617	177342.0	215.7	21.8	95.8
MN1	217344.0	184.0	21.9	110.5
N12	184009.0	186.6	21.7	103.5
N41	188009.0	207.2	21.9	105.6
N47	161341.0	212.0	21.8	117.7
R570	182676.0	193.3	22.0	88.3
MEAN	145588.0	199.8	21.8	103.6
LSD (0.05)	1354.9	28.5	0.2	23.0
CV (%)	0.7	10.8	0.7	16.9
P-Value	0.110	0.124	0.110	0.160

Growth start date: 22/02/2017 Harvest date: 28/06/2018

Age at harvest: 16.2 Months Crop cycle: R1

Field LR6a
Five varieties (4N and R) were evaluated against Co617 in field LR6a in plant cane. Results indicated significant differences (P<0.05) among the tested varieties. However, Variety MN1 performed better (TCH) compared to other varieties followed by Co617 and N41 (Table 2.28). Alternatively, N12, R 570 and N47 performed least.

Table 2. 28: Preliminary sugarcane variety trial (LR6a)

Variety	Stalks/Ha	Stalk height (cm)	Brix %	TCH
Co617	145341.0	232.5	19.7	108.6
MN1	122673.0	227.7	21.0	117.3
N12	124006.0	211.0	20.8	56.2
N41	133340.0	195.9	21.5	89.6
N47	144007.0	191.8	21.3	81.0
R570	130673.0	172.7	20.9	72.5
MEAN	139029.0	205.3	20.9	87.5
LSD (0.05)	5273.8	50.2	0.8	33.8
CV (%)	2.9	18.5	2.9	29.2
P-Value	0.002	0.158	0.002	0.012

Growth start date: 8/10/2016 Harvest date: 16/12/2018

Age at harvest: 14.3 Months Crop cycle: PC

Regarding stalk population, the highest was recorded in Co617 followed by N47. On the other hand the lowest stalk population was observed in N12 and MN1. Alternative, varieties did not differ significantly in stalk population test.

Mtibwa Sugar Estate (MSE) – Rainfed variety trials
Two variety trials at MSE (Field 3Ba and D8) were harvested in 2018/19 season in plant cane stage under rainfed condition. Thirteen varieties (8R, 2 CPCL, 2 TZ and 1N) and NCo376 as check were evaluated.

Field 3Ba
Twelve varieties were tested in field 3Ba, Results on plant cane indicated there were significant differences (P < 0.05) in TSH among tested varieties. The varieties R98/8115 and R 97/6177 scored the highest TSH statistically to control variety, R 00/4055 had the lowest TSH (Table 2.29).

Table 2. 29: Preliminary sugarcane variety trial (3Ba)

Variety	POL	Purity	Sucrose	TCH	TSH
CPCL02-6848	18.44	84.25	16.82	69.6	11.61
CPCL05-1102	18.89	83.62	17.13	50.2	8.57
N 12	17.51	84.76	16.39	60.2	9.79
NCo376	18.03	85.78	16.83	65.4	11
R570	19.37	84.48	17.55	68.5	12.05
R93/4541	18.48	86.12	17.18	81.2	13.95
R95/4065	17.42	86.4	16.49	65.6	10.98
R96/2281	17.42	83.6	15.93	74.7	11.95
R97/6177	18.06	85.39	16.87	87.5	14.76
R98/4001	16.86	84.19	15.5	61.4	9.75
R98/8115	17.4	85.35	16.27	92.2	15.02
ROO/4055	17.7	84.74	16.34	50.9	8.31
MEAN	17.97	84.89	16.61	68.9	11.48
LSD (0.05)	1.45	3.843	1.429	2120	3.626
CV (%)	5.6	3.1	6	21.4	22
P-Value	0.054	0.902	0.255	0.005	0.005

Growth start date: 06/10/2017 Harvest date: 30/11/2018

Age at harvest: 13.8 Months Crop cycle: PC

Field D8

Five varieties were tested in field D8, Results on plant cane indicated there were highly significant differences (P< 0.001) among the candidate varieties for all traits measured. However, with regards to TSH the highest score was observed in N12 which had the highest TSH statistically to control variety, TZ93-KA-120 had the lowest TSH (Table 2.30).

Table 2. 30: Preliminary sugarcane variety trial (D8)

Variety	POL	Purity	Sucrose	TCH	TSH
N 12	14.03	66.46	12.72	68	11.45
NCo 376	15.39	62.43	12.7	66.3	8.334
R 570	12.3	54.69	10.1	65.7	6.574
TZ93-KA-120	14.01	66.01	11.85	26.8	3.204
TZ93-KA-122	14.35	69.28	12.88	61.5	7.861
MEAN	14.02	12.03	12.03	57.6	
LSD (0.05)	1.299	1.263	1.263	17.52	1.079
CV (%)	6	6.8	6.8	19.7	15.58
P-Value	0.004	0.002	0.002	0.001	<0.001

Growth start date: 24/11/2017 Harvest date: 1/09/2018

Age at harvest: 10 Months Crop cycle: PC

2.3.4 Discussion

Kilombero Sugar Company (KSC)

Various sugarcane varieties were evaluated based on respective parameter. Tone cane per hectare (TCH) and tone sugar per hectare (TSH) are important sugarcane parameters as they provide an insight toward selecting elite sugarcane variety for commercial purposes. From the current experimental data at the preliminary stage of evaluation at KSC, there is an insight that better varieties for both rainfed and irrigated conditions are going to be identified.

Under irrigation conditions the TCH and TSH ranged from 62.0 - 161.1 and 6.7 - 14.4 respectively. Whereas varieties R98/6092, R99/4064, B001250, Q231, N25 and R96/2569 were the best performers across the trials. In the other way, TCH and TSH under rainfed condition ranged from 27.0 – 118.1 and 1.0 – 12.7 respectively. The best performers under rainfed condition were N47, R92/4246, R94/6113, NCo376, R570, BT88404, R94/6113 and Q219. However, the candidate variety TZ93-KA122 consistently appeared in most frequencies among the top four in terms of TSH and TCH across the trials. Therefore these varieties are recommended for further evaluations to check their stability in performance as most of the trials were at the PC level.

Tanganyika Planting Company (TPC)

Trial 31 was in second ratoon whereby twelve varieties were tested against N25 and R579. The variety R 94/6113 is promising, had high TCH and TSH. Variety R580 had higher TSH as compared to control. The promising ratooned varieties are essential commercially for the development of sugar industry in Tanzania. These findings are in line with Aamer *et al.* (2017) who found that, the promising ratoon varieties are considered economical for the farming communities because production cost is 25 to 30% less than plant crop along with saving of seed material. TCH and TSH were assessed in other field trials for selecting elite sugarcane variety. Field trial 35, 36 and 37 some varieties are promising for future benefits. Varieties N25 and R579 of field trial 35; varieties R 85/1334, N25, and KQ228 of field trial 36; and varieties R579, CGPS98-09, and N25 of field trial 37 are mostly promising in terms of TCH. The capability of the amount of sugar to be produced by the sugarcane for commercial purposes and home consumption is determined by TSH. Each trial 35, 36, and 37 was evaluated on TSH. Varieties R579, and N25 of field trial 35; varieties KQ228, CG00-028, and Q190 of field trial 36; and varieties N25, R579, and CGPS98-09 of field trial 37 are also promising varieties as they indicates to have valuable amount of sugar in terms of quantity and quality.

Kagera Sugar Ltd (KSL)

Varieties MN1 and N47 showed superior performance in producing more tonnes caner per hectare compared to all varieties tested under irrigated regime at KSL in plant cane, first and second ratoon stages. If trends continue to third ratoon can be recommended for advance evaluation before commercially released under irrigated regime while R570 struggles in the same condition. Varieties MN1 showed superior performance in producing more tonnes cane per hectare compared to all varieties tested under rainfed conditions at KSL in plant cane and first ratoon stages. This suggested it can adapt to moisture stress and hence if trends continue to third ratoon can be recommended for advance evaluation before commercially released while R570 struggles in the same condition.

Mtibwa Sugar Estate (MSE)

Varieties R98/8115, R97/6177 and N12 proved statistically to produce more tonnes sugar per hectare compared to other varieties tested in rainfed scheme for this reported period at MSE in plant cane stage. This suggested they can easily adapt to drought environment and hence if trends continue can be recommended for advance evaluation before commercially released. Varieties R00/4055 and TZ 93-KA-120 struggles in the same conditions. Generally, the yields were encouraging. This could have been attributed by good management such as weed management and fertilization.

2.4 National Performance Trials

Project Codes	**SCB 2016/05, 2017/4**
Principle investigator	**TOSCI**
	A. Kachiwile, N. Mwakyusa, G. Mwasinga and R. Mlimi
Collaborators	**Sugarcane Estates**
Duration	**2016/17 - 2021**

Project summary

National performance Trials (NPT) are designed to test new plant varieties for performance compared to varieties currently in the market. Aim is to allow regulatory authority TOSCI to evaluate before they release as improved varieties. In this work, four varieties which include rainfed (R 570 & N47) and irrigated (N36 and R 85/1334) varieties were planted in different sugarcane estates. The trials are in progress for data collection and evaluation.

Key results

Results are in pipeline for data collection

2.4.1 Introduction

National performance Trials (NPT) are designed to test new plant varieties for performance compared to varieties currently in the market. The trials are done across the country at specific agro-ecological zones where the full potential of the sugarcane varieties can be expressed.

NPTs are designed to determine the agronomic potential of a new variety before it is released for commercialization. Candidate varieties are planted alongside existing varieties (checks) and performance gauged to ensure only superior varieties are released.

Tanzania Official Seed Certification Institute (TOSCI) is mandated to monitor and evaluate these trials in collaboration with TARI Kibaha. Candidate varieties are tested for Distinctiveness, Uniformity and stability (DUS) for a minimum of two seasons. DUS tests are conducted by TOSCI in selected areas depending on the recommended areas for the variety. Once the tests are complete, the Variety Release and Seed Certification Committee evaluate the data in order to make recommendations for release

It is important that a reasonable number of commercial varieties with different genetic background are deployed to avoid monoculture system which has for many years been the case in the Tanzanian sugar industry. Hence, we found it is important to evaluate varieties in both irrigated and rainfed condition in various agro-ecologies where sugarcane is grown.

Objective
To verify performances of the new varieties under NPT compared to those currently in the market, in order to determine their potentiality before commercially released.

Specific Objectives

i. Performance evaluation of new varieties tested under national performing trials with commercially available varieties in the market
ii. To identify potential new varieties for release at national level

Output achieved

- 5 National Performance Trials (NPT) established at different sugarcane estates

2.4.2 Materials and Methods

The experiments were laid out under irrigation system in all fields both at TPC and KSC estates. The experiment details were as hereunder:

- Plot size: 10 m x 4 row with a net plot size of 8 m x 2 rows
- Treatments: Test varieties N36 and R 85/1334
  : Control varieties N19, N25, N30, N41, R 570 and R 579
- Design: RCBD at TPC with three replications
- A 4 x 4 Triple lattice design at KSC, KSL and MSE
- Cultural practices: irrigation, fertilization and weeding as per commercial field recommendation
- Data collected:
  - ✓ cane yield (TCH)
  - ✓ sugar yield (TSH)
  - ✓ sucrose %
  - ✓ reaction to insect and diseases

2.5 Advanced Sugarcane Fuzz Evaluation and Selection

Project Code	**SCB 2017/06**
Principle investigator	**Kachiwile, N. Mwakyusa, R. Mlimi, G. Mwasinga**
Location	**TARI-Ifakara and Sugarcane Estates**
Duration	**2017/18 - 2021**

Project summary
The sugarcane varieties genetic makeup varying in traits expressing desirable characteristics in different environmental conditions. The trait influences selection of variety which can be used as a superior variety for commercialization. The project intend to contribute on sugarcane productivity through improved sugarcane varieties with genetic variability for commercialization in Tanzania. The project imported a total of 31 new/promising clones of

sugarcane and distributed to TARI Ifakara, KSC, TPC and KSL. At the end of the project, one or two clones will be identified for improved sugarcane productivity. A total of 142 selected sugarcane clones have been planted in different agro ecological zones in plant cane stage.

2.5.1 Introduction

In Tanzania sugarcane is grown in about 60,000 hectares. However, its productivity is relatively low and not rewarding to investment made particularly to small-scale farmers. Low cane and sugar yields are attributed to multiple factors including predominantly use of low yielding varieties, prevalence of pests and diseases, poor ratoonability and many others. To overcome problems associated with low potential varieties; TARI Kibaha imported botanical seeds for sugarcane from Barbados. The seeds have undergone several stages of evaluations leading to selection of few promising clones. The evaluation was done at TARI Ifakara.

Because selection using imported fuzz has provided few commercially valuable clones, it is necessary to establish multi-locational trials to test for their performance and adaptability. Performance of promising clones will be compared for general establishment, growth, cane yield, sugar recovery, ratooning ability, resistance against major diseases and pest insects in different locations namely KSC, TPC, MSE and KSL.

Objective

- To contribute to improved sugarcane productivity in Tanzania through increased genetic variability of commercial varieties

Specific Objectives

- To identify predetermine genetic combination from imported fuzz
- To identify and select the potential and best plant arising from single seedling
- To evaluate and select sugarcane clone from single row to 4th stage (two row)
- To evaluate selected clones from stage 3 in different agro-ecology for yield and resistance to biotic and abiotic factors.

Expected Output

At least one (1) or two (2) clones identified for improved sugarcane productivity and enhanced gene pool by the end of the project cycle.

2.5.2 Materials and Methods

Source and description of botanical seeds of sugarcane (fuzz)

Fuzz from the predetermined genetic combinations (GC) were sourced from Barbados at West Indies Central Sugar Cane Breeding Station (WICSCBS). The breeding station was commissioned to undertake crossing between selected parents (100 GC) with desirable attributes for the sugar industry in Tanzania. The attributes included: high cane and sugar yields, resistance to sugarcane smut and other diseases, free trashing habit, shy flowering and adaptability to moisture stress. Thereafter, fuzz from 92 cross combinations in 6 clusters out of the 100 genetic combinations were successfully imported to Tanzania in August 2014.

Experimental locations and set ups

Selection criteria of clones

Generally selection of promising clones was based on general appearance (stool architecture), stalk number/mass as an indicator of potential yield, growth habit (erect growth), and ability to withstand attack/not to be infested by insect pests and diseases (absence of smut, white scale and *Eldana*) and brix content. For brix content, quality analysis was done by using a brix refractometer on selected clones from stage 3 by brix reading from at the bottom, middle and top for two stalks per clone.

2.5.3 Results

At stage three of selection, a total of 142 selected sugarcane clones have been planted in different agro ecological zones in plant cane stage. Distribution is as shown in the table 2.31 below. Evaluation using selection criteria will be done at right growth stage.

Table 2. 31: Sugarcane clones distribution data 2019

Estate/site	Clones (#)	DOP	Rep	Status
IFAKARA	31	4 /04/ 2018	3	Very good
TPC	44	17/01/2019	3	20 are promising
KSL	67	15/03/2019	3	NA

2.6 Rapid Seedcane Multiplication (Evaluation of Sugarcane Seed Cane Production Methods)

Project Codes.	**SCB 2017/07**
Principle investigator	**A. Kachiwile, N. Mwakyusa, R. Mlimi, G. Mwasinga**
Location	**TARI - Kibaha**
Duration	**2017/18**

Project summary

Sugarcane production in Tanzania is done by large-scale and small-scale farmers. Small-scale farmers contribute forty percent of total cane crushed per annum. However, their contribution is likely to decrease due to low productivity caused by several factors including prevalent of pests and diseases resulting from use of poor quality planting materials. Thus, a large proportion of the farmers use traditional, poor quality seedcane resulting in poor yields. A total of 11 sugarcane varieties (NCo376, R579, N41, R570, R575, N25, N30, N19, N36, N47 and R85/1334) that were sourced from TARI Kibaha were used for rapid seedcane multiplication. The aim of the project is to increase sugarcane productivity in Tanzania through improved access and deployment of healthy seed canes. 34,111 seedlings produced from eleven sugarcane varieties.

2.6.1 Introduction

Sugarcane is a perennial crop, as once a new crop is planted it is harvested repeatedly for up to five seasons or more. Being vegetatively propagated and practice of ratooning which is necessary for economic optimization, permits systemic pathogens to survive, multiply and spread from one crop to the next. Also, the perennial nature of the crop and the fact that it is usually grown as a monoculture favours the build-up of diseases.

A properly designed seed production system is must *i.e.* a system through which seed borne diseases are eliminated or its spread is minimized and at the same time quality, vigour and production potential of a variety could be maintained over a longer period. The benefit of improved sugarcane varieties cannot be realized until enough healthy seed is produced and supplied to farmers for growing on large scale (Karuppaiyan & Ram, 2012).

Sugarcane production in Tanzania is done by large-scale and small-scale farmers. Small-scale farmers contribute forty percent of total cane crushed per annum. However, their contribution is likely to decrease due to low productivity caused by several factors including prevalent of pests and diseases resulting from use of poor quality planting materials. Thus, a large proportion of the farmers use traditional, poor quality seedcane resulting in poor yields. Moreover, they rely on very old, degenerated and low genetic potential varieties; namely, NCo376 for KSC and MSE, and Co617 for KSL mill areas (Chambi & Isa, 2010). These varieties have are susceptible to several diseases including smut. Use of seedcane from the commercial crop has been responsible for rapid multiplication of a large number of diseases and pests such as smut, ratoon stunting, stalk borers and white scale which adversely affect cane yield and quality.

Inadequate availability of quality seedcane, poor seedcane replacement rate and poor quality canes has adversely contributed to low sugarcane productivity and sugar recovery. The importance of enhancing smallholder farmers' access to quality seedcane can play a role in raising sugarcane productivity. To maximize yield potential for all sugarcane varieties, it is essential that plantings be made with seedcane that is free of pests and diseases. To accomplish this, healthy seed-cane nurseries should be established with seedcane of recommended varieties from a heat treatment program or from seedcane that has been produced by tissue culture.

Objective

To increased sugarcane productivity in Tanzania through improved access and deployment of healthy seed canes.

Achieved Output

34,111 seedlings produced from eleven sugarcane varieties.

2.6.2 Materials and Methods

Plant materials

A total of 11 sugarcane varieties (NCo376, R579, N41, R570, R575, N25, N30, N19, N36, N47 and R85/1334) that were sourced from TARI Kibaha were used for rapid seedcane multiplication activity that took place at the station from March 12, 2019 to April 11, 2019.

Preparation of growth media

A mixture of forest soil, sand and farm yard manure was sterilized 3hours; after cooling the soil was potted in polythene. For each variety, a single eye bud was planted per polythene bag of 4 inches polythene bags. Routine irrigation was done. Pesticide (Gladiator) was applied i.e. 25cc/15L of water to control termites. Sprouting of each variety was recorded seven days after planting. At four weeks, a compound fertilizer (N17:P17:K17) was applied at a rate 5g per seedling.

2.6.3 Results

Establishment of the seedlings after planting at TARI Kibaha is as presented in Table 2.32. The establishment rate ranged from 31.0 to 97.5%. The highest establishment was observed in variety R570 (97.5%) followed by N19 (93.9%) and NCo376 (89.6%). To the contrary, the lowest establishment was on varieties N30 (31.0%), N36 (32.2%) and R575 (45.8%).

Table 2. 32: Seedcane establishment from single bud multiplication method at TARI Kibaha

Variety	Stalks (#)	Buds planted (#)	Dispositio n (%)	Established settlings (#)	Establishment rate (%)
NCo376	4218.0	29580.0	69.0	26490.0	89.6
R579	172.0	1610.0	3.8	1203.0	74.7
N41	227.0	1280.0	3.0	1020.0	79.7
R570	36.0	200.0	0.5	195.0	97.5
R575	334.0	1836.0	4.3	840.0	45.8
N25	100.0	615.0	1.4	400.0	65.0
N30	247.0	3749.0	8.7	1164.0	31.0
N19	128.0	756.0	1.8	710.0	93.9
N36	71.0	1000.0	2.3	322.0	32.2
N47	140.0	1572.0	3.7	1227.0	78.1
R85/1334	68.0	680.0	1.6	540.0	79.4
Total	**5,741**	**42,878**	**100**	**34,111**	**766.9**

2.6.4 Discussion

The differences in establishment among the varieties are thought to be due to their genetic variations, high genetic variation may promote long-term population persistence by allowing adaptations to changing environmental conditions (Lavergne and Molofsky, 2007; Bock *et al.*, 2015) however, further investigations especially for poor performers is paramount.

Recommendations

Other rapid seedcane multiplication techniques such as bud chips and tissue culture need to be investigated.

2.7 Germplasm Conservation and Maintenance (Sugarcane Germplasm Conservation for Sustainable Sugarcane Sector Development)

Project Code.	**SCB 2017/08**
Principle investigator	**A. Kachiwile, N. Mwakyusa, R. Mlimi and G. Mwasinga**
Collaborators	**Agronomy Section**
Location	**TARI - Kibaha**
Duration	**2017/18**

Project summary

Germplasm conservation conserve the genetic traits of endangered and commercially valuable species. Such conservation serves as the link between the acquisition and utilization of plant genetic resources and includes all the means by which plant genetic resource is stored and preserved. Sugarcane germplasm are concerned for the project. The aim of the project is establishment and conservation of sugarcane germplasm of both improved and locally sugarcane varieties. 279 sugarcane imported varieties have been collected from all sugar estates, while 41 local sugarcane clones have been collected from different sugarcane growing regions of Tanzania planted and are growing well. A total of 320 sugarcane varieties have been collected and conserved at TARI Kibaha for future application of conserved traits.

2.7.1 Introduction

Traditional plant breeding has contributed to crop improvement. Because of the biological complexities of sugarcane, sexual hybridization strategies have not been very effective in developing improved cultivars. Nevertheless, successful crop improvement through breeding relies on diversity of the gene pool; the wide diverse the germplasm collections the more effective the crop improvement (Withers et al., 1990; Rao, 2004). Hence collection and conservation of germplasm are prerequisite for assured availability to different users including plant breeders.

The genetic resources of most crops can be conserved as seeds in seed gene banks; however, some highly heterozygous and vegetatively crops, and those that produce recalcitrant seeds cannot (Withers et al., 1990). Conservation serves as the link between the acquisition and utilization of plant genetic resources and includes all the means by which plant genetic resource is stored and preserved. There are basically two approaches for plant genetic resources conservation; namely in field gene bank (*in situ)* and in vitro (*ex situ)* (Engelmann and Engels, 2002; Rao, 2004). While i*n situ* involves maintaining genetic resources in natural habitats where they occur, *ex situ* refers to conservation of genetic resources outside the native habitat (Engelmann and Engels, 2002; Rao, 2004). Therefore, the objective of this project is to ensure readily availability of genetic resources for future crop improvement.

Objective

To establish and conserve germplasm collection of improved and locally collected sugarcane varieties available in Tanzania

2.7.2 Materials and methods

A total of 279 sugarcane imported varieties were collected from different estates in Tanzania 41 local sugarcane clones were collected from different sugarcane locality and planted at TARI Kibaha. Varieties were planted in two-row plot, having a spacing of 1.5m and length of 10m, each plot was planted with 50 setts.

Output achieved to date

A total of 320 sugarcane varieties collection conserved at TARI Kibaha.

Challenges

The most challenge is availability of irrigation water during the dry seasons. Apart from stressing the plants also exacerbated the problem of termites.

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3.0 AGRONOMY AND PHYSIOLOGY

3.1 Evaluation of Existing Agronomic Package to Selected Sugarcane Varieties in Outgrowers Fields of Kilombero Sugar Mill Area (Variety trial in OG fields)

Project Code: **AP 2013/03/02**
Investigators: **Kalimba. H. F, L. Lwiza, S. Kajiru and Msita, H. B.**
Collaborators: **LAO's, VAEO's**
Date of commencement: **2013/14**
Planned end date: **On going**
Reporting period: **2018/2019**

Summary
Sugarcane (*Saccharum officinarum* L) is an important commercial crop in Tanzania. It is the main source of sugar produced for domestic consumption and export. The average sugarcane yield in outgrowers fields has remained low (30-40 tons/ha) below the attainable yield potential of more than 100 tons/ha. Farmers at Kilombero rely on a single variety (NCo376) which is highly susceptible to a number of diseases including smut. In order to recommend new sugarcane varieties for outgrowers under rainfed environment, trials were established to assess three promising varieties (N47, N12, and R 570) against NCo376. Preliminary results revealed to have two promising varieties (N47, R 570) which were selected for further evaluation in large blocks (1 acre for each variety).

3.1.1 Introduction

Sugarcane (*Saccharum officinarum* L) is an important commercial crop in Tanzania. It is the main source of sugar produced for domestic consumption and export. In Tanzania its production is concentrated mainly in three regions of Morogoro, Kagera and Kilimanjaro. Currently, most sugarcane is grown in estates, owned by the sugar processing factories and also small scale growers known as outgrowers (OG).
Kilombero mill area have about 8500 active registered OG who supply about 43% of sugarcane crushed at Kilombero 1 (K1) and Kilombero 2 (K2) factories (SBT, 2017). Average sugarcane yield in OG fields is about 40 tons/ha (Chongela, 2015). This is low compared to the attainable yield potential of more than 100 tons/ha (SBT, 2017). According to survey conducted to small scale sugarcane producers it was observed that lack of improved varieties was among the major factors contributing to low sugarcane production (Mtunda *et al*., 1998). Other factors included low level of field management particularly poor management of weeds, low level of fertilization and sometimes moisture stress due to unreliable rainfall. At Kilombero only one variety (NCo376) is grown by outgrowers, this variety is very susceptible to smut disease. The long existence of NCo376 to outgrowers is due to fact that most of the new varieties being evaluated do not exhibit wide adaptability like NCo376. It was therefore important to screen new varieties which are adaptive to drought and also resistant to smut.

Objective

1. To test new promising varieties with the existing management package under rainfed condition in OG fields

Specific Objectives

1. To test performance of tested varieties on existing management packages

Output achieved to date

Two promising varieties for rainfed condition identified

3.1.2 Materials and Methods

Location

Kilombero mill area.

During 2013/14 seasons experiment was designed to evaluate sugarcane varieties under rainfed conditions. Experiments comprised of two phases. During the first phase experiments were conducted consecutively for four seasons in small replicated trials. Second phase started in 2017/18 season in which selected varieties were planted in large blocks trials of one acre for each variety and were compared to NCo376 as a standard check so as to have viable variety recommendation.

Design

1st Phase experimentation

Experiment comprised of four treatments namely R 570, N12, N47 and NCo376 as a standard check, designed in Split plots in RCBD with three replications. Main factors were two management levels (1) The recommended technologies (RT) which was 100 kg N ha^{-1} + 100 kg K ha^{-1} +25 kg P ha^{-1} and 4 lit Volmuron ha^{-1} (2) Farmers' practices (FP) which varied from farmer to farmer but usually averaged to 30 kg of nitrogenous fertilizer without phosphate and potash. Each variety was tested against the selected management packages in different sites at K1 and K2. Phosphate and potash fertilizers were applied at planting and nitrogen was applied two months later.

Plot size

Six rows of 10 m long spaced at 1.2 m, comprising two centre rows of test varieties and two guard rows of NCo376 variety on each side.

2nd Phase experimentation (Large block trials)

Large blocks comprising of three acres each, three varieties R 570, N47 and NCo376 were planted each variety occupying one acre at every location.

Data collected

- Data on yields (stalks number, stalks weight, purity % and sucrose %,) were collected during harvest at the age of 10-12 months

Data analysis

Data were subjected to ANOVA using GenStat statistical package version 12, Means were compared using LSD at P=0.05.

3.1.3 Results

2017/18 trials (PC)

Four trials were established in November 2017, at Sonjo, Nyange, Kitete and Mfilisi. Results are presented in Table 3.1.

Tons of cane per hectare (TCH)

Results presented in Table 3.1 indicated that higher TCH (169.6) was recorded in RT with variety R 570 at Mfilisi and lowest (54.0) in FP with variety N12 at nyange. Generally in RT all tested varieties performed above the standard check NCo376. Performance of each variety differed from one location to another; however R 570 had higher TCH followed by N12. Standard variety NCo376 was the least compared to all new tested varieties for both FP and RT.

Table 3. 1 Results of TCH from different varieties grown under two management practices in OG fields at Kilombero

	Nyange			Mfilisi			Kitete		
Varieties	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	89.4	101.2	95.3	145.4	169.6	157.5	117.0	166.9	142.0
N12	54.0	93.5	73.7	163.2	173.2	168.2	110.0	140.9	125.4
N47	94.5	88.1	91.3	132.5	166.2	149.3	115.7	107.5	111.6
NCo376	76.2	83.1	79.7	133.6	134.3	133.9	113.0	125.3	119.1
MM	78.5	91.5		143.7	160.8		113.9	135.2	
CV %	**22.4**			**22.4**			**16.6**		
LSD (0.05)	**23.91**			**42.94**			**26.06**		
P(0.05)	**0.27**			**0.39**			**0.12**		

Note: FP= Farmers Practice, RT= Recommended Technology, VM= Variety Mean, MM=Management Mean

Tons of Sugar per Hectare (TSH)

Results presented in Table 3.2 indicate that R 570 had higher TSH compared to other tested varieties including the standard variety NCo376. N12 was the second followed by N47.

Table 3. 2 Results of TSH from different varieties grown under two management practices in OG fields at Kilombero

	Nyange			Mfilisi			Kitete		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	11.3	12.8	12.0	21.7	25.1	23.4	14.7	20.0	17.4
N12	6.3	10.0	8.1	23.2	24.8	24.0	13.3	16.0	14.6
N47	11.4	10.2	10.8	18.8	23.4	21.1	13.7	13.3	13.5
NCo376	8.5	9.8	9.2	19.9	18.7	19.3	12.4	13.3	12.9
MM	**9.4**	**10.7**		**20.9**	**23.0**		**13.5**	**15.7**	
CV %	**31.1**			**23.0**			**19.6**		
LSD (0.05)	**3.93**			**6.36**			**3.60**		
P(0.05)	**0.19**			**0.39**			**0.08**		

2016/17 trials (R1)

Eight trials were established in January and March 2016 at Mang'ula (Ulanga cotton), Kitete mradini, Kitete mgudeni, Kungurumwoga, Msolwa station, Msolwa ujamaa, Nyange and Nyamamba. Results presented are for R1 crop cycle.

Tons of cane per hectare (TCH)

Results are presented in Table 3.3. Performance of each variety were not significant (P>0.05) from one variety to another. The highest TCH of 131.3 was recorded in variety N12 under RT at Nyamamba and lowest 66.6 in variety N47 under FP at Nyange.

Table 3. 3 Results of TCH from different varieties grown under two management practices in OG fields at Kilombero

	Nyamamba			**Nyange**			**Kitete**		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	77.4	113.0	95.2	71.8	76.1	73.9	113.3	129.7	121.5
N12	100.5	131.3	115.9	67.9	84.0	75.9	99.1	99.7	99.4
N47	79.1	99.5	89.3	66.6	76.6	71.6	88.9	113.2	101.0
NCo376	110.8	114.9	112.9	88.9	88.9	88.9	93.0	93.4	93.6
MM	**91.95**	**114.68**		**73.8**	**81.4**		**98.8**	**109.0**	
CV %	**26.30**			**21.90**			**24.90**		
LSD (0.05)	**34.20**			**21.35**			**32.52**		
P(0.05)	**0.29**			**0.34**			**0.30**		

Tons of Sugar per Hectare (TSH)

Results presented in Table 3.4 indicated that average TSH for R570 was significant (P<0.05) higher compared to other tested varieties. Kitete field recorded the highest TSH than other locations.

Table 3. 4 Results of TSH from different varieties grown under two management practices in OG fields, Kilombero.

	Nyamamba			**Nyange**			**Kitete**		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	10.7	8.0	9.3	6.4	7.8	7.1	14.54	17.0	15.7
N12	10.2	13.2	11.7	6.6	8.7	7.7	11.9	12.7	12.3
N47	6.9	9.8	8.3	6.3	7.6	7.0	11.8	15.2	13.5
NCo376	11.0	11.8	11.4	8.6	9.0	8.8	11.9	12.7	12.3
MM	**9.7**	**10.7**		**7.0**	**8.3**		**12.6**	**14.4**	
CV %	**27.50**			**20.60**			**25.00**		
LSD (0.05)	**3.56**			**2.00**			**4.23**		
P(0.05)	**0.02**			**0.21**			**0.03**		

2015/16 trials (R2)

Eight trials were established in December 2015 at Kielezo, Kitete, Mbwade, Mtakanini, Kungurumwoga, Msolwa, Miwangani and Mkula. Results are presented in table 3.5.

Tons of cane per hectare (TCH)

During this season high yield in TCH was observed both for FP and RT in all the experimental sites. In management practices where RT was used variety R 570 recorded the highest TCH of 173.2. The lowest TCH of 57.1 was recorded in FP.

Table 3. 5 Results of TCH from different varieties grown under two management practices in OG fields, Kilombero.

	Kitete			Mtakanini			Deco (Mbwade)		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	145.4	169.6	157.5	57.1	63.8	60.4	96.5	111.0	103.8
N12	163.2	173.2	168.2	58.9	68.9	63.9	83.3	103.6	93.5
N47	132.5	166.2	149.3	60.3	63.3	61.8	76.2	111.6	93.9
NCo376	133.6	134.3	133.9	69.4	108.3	88.9	120.3	121.6	121.0
MM	**143.7**	**160.8**		**61.5**	**74.4**		**94.1**	**112**	
CV %	**22.4**			**24.5**			**27.1**		
LSD (0.05)	**42.94**			**21.21**			**35.2**		
P(0.05)	**0.39**			**0.03**			**0.32**		

Tons of Sugar per Hectare (TSH)

Results are presented in Table 3.6. Generally RT recorded higher TSH compared to FP in almost all sites. Variety R 570 performed better compared to other tested varieties including NCo376

Table 3. 6 Results of TSH from different varieties grown under two management practices in OG fields, Kilombero.

	Kitete			Mtakanini			Deco		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	21.7	25.1	23.4	10.0	9.0	9.5	13.1	15.9	14.5
N12	23.2	24.8	24.0	9.1	10.6	9.9	11.3	13.7	12.5
N47	18.8	23.4	21.1	9.4	8.9	9.1	10.5	16.0	13.3
NCo376	19.9	18.7	19.3	10.5	15.4	13.0	12.8	16.1	14.5
MM	**20.9**	**23.0**		**9.7**	**11.0**		**12.0**	**15.5**	
CV %	**23.0**			**27.3**			**28.6**		
LSD (0.05)	**6.36**			**3.56**			**4.92**		
P(0.05)	**0.39**			**0.31**			**0.78**		

2014/15 trials (R3)

Eight trials were established in December 2014 at Kungurumwoga, Mbwade, Mang'ula, Sonjo, Msolwa Ujamaa and Kidatu. The results for this experiment are presented in Table 3.7.

Tons of Cane per Hectare (TCH)

Based on the results high yield in TCH was recorded in almost all sites for both FP and RT. However, R 570 recorded the highest TCH (124.9) under RT while NCo376 recorded the lowest TCH (45.1) under FP. These results did not differ significantly (P>0.05) in most of the sites. In general R 570 had higher TCH compared to other tested varieties including NCo376.

Table 3. 7 Results of TCH from different varieties grown under two management practices in OG fields, Kilombero.

	Kungurumwoga			Mbwade			Sonjo		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	54.2	77.2	65.7	102.5	124.9	113.7	76.2	93.2	84.7
N12	49.4	73.9	61.7	92.8	112.2	102.5	76.0	82.9	79.5
N47	46.6	74.0	60.3	87.4	119.2	103.3	63.9	62.3	63.1
NCo376	45.1	55.4	50.3	83.4	115.3	99.4	69.5	82.7	76.1
MM	**48.8**	**70.1**		**91.5**	**117.9**		**71.4**	**80.8**	
CV %	**28.4**			**24.0**			**10.7**		
LSD (0.05)	**21.43**			**31.62**			**10.19**		
P(0.05)	**0.47**			**0.78**			**0.004**		

Tons of Sugar per Hectare

Results for TSH are presented in Table 3.8. Based on the results TSH ranged from 3.5 to 13.1 under FP and 5.5 to 18.2 under RT. On average R 570 had higher TSH compared to other varieties.

Table 3. 8 Results of TSH from different varieties grown under two management practices in OG fields, Kilombero

	Kungurumwoga			Mbwade			Sonjo		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	7.9	11.2	9.6	13.1	18.2	15.6	9.1	7.1	8.1
N12	7.0	10.7	8.9	13.0	15.8	14.4	7.6	7.1	7.3
N47	6.9	10.3	8.6	12.6	16.3	14.5	6.3	5.5	5.9
NCo376	6.2	7.8	7.0	11.9	16.9	14.4	6.1	7.7	6.9
MM	**7.0**	**10.0**		**12.7**	**16.8**		**7.3**	**6.8**	
CV %	**28.4**			**29.1**			**10.9**		
LSD (0.05)	**3.07**			**5.40**			**0.97**		
P(0.05)	**0.35**			**0.95**			**0.003**		

2013/14 trials (R4)

Ten trials were established in December 2013, in the following locations. Kitete, Msowero, Mang'ula, Mkula, Msolwa Ujamaa, Miwangani, Mbwade and Matambiko. Results for these trials are presented in Table 3.9.

Tons of Cane per Hectare

Results presented in Table 3.9 revealed that TCH was higher for RT in all the sites compared to FP except at Mang'ula where R 570 recorded higher TCH in FP, however, the difference was not significant (P >0.05).

Table 3. 9 Results of TCH from different varieties grown under two management practices in OG fields, Kilombero.

	Msowero			Mang'ula		
Variety	FP	RT	VM	FP	RT	VM
R 570	61.1	117.6	89.3	105.3	94.3	76.0
N12	96.9	113.7	105.3	64.6	94.9	79.3
N47	82.6	106.1	94.4	65.2	62.8	64.0
NCo376	82.2	69.9	76.1	76.0	113.1	94.5
MM	**80.7**	**101.8**		**69.6**	**90.4**	
CV %	**27.5**			**23.5**		
LSD (0.05)	**31.61**			**23.66**		
P(0.05)	**0.086**			**0.09**		

Tons of Sugar per Hectare

Results for TSH are presented in Table 3.10**.** The levels ranged from 6.7 to 16.6. Variety R 570 recorded high TSH compared to other varieties.

Table 3. 10 Results of TSH from different varieties grown under two management practices in OG fields, Kilombero.

	Msowero			Mang'ula		
Variety	**FP**	**RT**	**VM**	**FP**	**RT**	**VM**
R 570	9.6	16.6	13.1	8.0	10.8	9.4
N12	14.4	15.8	15.1	7.6	10.9	9.2
N47	12.2	15.9	14.1	7.1	6.7	6.9
NCo376	10.9	10.4	10.6	8.2	12.2	10.2
MM	**11.8**	**14.7**		**7.7**	**10.2**	
CV %	**28.7**			**26.2**		
LSD (0.05)	**4.77**			**2.94**		
P(0.05)	**0.24**			**0.14**		

Yield response of tested varieties across seasons

Tons of cane per hectare (TCH)

Results for four cropping cycles for two management levels are presented in Figure 1(a) and 1(b). Based on the results there was a decrease in yield (TCH) under FP for R 570, N47 and NCo376 from PC to R1, but N12 remained almost constant. From R1 to R2 yields of N12, R 570 and NCo376 remained constant but that of N47 increased. From R2 to R3 yields of R 570 and N47 increased but N12 and NCo376 decreased, from R3 to R4 TCH for all varieties increased.

For RT yields of N47 and NCo376 decreased from PC to R1, but there was a slight increase in TCH for R 570 and N12. From R1 to R2 TCH for all varieties decreased significantly, while from R2 to R3 TCH for N47, R 570 and NCo376 increased but N12 continued to decrease. From R3 to R4 TCH for all varieties increased subsequently.

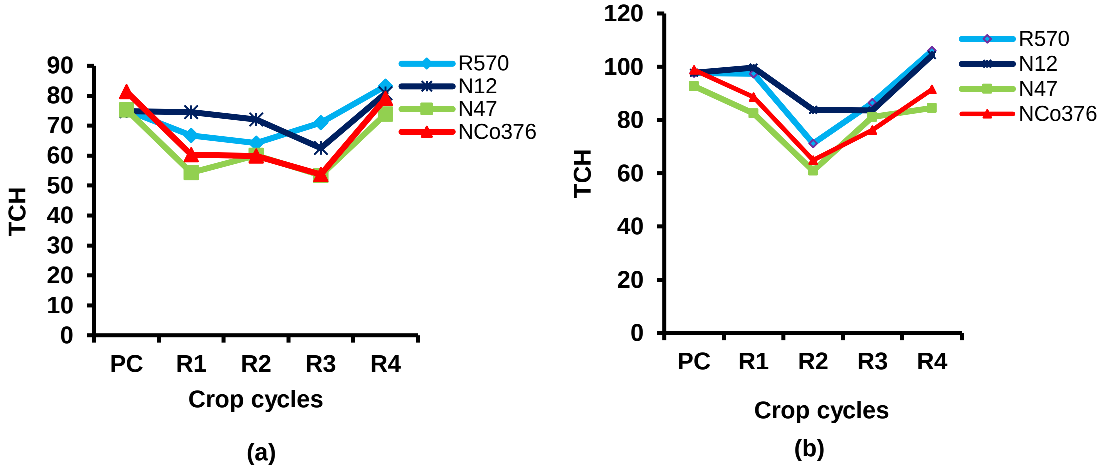


Figure 3. 1 Yield (TCH) of tested varieties vs crop cycles in two management levels

Where a=FP, b=RT

Tons of sugar per hectare

Trends in TSH for four cropping cycles presented in figure 2(a) and 2(b) revealed that, there was a decrease in TSH for all varieties from PC to R3. N47 increased from R2 to R3 while from R3 to R4 TSH in all varieties increased. Generally all the tested varieties performed higher than the standard variety NCo376.

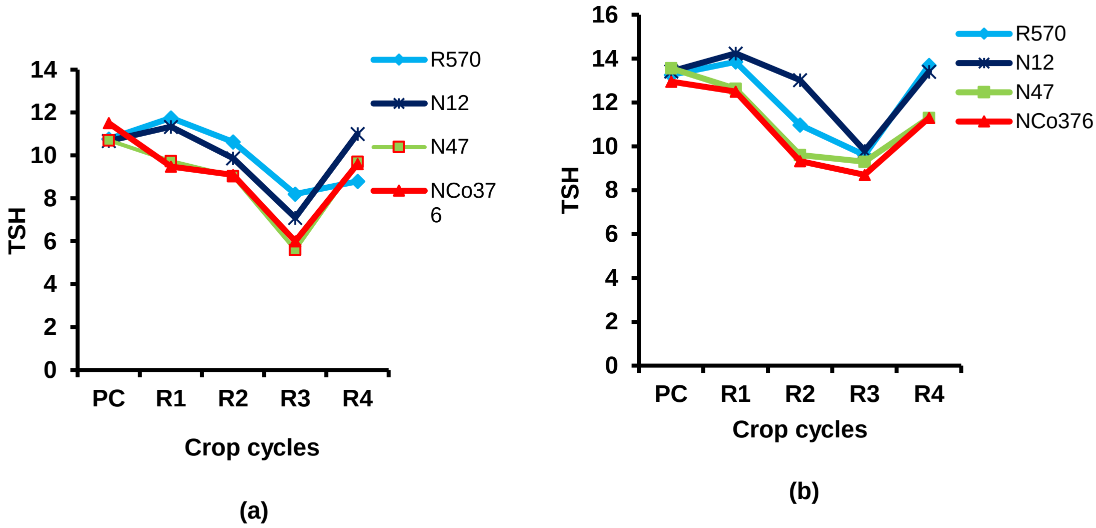


Figure 3. 2 Yield (TSH) of tested varieties vs crop cycles in two management levels

3.1.4 Discussion

Preliminary results revealed that all tested varieties performed better in term of yields (TCH, TSH) when compared to standard variety NCo376. Variety N12 is referred to as very susceptible to smut disease next to NCo376 hence terminated from further evaluation. The decrease in cane yield from ratoon 1 to ratoon 2 might have been attributed to long dry spell which was experienced during that season (2015/16). The dry weather might have affected the growth of sugarcane and subsequent cane yields (TCH). TSH is the product of TCH and sucrose percent therefore the decrease or increase of one or both of these parameters automatically affect TSH accordingly (Gilbert *et al.*, 2005).

Way forward

Varieties N47 and R 570 undergone the second phase of evaluation where they were planted in large blocks (one acre each) for further evaluation in order to come up with a viable recommendation.

Second phase experimentation (Large blocks trials)

2018/19 blocks (PC)

Three blocks each comprising of three acres were established at Kiberege, Msolwa and Kungurumwoga at Kilombero and two blocks were established at Kisala and Kwadori at Mtibwa. Results for these trials are presented in Tables 3.11 and Table 3.12. In terms of tillering, NCo 376 in both locations (Kilombero and Mtibwa) had higher number of tillers followed by N47 while R 570 had the least tillers.

Table 3. 11 Tillers count in large blocks in four sites at Kilombero

Variety	Kiberege	Msolwa	**K'mwoga**
R 570	162,500	110,000	59,583
N47	156,667	104,167	85,000
NCo 376	187,500	106,250	163,333

Table 3. 12 Tillers count in large blocks in four sites at Mtibwa

Variety	Kisala	Kwadori
R 570	107,917	130,833
N47	80,000	150,833
NCo 376	173,750	213,750

2017/18 blocks (PC)
Four blocks each comprising of three acres were established at Mang'ula, Mbwade, Ruhembe and Mfilisi in Kilombero.

Tons of cane per hectare (TCH)
Results are presented in Table 3.13. Generally the two tested varieties performed higher than the standard variety NCo376. Variation in variety yield was observed from one site to another. For example at Mang'ula N 47 performed higher than the standard check while at Mbwade N47 was the lowest among others.

Table 3. 13 Results of TCH from selected varieties grown in large block fields at Kilombero.

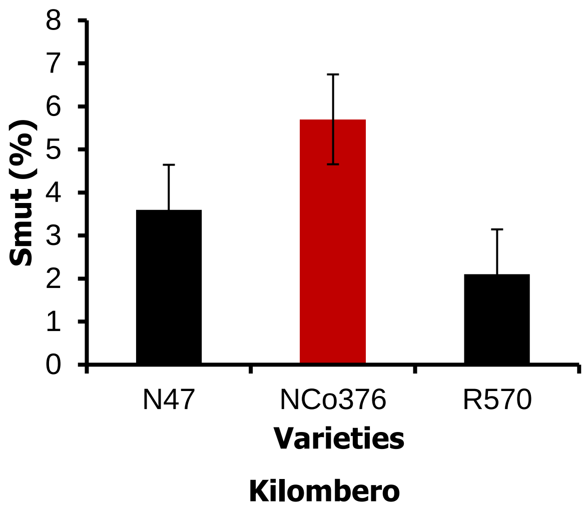
Variety	**Mang'ula**	**Mbwade**	**Ruhembe**
R 570	104.0	95.7	127.3
N47	118.8	67.9	78.3
NCo376	93.5	85.4	72.9

Tons of sugar per hectare
Results are presented in Table 3.14.TSH ranged from 7.1 to 12.2. All tested varieties recorded TSH above NCo376, with R570 having higher TSH compared to other varieties.

Table 3. 14 Results of TSH from selected varieties grown in large block fields at Kilombero

Variety	Mang'ula	Mbwade	Ruhembe
R 570	11.2	9.4	12.2
N47	10.3	7.1	7.6
NCo376	9.1	8.2	7.1

Smut incidence
Results presented in fig 3 (a) and 3(b) indicated that smut incidences for two varieties R 570 and N47 were below 4 % threshold at Mtibwa and Kilombero. This was low compared to NCo376 which had 6 percent incidences



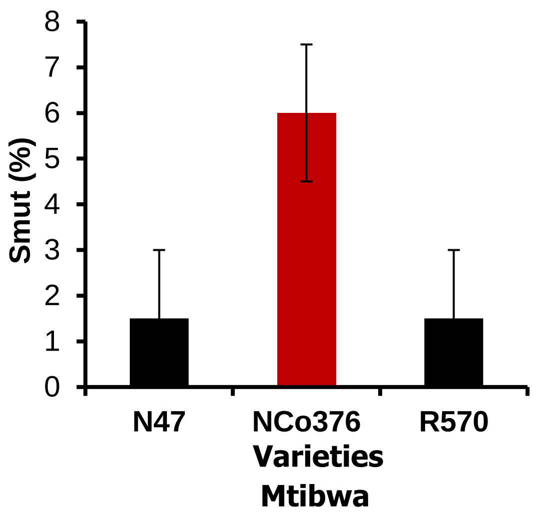


Figure 3. 3 Smut infestation levels for selected varieties in two management levels at Kilombero and Mtibwa

Discussion

Crop varieties may show wide variations in their yielding ability when grown over varied environments or agro-climatic zones. The results for 2017/18 large block trials revealed that there were variations in varieties yield for some sites which is attributed by the existing micro climates (soil, temperature, rainfall, vegetation). This can cause difficulty in demonstrating the superiority of a particular variety over sites. Same scenario has been reported by other researchers. Gilbert *et al.* (2005) reported on the adoption of the variety, productivity and total production of the crop as a result of changes in environments. Smut incidences as per 2017/18 large block trials revealed that NC_O376 is still the highly susceptible variety in smut followed by N 47. Smut susceptibility or resistance are said to be heritable character of a variety. Two types of resistance behavior were reported by Ramesh, *et al* (2012); external resistance mediated by a chemical or physical barrier in the sugarcane bud and an internal resistance which is speculated to be governed during host-pathogen interaction.

Significantly high tillering as reported in 2018/19 is a good indication towards yield because it is a primodial characteristics through which the final harvestable stalks in sugarcane is determined. Kapur *et al.* (2011 reported, a product of photosynthesis are stalks formed from the growth of tillers and thus the profitability of the crop is highly dependent on the tillers produced.

Wayforward
These trials are in the last stages of evaluation soon to be released for commercial production in outgrowers.

3.2 Evaluation of Different Levels of Fertilizers for Improved Sugarcane Productivity at Kagera Mill Area (Fertilizer trial)

Project code:	**AP 2016/03/03**
Investigators:	**Dr. Msita H. B., Kalimba H., S. Kajiru and Lwiza L.M**
Collaborators:	**Outgrowers, LAO, DAICO, YARA Fertilizer Company**
Start date:	**2016-17**
Reporting time:	**2018-19**

Summary
Fertilizers are crucial input in sugarcane production. There is a clear correlation between increased production and use of fertilizers. Most farmers rely on estimation and past experience when deciding on fertilizer rates. Outgrowers in Kagera mill area are faced by the problem of low yield due to inappropriate fertilization. In order to establish fertilizer recommendations, a trial with twelve treatments (different fertilizer rates) was conducted. Phosphate and potash fertilizers were applied at planting while nitrogen was applied three months after planting. Results showed that each treatment responded differently in each site. There was a significant difference in yield for some of the treatments observed. These experiments are in preliminary results and collection of data is still continuing

3.2.1 Introduction

Sugarcane is a tropical plant that requires warm, humid climate for good growth (Saleem *et al.,* 2012). It is grown throughout the sub tropical land surface of earth between latitude 30° N and 35° S in a wide variety of soil types ranging from sandy loam to heavy clay (Nazir, 1994). It is an important commercial crop and is the main raw material of sugar produced in Tanzania for both export and domestic consumption (Tarimo, 1998). Currently, most sugarcane is grown in estates, owned by the sugar processing factories (SPF) as well as contract growers (CG). The productivity in outgrowers' fields in Tanzania has remained low below the attained yield potential of more than 70-100 tons per Hectare (SBT, 2016). Among other factors, imbalanced and inadequate use of fertilizers has led to the decline in productivity in most of the outgrowers' field within the country.
Moreover, continuous planting of sugarcane in the same field depletes soil nutrients. For instances a crop having yield of 100 t ha^{-1} removes 207 kg N, 30 kg P_2O_5 and 233 kg K_2O from the soil (Jagtap et al., 2006). Therefore these nutrients must be added in adequate quantities in the root zone of the crop to obtain higher yield. Among these, Nitrogen (N) is

the primary nutrient limiting sugarcane production (Wiedenfeld and Enciso, 2008). Others include Phosphorus (P) and Potassium (K).
Outgrowers in Kagera mill area are faced with the same problem of low sugarcane productivity within their fields; they contribute less than 8% of the total factory production. Poor soil fertility and inadequate fertilization are the main challenges. This called for establishment of fertilizer trials in outgrower's fields of Kagera mill area in order to establish specific recommendation packages for sugarcane farming.

Specific objectives

1. Determination of soil properties in sugarcane fields in Kagera Mill area
2. Establishment of specific fertilizer recommendation rates for sugarcane

Achieved output todate

1. Data on physical and chemical properties of the soil known in Kagera is known
2. One promised fertilizer recommendation based on yield data available

3.2.2 Materials and Methods

Location

The experiments were conducted in OG fields of Kagera mill area in Misenyi District, between latitude S 1°13.06′ and Longitude E 31°16.327 and about 1300 m asl. Rainfall in the area is bimodal (October-November and March-May) whereby the mean annual rainfall is about 1500 mm and the mean temperature is 20^0C.

Experimental design and sites

Before trial establishment, four zones (Kasambya, Nsunga, Bubale and Kyaka) were selected as study area where 12 soil samples from each zone were collected to make total of 48 samples. The collected soil samples were sent to Lancop Lab in United Kingdom for analysis to get data on physical and chemical properties of the soil.

Experimental design

Randomized Complete Block Design with three replications, Plot size of 48 m^2 comprising of four rows of 10 m long spaced at 1.2 m.

Table 3. 15 Treatments details

No.	Treatments	Nutrient levels (Kg/ha)		
		N	P	K
1	T1	100	25	100
2	T2	100	50	100
3	T3	100	75	100
4	T4	100	100	100
5	T5	125	25	125
6	T6	125	50	125
7	T7	125	75	125
8	T8	125	100	125
9	T9	150	25	150
10	T10	150	50	150
11	T11	150	75	150
12	T12	150	100	150

Fertilizer application

Phosphate and Potash fertilizers were applied at planting and Nitrogen was applied in two splits at three and six months after planting. Other nutrients including $Ca_{7.5}$, $Mg_{1.25}$, $S_{17.5}$ and $B_{0.03}$ were added in all the treatments

Data collected and to be collected

- Number of stalks at 16 months of age
- Stalks weight at 18 months of age
- Quality parameter (brix) determined in the laboratory (KSL)
- TCH was calculated using formulas

Data analysis

Data collected were statistically analyzed by Analysis of Variance (ANOVA) using GenStat statistical package version 14.00 and mean differences among treatments were compared using Least Significant difference (P=5%).

3.2.3 Results

Following the analysis of soil samples it was observed that most of the soils are sandy loam to loam with acidic to slightly acidic reaction. The soils are medium in N and K but deficient in P.

2016/17 fertilizer trial (PC)

Eight sites were selected for experimentation; seven sites were planted in November 2016. Results are presented in Table 3.16 and Table 3.17.

Tons cane per Hectare (TCH)

Yield of sugarcane to applied treatments in experimental sites are presented in Table 3.16. The results revealed that there is a significant difference in yield ($p \leq 0.05$) for some treatments in some of the sites. Based on the presented results each treatment performed differently in different locations. For example at Kyaka treatment 3 had a significant higher

TCH of 284 while the same treatment was the least at Nsunga (127) and Kasambya (141). For Kasambya, higher TCH was 166 for treatment 1 while treatment 10 recorded higher TCH Nsunga had the highest TCH of 284.

Table 3. 16 Results of TCH to applied fertilizer in OG fields at Kagera

Treatments	Kyaka	Kasambya	Nsunga(M)	Nsunga (J)
1	182	166	128	180
2	118	141	152	184
3	284	127	141	136
4	185	106	132	163
5	132	141	113	134
6	130	152	148	211
7	103	145	141	175
8	126	127	142	124
9	145	124	171	135
10	120	146	114	284
11	123	158	156	175
12	120	143	143	143
CV %	**43.6**	**30.0**	**26.0**	**32.7**
LSD (0.05)	**108.8**	**70.94**	**61.55**	**94.30**
P (0.05)	**0.118**	**0.905**	**0.785**	**0.098**

Brix percentage

Table 3.17 indicates the relationship of the applied treatments to quality of juice (brix). Based on the results brix % significantly and positively responded well under lower treatments. For instances in all the harvested sites where treatment dose was low ($N1_{00}P_{25}K_{100}$) brix percentage was higher compared to higher treatment dose ($N_{150}P_{100}K_{150}$).

Table 3. 17 Percent brix with reference to the applied fertilizers

Treatments	Kyaka	Kasambya	Nsunga(1)	Nsunga (2)
1	15.07	16.07	15.33	15.76
2	15.01	14.85	15.16	14.49
3	13.38	14.75	14.82	14.15
4	14.91	14.91	14.55	14.45
5	14.50	15.05	15.30	14.93
6	14.79	15.86	15.24	14.62
7	14.62	13.17	14.37	15.18
8	14.75	14.31	15.25	15.13
9	14.95	15.23	14.05	14.97
10	15.60	15.57	15.17	13.83
11	14.95	13.97	14.83	15.55
12	15.48	15.09	14.80	13.04
CV %	**7.3**	**3.5**	**4.1**	**7.2**
LSD (0.05)	**1.9**	**13.9**	**1.02**	**1.78**
P (0.05)	**0.180**	**0.913**	**0.247**	**0.180**

2017/18 fertilizer trials (PC)

Eight sites were selected for experimentation but only 7 trials were established in October/November 2017 at Nsunga (1), Kasambya (3) Bubale (1) and Kyaka (2).

Stalk count

Results on the number of millable stalks are presented in Table 3.18. From the results, the performance of the applied treatments was different from each site. Significant difference ($p \leq 0.05$) in number of stalks per applied treatments was only observed at Kasambya. In General treatment 11 ($N_{150}P_{75}K_{150}$) performed better as compared to other treatments across all the sites.

Table 3. 18 Results of stalks to applied fertilizers in OG fields at Kagera

Treatments	Kyaka (M)	Kyaka (H)	Kasambya (E)	Kasambya (J)	Nsunga (B)
1	158333	125001	134723	107222	119215
2	183333	131946	140696	94722	112823
3	138611	130557	144584	91666	133665
4	134166	140696	132362	94722	124495
5	161110	113890	136112	88611	113101
6	173055	136112	139029	86389	120048
7	169999	98612	143057	90000	130053
8	138611	108347	148612	89444	120048
9	184721	127779	125695	90833	130886
10	173055	111112	127084	86944	126718
11	188888	125001	134307	121388	112823
12	162499	111112	140557	91666	128385
CV (%)	**24.6**	**20.4**	**8.0**	**18.8**	**12.0**
LSD (0.05)	**68311.8**	**42242.0**	**18544.7**	**30086.4**	**24947.3**
P (0.05)	**0.773**	**0.642**	**0.035**	**0.045**	**0.672**

2018/19 trials (PC)

Eight sites were planted September/October 2018 at Nsunga (2), Kasambya (2) Bubale (2) and Kyaka (2). Results on number of tillers are presented in Table 3.19.

Table 3. 19 Results of tillers to applied fertilizer in OG fields at Kagera

Treatment	Kyaka (K)	Kyaka (M)	Bubale (K)	Bubale (N)	Nsunga (J)	Nsunga (B)	Kasambya (M)	Kasambya (S)
1	141332	285719	238793	408448	203530	96906	151884	237405
2	137167	200475	314874	389289	193534	59698	161602	335421
3	210194	289051	277389	444544	241848	53590	233518	299602
4	129948	315707	272669	417333	206862	79968	192145	356524
5	210471	328313	344307	370685	159936	84411	168821	275168
6	241570	306266	339864	394287	212137	78857	212970	271558
7	206029	356524	301268	353470	199087	73026	173542	314874
8	197699	347639	268226	315429	242958	75248	171320	356246
9	113566	348749	296826	390955	232129	83300	203530	300436
10	152994	317095	334033	367908	204085	66085	194367	281554
11	168544	297659	357079	343474	277667	83855	184093	282942
12	246846	304323	333755	345417	269892	86910	162990	302657
C.V	**38.8**	**22.9**	**21.5**	**19.2**	**22.4**	**19.6**	**21.5**	**17.8**
LSD(0.05)	**117984**	**119060**	**111735**	**123111**	**83603**	**25450**	**67031**	**90870**
P (0.05)	**0.316**	**0.186**	**0.666**	**0.327**	**0.894**	**0.631**	**0.105**	**0.889**

Based on the results in Table 3.19 each treatment had performed differently in each site. Productivity (tiller count) in relation to the applied treatments was significantly higher in all the sites. Generally treatment 6 ($N_{125}P_{50}K_{125}$) among others performed well while treatment 1 ($N_{100}P_{25}K_{100}$) was the least.

3.2.4 Discussion

The presented results are still preliminary since the trial is on-going, so many factors might have been contributed to the observed results. The study revealed that in year 2016/17 a combination of $N_{100}P_{75}K_{100}$ at Kyaka, $N_{150}P_{25}K_{150}$ at Nsunga and $N_{100}P_{25}K_{100}$ at Kasambya had a substantial yield of Sugarcane in each zone. The observed difference in yield in some of the treatments might be due to differences in soil pH, soil erosion and flooding. These results are in contrast with results reported by Gana (2008) that application of N more than 120 kg N ha^{-1} indicates no significant difference between tillers number, stalk length and cane yield. The difference between our results and his results can be due to differences in environment and soil status of the area where two studies were conducted. Furthermore percent brix was higher for lower dose treatment the observation which was observed by other researchers. El-Geddawy *et al*. (2005) that application of 72 kg k_2O favored cane growth, produced the highest yield of millable cane and increased juice quality traits in terms of Brix, sucrose and sugar recovery percentages. They further clarified that as levels of K increased the reduction in sugar quality is expected. High fertilizer doses enhance a longer vegetative growth rather than accumulation of sugar hence lowers percent brix levels.

For 2017/18 the study revealed that higher number of millable cane for 2017/18 season was observed in treatment 11 where higher doses of N, and K were applied. The large number of millable cane due to high N might have been due to importance of N in establishment of strong and vigorous stems and leaves which are important in photosynthesis and nutrient synthesis for most of the plants including sugarcane. The same scenario of having high millable cane with high N levels has been reported by different researchers (Ahmad *et al.,* (1995), Kolage *et al.,* (2001), Afzal *et al.,* (2003) and Sinha *et al.,* (2005).

Way forward

For three cropping cycles established since 2016 we have managed to gather results on one crop cycle only given the long cane growth period at Kagera (18months). We still need results from three cropping cycles before arriving to the conclusion. However, the preliminary results however revealed that each treatment applied behaved different in different sites

3.3 Baseline Survey on the Status of *Striga spp* in Sugarcane Fields in Tanzania

Project Code: AP 2017/03/04
Investigators: Kalimba, H. F, L. Lwiza, S, Kajiru.
Collaborators: Yonna Kalinga, Mohamed Salumu, Nasser Mlawa, Nassoro Abubakari
Date of commencement: 2017/18
Reporting period: 2018/19

Summary

Striga spp, commonly known as witch weed, are root parasitic flowering plants that occurs naturally in sub Saharan Africa and Asia. Three species: *S. hermonthica*, *S. asiatica* and *S. gesnerioides* have been reported to cause serious damage to crops. In recent years *Striga* has been observed in some sugarcane fields. Infestation area and levels are likely to increase in future because of continued monoculture. A survey was conducted for the purpose of identifying species and levels of infestation in sugarcane fields at Kagera. Observations were done at an interval of 100 m and field in vicinity was observed. A total of 100 fields were observed, 50 in estate and 50 in OG. In estate none of the fields were infested and for out growers only one farm was infested. Results indicated that *Striga* is not a serious weed of sugarcane at Kagera mill area.

3.3.1 Introduction

Striga spp, commonly known as witch weed or witchers weed, are root parasitic flowering plants that occurs naturally in sub Saharan Africa and Asia, attacking a wide range of crops. *Striga spp* are amongst the world's worst weeds (Nail *et al*., 2014), reducing the value of grain crops particularly in Africa. *Striga spp* are prolific seed producers, the fine dust-like seed which can last more than 15 years, and consequently, eradication and control attempts are extremely difficult and prolonged (Nail *et al*., 2014). *Striga spp* reduces crop yields by extracting water, nutrients (particularly nitrogen), and affect photosynthetic process from the root system of its host plant, resulting in stunting and yield reduction (Parker and Riches., 1993). The attack of this weed causes a lot of economic losses. In

Tanzania, the weed has been reported mainly in cereal crops such as sorghum, maize and finger millet including sugarcane (Ramaiah, *et al.,* 1983).
Three species: *S. hermonthica, S. asiatica* and *S. gesnerioides* have been reported to cause the serious damage to crops (Ramaiah, *et al.,* 1983). The symptoms of attack by *Striga* may be apparent, sometime before the weed emerges. At early stages, symptoms are indistinguishable from those caused by drought for example wilting and curling of the leaves but they are strong indicators if they occur when the soil is still moist (Nail *et al*., 2014). The infected plant may also show stunting from quite an early stage and pronounced scorching of the leaf borders and finally of the whole leaf area may occur at a later stage.

Crop yield loss due to *Striga spp* attacks can vary depending on density, soil fertility, rainfall distribution, host species and variety grown. It has been reported that *Striga spp* can cause yield loss between 20 and 80% on sorghum crop and thus farmers are obliged to abandon highly infested field (Altera and Itoh, 2011).

In recent years *Striga spp* has been observed in some sugarcane fields. This called urgent need to assess the levels and distribution of *striga spp* infestation in sugarcane field in Kagera and Kilombero

Objective

1. To determine level and identify species of *Striga spp* infestation in sugarcane fields in Tanzania.

Output achieved to date

Two species of striga identified

3.3.2 Material and methods

Location

In 2018/19 the survey was conducted at Kagera mill area (Kagera estate and outgrowers fields).

Survey method

Survey was conducted where by transects along the road were used. Observations were done in all sugarcane fields at an interval of 100m and fields in vicinity after each stop was observed for presence or absence of *Striga*. Species identification was done by characterizing *Striga* morphologies as described by Ramaiah, *et al.,* (1983).

3.3.3 Results

A total of 100 fields were surveyed in Kagera mill area, that is, 50 fields at the estate and 50 fields in outgrowers. Out of 50 fields surveyed at the estate none was infested by *Striga* while in outgrowers only one field was infested. Results are summarized in Table 3.20

Table 3. 20 Status of Striga infestation at Kagera

SN	Location	No of field surveyed	Field found with striga	Percent of field with infestation
1	Estate	50	0	0
2	Outgrowers	50	1	2
	Total	**100**	**1**	**2**

Figure 3. 4 Striga hermonthica at Kagera mill area

3.3.4 Discussion

The study found that only small percent of the outgrowers field were infested with striga. This indicates that *Striga* is not a serious weed in Kagera mill area. This can be due to host specificity of striga to cereal crops which might not be for sugarcane.

Wayforward

Further study on Striga will be carried out at Mtibwa and TPC estates in order to have proper overview on the status of *Striga* infestation in Tanzania so as to come up with appropriate control strategies.

3.4 Evaluation of Different Herbicide for Use in Sugarcane Fields at Kagera

Project Code: **AP 2017/03/06**
Investigators: **Kalimba, H. F, G. Mwasinga, S. Kajiru, L. Lwiza and Dr. H. B. Msita**
Collaborators: **Nassoro Abubakari, Nelson Mshana,**
Date of commencement: 2017/18
Reporting period: 2018/19
Duration: **3 years**

Summary

Herbicides are chemicals that inhibit or interrupt normal plant growth and development. They are widely used in agriculture. Sugarcane is grown in well drained fertile soils, with good supply of moisture and nutrients. Such condition favors an intense and rapid growth of

wide range of weed species. Hand hoe is a common method in controlling weeds but not 100% effective. Herbicides are considered to be effective and quick method of weed control. Trials were conducted to evaluate efficacy of different herbicides at Kagera mill area. Experiments were laid out in randomized complete block design. Herbicides were applied as early post emergence. Assessment of herbicides action was based on direct comparison between treated and untreated plots. Current results revealed that all herbicides were effective in controlling weeds for more than nine weeks.

3.4.1 Introduction

Herbicides are chemicals that inhibit or interrupt normal plant growth and development and widely used in agriculture (Peng, 1984). Sugarcane is grown in well drained fertile soils, with good supply of moisture and nutrients In addition, sugarcane receives dressing of nitrogen, phosphorus and potassium. Such condition favors an intense and rapid growth of wide range of weed species (Cardoso, 1997). Weed competition in the initial stages of crop growth can be so severe and that plants remain stunted and final yields are a mere fractional of the true potential (Fute, 1990). Losses up to 45% have been reported in sugarcane fields when weeds were not controlled within the first six weeks (Isa and Kalimba, 2000). This is due to the fact that emergence and early growth of sugarcane is inherently slow and considerable time elapse between planting and development of foliage cover, hence the crop competes very poorly with weeds (Isa and Kalimba, 2000; Fute, 1990). For these reasons weed infestations is considered a major constraint in the achievement of yield potentials in sugarcane production.

Hand hoe weeding, mechanical weeding and use of herbicides are common methods used in controlling weeds in sugarcane fields (Isa and Kalimba, 2000). Disking and interrow cultivation methods are also practiced, however the methods do not solve the problem fully as they do not remove weeds within the crop rows (Isa, 2000). Proper use of herbicides is considered as an effective and quick method of controlling many weed species (Fute, 1990). In all estates during the rainy season weed growth becomes vigorous and intense which require constant application of control measures. Manual weeding during this period has also many limitations including labour availability due to high labour demand for planting and weeding of annual crops (Mtunda *et al*, 1998). Moreover, some weed species such as *Cyperus spp, Commelina spp* are not easily killed by tillage alone due to high soil moisture. On the other hand tillage operations, manual or mechanical, are rendered ineffective and costly. Due to this TARI Kibaha conducted this project to come up with effective herbicides for managing weeds in sugarcane.

Objective

1 To evaluate effectiveness of different herbicides in sugarcane fields at Kagera mill area

Output achieved to date

- Four effective herbicides combinations rates developed

3.4.2 Materials and methods

Location
Kagera mill area Estate and OG
Design
Experiment had five herbicides, which were combined to make nine combinations and two controls hence total of eleven treatments which were designed in Randomized Complete Block Design (RCBD) and replicated three times. Plots were in four rows spaced at 1.2 m,

Herbicide application
Herbicides were applied as early post emergence two weeks after planting. Treatments are as shown in Table 3.21. Weed count was made at three weeks intervals and assessment of herbicides action was based on direct comparison between treated and untreated plots, to get percentage control which was then converted to a 1 to 9 logarithmic scale as in accordance to (Werner, 1981) Where 1 = complete control, 4.5 = Just an acceptable control and 9 no control at all (Table 3.25).

Statistical analysis
Percentage weed control was transformed (Arc sine Transformation) and subjected into statistical analysis (ANOVA) using Genstat statistical package version 12.where the coefficient of variation was determined and used as a measure of consistence of treatments effect.

Table 3. 21 Treatments details

Treatment	Acetochlor	Metribuzine	Chlorimuron	Paraquat	Surfactant
	Litres/ha	Litres/ha	Kilograms/ha	Litres/ha	Litres/ha
T1	4.0	1.6	0.250	1	0.2
T2	0.0	1.6	0.250	1	0.2
T3	0.0	1.6	0.250	1	0.0
T4	4.0	1.6	0.375	1	0.2
T5	0.0	1.6	0.375	1	0.2
T6	0.0	1.6	0.375	1	0.0
T7	4.0	2.4	0.250	1	0.2
T8	0.0	2.4	0.250	1	0.2
T9	0.0	2.4	0.250	1	0.0
T10	weed free check				
T11	Weed check				

3.4.3 Results
Results presented in Tables 3.22, 3.23 and 3.24 indicate that all herbicide treatments were statistically different from each other ($P \leq 0.05$) hence able to control all types of weeds for more than nine weeks after herbicide application similar to weed free check.

Table 3. 22 Results of tested herbicide on grasses at Kagera mill area

Treatments	3 WAT			6 WAT			9 WAT		
	Score	% control	T.D	Score	% control	T.D	Score	% control	T.D
1	2	98.50	82.98	2	99.30	85.29	2	98.90	83.88
2	4	91.80	73.39	3	97.20	80.44	4	92.40	73.99
3	2	99.30	85.10	2	99.80	87.21	2	98.80	83.76
4	2	98.70	83.52	2	99.40	85.58	2	99.30	84.96
5	1	100.00	90.00	2	99.30	85.08	2	98.50	83.04
6	5	88.40	70.09	3	97.50	80.88	2	99.10	84.71
7	4	92.50	74.13	3	97.50	80.85	2	98. 70	83.43
8	6	78.30	62.25	2	98.50	83.12	2	99.40	85.42
9	2	98.10	82.06	2	99.70	87.00	2	99.10	84.58
10	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
11	9	0.00	5.74	9	0.00	5.74	9	0.00	5.74
CV (%)			**11.90**			**3.90**			**6.60**
LSD (0.05)			**14.67**			**5.43**			**9.16**
P (0.05)			**0.001**			**0.001**			**0.001**

WAT= Weeks after Treatments

T.D = Arcsine transformed data

Table 3. 23 Results of tested herbicide on Broadleaves at Kagera mill area

Treatment	3 WAT			6 WAT			9 WAT		
	Score	% control	T.D	Score	% control	T.D	Score	% control	T.D
1	4	93.80	75.60	2	99.00	84.30	2	99.40	85.65
2	4	94.00	75.85	2	99.30	85.08	4	91.10	72.68
3	1	100.00	90.00	2	99.90	88.94	2	98.80	83.88
4	2	98.90	81.76	2	99.30	85.28	2	98.40	82.73
5	2	98.20	82.24	2	99.60	86.55	3	97.50	80.93
6	2	98.50	83.10	2	99.80	87.84	2	99.40	85.42
7	2	98.50	83.10	2	99.30	84.95	3	98.00	81.79
8	4	94.60	76.55	3	97.50	80.90	3	98.60	83.16
9	3	97.90	81.64	2	99.90	89.01	2	99.40	85.51
10	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
11	9	0.00	5.74	9	0.00	5.74	9	0.00	5.74
CV (%)			**12.60**			**3.00**			**6.90**
LSD (0.05)			**16.04**			**4.23**			**9.39**
P (0.05)			**0.001**			**0.001**			**0.001**

WAT= Weeks after Treatments

T.D=Arcsine transformed data

Table 3. 24 Results of tested herbicide on sedges at Kagera mill area

Treat ments	3 WAT			6 WAT			9 WAT		
	Score	% control	T.D	Score	% control	T.D	Score	% control	T.D
1	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
2	2	99.30	85.34	2	99.90	89.01	2	99.90	88.14
3	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
4	2	99.40	85.75	1	100.00	90.00	1	100.00	90.00
5	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
6	2	99.90	88.91	2	99.90	88.94	2	99.90	87.80
7	2	99.90	88.91	2	99.90	87.99	2	99.50	85.95
8	1	100.00	90.00	2	99.90	88.60	2	99.80	87.30
9	2	99.90	88.91	1	100.00	90.00	1	100.00	90.00
10	1	100.00	90.00	1	100.00	90.00	1	100.00	90.00
11	9	0.00	5.74	9	0.00	5.74	9	0.00	5.74
CV (%)			**3.50**			**1.60**			**3.30**
LSD (0.05)			**5.15**			**2.41**			**4.81**
P (0.05)			**0.001**			**0.001**			**0.001**

T.D=Arcsine transformed data
WAT= Weeks after Treatments

3.4.4 Discussion

Several weed species were observed in the experimental site, all herbicides treatments reduced grasses, broadleaves and sedges to an acceptable level for the period exceeding nine weeks.

According to Isa (1996) and Rugaimukamu (2000), herbicide products which can control weeds for the period of more than 8 eight weeks can be recommended for use in sugarcane fields, because after that period the crop develop canopy cover sufficient to suppress emerging weeds. Treatments with surfactants seems to perform better compared to those which did not have, because surfactant is used as binding material and therefore herbicide was not easily washed by rainfall water and thus increased the effectiveness of herbicides applied.

Table 3. 25 Weed classification scale

Score	% Activity
1	100
2	99.9 – 98
3	97.9 – 95
Limit of 4 .... Acceptability 5 6 7 8 9	94.9 – 90 .... 89.9 – 82 81.9 – 70 69.9 – 55 54.9 – 30 29.9 – 0

Wayforward

Presented results are still preliminary since we have managed to gather information from one cycle only.

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4.0 SUGARCANE ENTOMOLOGY

4.1 Project Tittle: Study of seasonal insect population fluctuations influenced by weather changes and crop management practices in all estates and out growers fields.

Project Number: CPE2018/01
Principal Investigators: J. M. Katundu, F. A. Urassa A. Yusuph and M. Mwinjummah.
Collaborators: A. Nassoro, N. Mlawa, Y. Kalinga and M. Salum, SBT
Reporting Period: 2018/2019.

Project summary
This study aimed at monitoring the seasonal insect pests that feed on sugarcane to understand the current insect pest status, spread and seasonal trends in population build up influenced by weather changes and crop management practices**.** Surveys were conducted in selected fields to assess Stem borer (*Eldana Saccharina*), Yellow Sugarcane Aphids (*Sipha flava* Forbes) and White scale (*Aulacaspis tegalensis* Zehnt) populations and extent and intensity of damage caused by these insects on sugarcane in the estates and out growers (OG) fields. Three key insect pests, the sugarcane stem borer*,* the white grub *Cochliotis melolonthoides* Gerst and the sugarcane white scale were found in all estates and out growers fields except for *C. melolonthoides* which is still confined to TPC and MSE estates. White scale incidences are still widespread, the intensity of infestation has been very low due to the use of varieties, such as R579, which are less susceptible to the insect damage. TPC and KSL remain the most vulnerable areas for sugarcane stem borer attack.

4.1.1 Introduction

A wide range of insects pests such as stem borers, termites, white-grubs, scale insect, mealy bug, army-worm and grasshoppers feed on sugarcane at various stages of its growth and cause significant yield losses (Sathe *et al.,* 2009). Many are only occasional feeders, but in most regions where this crop is grown insect pests are a significant factor in the economics of sugarcane production (James, 2004). In Tanzania, sugarcane stem borer, whitescale, sugarcane white grubs and Yellow Sugarcane Aphid are the key insect pests which feed on sugarcane (Anonymous, 2016). Other insects are usually classified as occasional or sporadic pests.

Factors which determine insect population and level of damage they cause on the crop include weather, varieties, natural enemies, agronomic practices and new invasions by exotic insect pests (Sathe *et al.,* 2009). Therefore, this study aimed to understand the current insect pest status, spread and seasonal trends in population build up. The information are useful in establishing immediate and future effective strategic management measures. Also, the results will be used to advise growers on what time to make necessary decision on management actions.

Specific Objectives

a) Monitoring of sugarcane stem borer *Eldana saccharina*, White scale *Aulacaspis tegalensis*, and other insects.
b) Assessment of damage and crop losses caused by sugarcane stem borer and white scale.
c) Scouting of Yellow Sugarcane Aphid (YSA) (*Sipha flava* Forbes)

Outputs achieved

- 121 fields surveyed for sugarcane stem bore and white scale in all estates and 56 fields in out growers fields.
- Data on level of damage caused by stem borer and White scale in estates and OG available.
- 48 fields surveyed for YSA in all estates fields and 140 in out growers fields.

4.1.2 Materials and Methods

Surveys were conducted in selected fields to assess Sugarcane stem borer (*Eldana Saccharina*), YSA and white scale populations and extent and intensity of damage caused by these insects on sugarcane in the estates and out growers (OG) fields. For white scale and assessment, a total of fifty stalks were sampled in each field except in some OG fields or multiplication blocks and variety trials in which twenty five or less stalks were taken for assessment of sugarcane stem borer and white scale. In scouting of YSA the sampled fields were divided into five sections where by two sampled stools from each section were randomly selected for assessment of YSA damage and presence of predators.

4.1.3.1 Results and Discussion

Sugar production in Tanzania is affected by four key insect pests, the sugarcane stem borer, *Eldana saccharina* Walker the white grub *Cochliotis melolonthoides* Gerst, sugarcane white scale *Aulacaspis tegalensis* Zehnt and Yellow Sugarcane Aphids *Sipha flava* Forbes. The two pests (sugarcane stem borer and white scale) are present in all major estates in the country *except for C. melolonthoides* which is still confined to TPC and MSE estates.

Sugarcane stem borer Infestation in Estate and Growers Fields

A total of 21 fields were assessed for sugarcane stem borer infestation at Kilombero estate (Table 4.1) and only two fields had infestation above economic threshold of 4% internode bored. At Kagera Sugar Limited, 49 fields were surveyed and 11 fields had infestation above economic thresholds of 4% internodes bored. These fields were in rainfed area in which were planted varieties N49, N47, N25, and N41. Variety N49 showed an extreme damage of 27.4% to 52.6% internodes bored. At TPC, a total of 33 fields were surveyed for stem borer infestation where by only 5 fields had stem borer infestation above economic threshold of 4%. Generally this implies that sugarcane stem borer infestation in many surveyed fields in all estates was below economic threshold. In out growers fields, in all estates, out of 56 fields surveyed only one field at Mtibwa was infested with sugarcane stem borer above economic threshold. The advice given based on this results was that all fields whose infestation was above economic threshold to be harvested immediately so as to minimize the economic loss.

Table 4. 1: Number of Fields Surveyed for Eldana Infestation in Miller Cum Planter (MCP) and Outgrowers Sugarcane

SURVEYED DATE	TPC	KSL	MSE	KSC	MANYARA	TOTAL
Aug-18				12 (1)		12 (1)
Sept -18					14(0)	14(0)
Oct-18		28 (1)	10 (0)			28 (1)
Nov-18				9(1)		13 (1)
Dec-19		10 (0)				10 (0)
Feb-19	7 (2)	8 (7)				15 (9)
Mar-19	26 (3)	3(3)				29 (6)
TOTAL	**33 (5)**	**49 (11)**	**10(0)**	**21(2)**	**14(0)**	**121 (18)**
			OUTGROWERS FIELDS			
Dec -18		16 (0)				16 (0)
April-19			20(1)	20(0)		40 (1)
TOTAL		**16 (0)**	**20 (0)**	**20(0)**		**56 (1)**

White scale Infestation in MCP and Growers Fields

From August, 2018 to April, 2019 a total of 105 fields were surveyed for white scale infestation in all estates. The summary of results in Table 4.2 shows that out of 105 MCP fields, 68 fields were not infested, while the remaining 37 fields had low infestation of less than 50 %. In Out growers fields only 3 fields out of 56 fields surveyed were infested with white scale at low levels of less than 25 percent.

Table 4. 2: Number of Fields in Different Categories of Whitescale Infestation in Miller Cum Planter (MCP) and out growers' Sugarcane

MCP FIELDS					
		Number of Fields in each Category of Infestation			
Date	**Estate**	**None (0%)**	**Low (< 50 %)**	**High (51%-100%)**	**Total**
Aug-18	KSC	10	2	0	12
Oct-18	KSL	18	10	0	28
Oct-18	MSE	7	3	0	10
Nov-18	KSC	0	9	0	9
Nov-18	BAGAMOYO	3	2	0	5
Feb-19	TPC	7	0	0	7
Feb-19	KSL	0	8	0	8
Mar-19	TPC	23	3	0	26
TOTAL		**68**	**37**	**0**	**105**
		OUTGROWERS FIELDS			
Dec-18	KSL	16	0	0	16
April-19	KSC	17	3	0	20
	MSE	20	0	0	20
TOTAL		**53**	**3**	**0**	**56**

On the other hand, Agronomy department at KSL have conducted about 646 sugarcane stem borer surveys which included old and new commercial varieties of Co617 (77 samples), N19 (50), N25 (205), N41 (82), N47 (54), N49 (64), R 570(30) and R579 (84). Those data have been summarized to understand better the influences of main crop and environmental factors on sugarcane stem borer population and damage on sugarcane. The graph in Fig 4.1 shows the relationship between varieties and percent internodes bored. Variety N49 had the higher infestation of 7.7% internodes bored as compared to other varieties like N25 with 1.2 % internode bored although at almost similar cane age.

Moisture stress is an environmental factor which is known to increase the susceptibility of sugarcane to sugarcane stem borer a damage (Anonymous, 2005). The summary of results in Figure 4.2 shows the relationship between sugarcane stem borer infestation levels and irrigation regimes at KSL. The results have shown higher levels of infestation (% internodes bored) of sugarcane under rainfed (RF) as compared to center pivot (CP) irrigation regimes. These results further emphasize the fact that areas prone with drought have higher sugarcane stem borer infestation compared to irrigated areas.

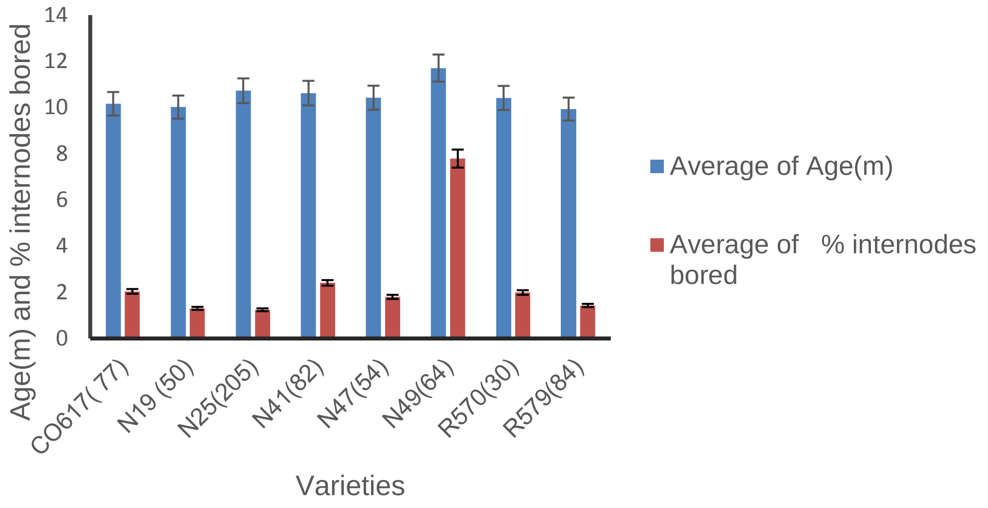

Figure 4. 1: Relationship between Varieties and Eldana Infestation

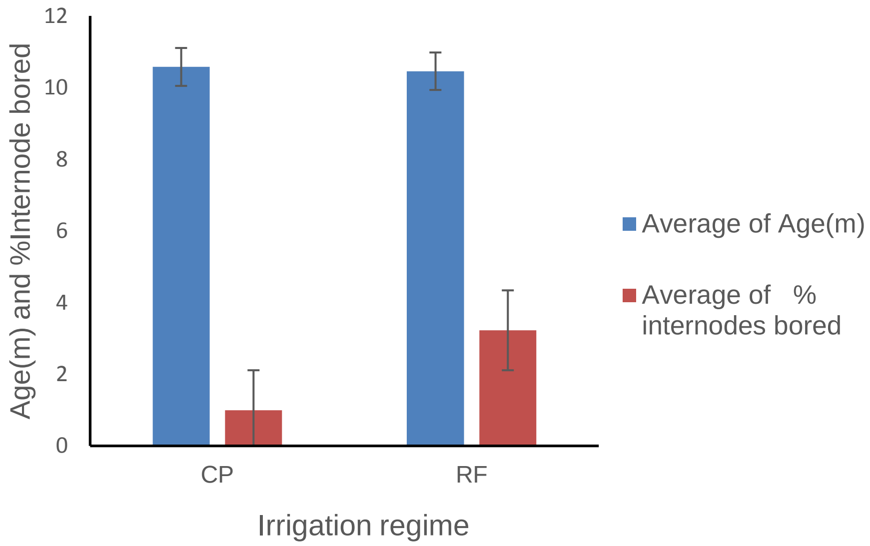

Figure 4. 2: Influence of Irrigation Regimes on Eldana Infestation on Sugarcane

YSA Scouting in MCP and Growers Fields 2017/2018

During September, 2018 and October, 2018 a total of 188 fields were surveyed for Yellow Sugarcane Aphids in MCP fields at Mtibwa, Manyara and Kilombero Cane Growers fields. The results in Table 4.3 show that 16.7 % of the fields surveyed in Manyara had YSA infestation above the economic threshold of 20% infested stools. Also, surveys conducted at MSE have shown that 60% of the fields had YSA infestation above the economic threshold.

In response to reports of YSA outbreak in Kilombero Cane Growers' sugarcane in September 2018, 140 fields were assessed and 71.4 % of them were found to have YSA infestation above economic threshold and required immediate control action.

Table 4. 3: Number of Surveyed Fields for YSA Infestation in MCP and out growers' Sugarcane

SURVEYED DATE	MSE	KSC	MANYARA	TOTAL
Sept-18	-	-	18 (3)	18 (3)
Oct-18	30 (18)	-	-	30 (18)
TOTAL	**30 (18)**	**-**	**18 (3)**	**48(21)**
	KILOMBERO CANE GROWERS FIELDS			
Sept-18	-	140 (100)	-	140 (100)
TOTAL	-	**140 (100)**	-	**140(100)**

() Number of fields with YSA infestation > 20 %.

At KSL, data of YSA infestation were collected and accumulated for several months in the data base of Agronomy department and summarized in Table4.4 for this presentation. About 912 fields or 2297 ha, planted with nine commercial varieties, were surveyed between June, 2018 and March, 2019. The scouted fields had sugarcane of 4 – 4.6 (mean 4.3) months old and YSA infestation of 13.9% – 20.3% (mean 17.5%) infested stools. High level of YSA infestation may have been attributed by type of variety and crop age at the time of sampling. The mean crop age at sampling of 4.3 months might have just missed the peak YSA population which usually occurs when the plants are 3 to 4 months old (Katundu, Personal observations) Otherwise the threat of YSA is real as indicated by the increasing trends of its incidence and intensity on sugarcane grown at the KSL. The data has confirmed that none of the commercial varieties cultivated at Kagera are resistant to YSA though the level of susceptibility vary between varieties.

Table 4. 4: Infestation levels of YSA on selected varieties in Surveyed MCP fields at Kagera

Variety	Number of surveyed fields	Total surveyed Area	Average Age(m)	Percent Infested stools
CO617	358	1022	4.12	18.01
MN1	60	129	4.02	20.28
N19	38	83	4.58	15.36
N25	158	329	4.00	20.08
N41	52	131	4.36	18.76
N47	72	236	4.39	16.57
N49	16	39	4.29	13.93
R570	31	74	4.33	16.13
R579	127	254	4.64	17.96
Grand Total	**912**	**2297**		
Average			**4.30**	**17.45**

Other Observations

A high incidence of an Entomopathogenic fungus (EP) of YSA was observed in field DR3B at Kagera after heavy rains and humid conditions. By microscopic examination, the characteristics white mycelial growth on the cadaver and in comparison with other common insect pathogens of Aphids the EP was likely to be *Verticillium lecanii*. Thus it's specific and strain identification is necessary in future. Also the presence of a Coccinellidae predators belonging to *Scymnus* sp was noted for further specific identification and evaluation of its role in YSA control.

Conclusion

- While the white scale incidences are still widespread, the intensity of infestation has been very low due to the use of varieties, such as R579, which are less susceptible to the insect damage. Therefore, introduction of relatively susceptible varieties such as N47 should be done cautiously.

- We would say that TPC and KSL remain the most vulnerable areas for Sugarcane stem borer attack. Kagera, however, has the disadvantage of a long crop season so that the sugarcane crop cannot be harvested below the age of 14 months as compared to TPC where maturity tests can allow for harvesting at the age of 12 months or less. Also a large area at KSL is rain fed and unfortunately, at the moment, we do not have suitable varieties which are tolerant to Eldana damage and moisture stress to be deployed there.

- Advice were given to all growers whose fields had Eldana infestation above economic thresholds of 4% to be harvested in order to reduce the economic loss.

4.2 Project Title: Evaluation of white scale damage and sugar loss in selected varieties

Project code: CPE 2018 /02
Principal investigators: J. M. Katundu, F. Urassa, A. Yusuph and M. Mwinjumah
Collaborators: Y. Kalinga
Reporting date: 2018/19

Project Summary

The sugarcane whitescale. *Aulacaspis tegalensis* (Zehntner) (Homoptera: Diaspididae) is one of the most important pests in sugarcane in Tanzania. The white scale is a stem pest which usually reduces juice quality of infested sugarcane. White scale damage in sugarcane estates has been reported to cause about 30% sugar loss in heavily infested fields. Information on yield losses and determination of appropriate control measures are important for proper management recommendations. The objective of the present study was to develop protocol for an artificial inoculation technique and later adopted for establishment of high white scale insect pressure necessary for screening of new sugarcane varieties. Adoption of the inoculation technique has enabled successful screening of varieties against white scale damage in the field.

4.2.1 Introduction

The sugarcane white scale. *Aulacaspis tegalensis* (Zehntner) (Homoptera: Diaspididae) is one of the most important pests in sugarcane in Tanzania which, if not managed, can cause up to 30 % crop losses (Fewkes,1971).

Together with biological and cultural methods, use of resistant varieties is an important component of white scale management. Therefore, resistance to whitescale is one of the factors which must be considered in the selection of new varieties.
The previous results of research conducted at TPC and KSC based on natural insect infestation have shown that assessment of white scale infestation in small plots of replicated trials has not been able to provide substantial information on how test varieties would respond to potential insect damage in large scale production.
In the proposed experiment a new inoculation technique has been used to ensure establishment and sustained pest pressure during the selection process of new sugarcane varieties.

Main Objectives
To provide quantitative information on risk potential of white scale in each of the new varieties before and post release.

Specific objectives
a) To assess the establishment of white scale on test sugarcane varieties after artificial inoculation.
b) To determine the effect of white scale on sucrose and TCH of different sugarcane varieties.

Output
One variety potentially showing antixenosis to white scale identified.

4.2.3 Materials and Methods
Location: The experiment was conducted at KSC
Treatments: Sugarcane varieties namely TZ 93KA - 120, TZ 93KA - 122, R 85/1334, B80689, KQ228 and EA70-97 as tolerant standard and MN1 or N25 as susceptible controls.

White scale inoculum source:
White scale eggs were collected from sugarcane stalks of infested fields and sieved. A weighed spatula full amount of eggs were inoculated and covered with a screen or netting material on four or two stalks of each variety per plot.
The design of the experiment:
Randomized Complete Block Design with 8 treatments and 5 replications.
Plot size: 4 rows X 10m.

Data collected and to be collected
- White scale infestation (% stalk infested; white scale cover (WSCI).
- Juice quality analysis (Brix; Purity; Pol; Sucrose).
- Yield parameters (TCH; TSH)

4.2.4 Results and Discussion White scale establishment
The preliminary results in Table 4.5 indicate that the establishment of white scale in the inoculated stalks was so poor that only 13.1 % of the inoculated stalks had low level of white scale infestation and none in the high category. However, in this trial variety B80689 appeared to have been potentially most susceptible with the white scale establishment of

20% of the inoculated stalks, similar to MN1. The standard resistant check variety EA70-97 had zero white scale establishment and variety TZ 93KA – 120, with white scale establishment on only 5% of the inoculated stalks, and could tentatively be considered resistant to the insect pest.

Table 4. 5: Percentage of inoculated stalks of test varieties in different categories of white scale cover

	Categories		
Variety	**None (0%)**	**Low (<50%)**	**High (51%- 100%)**
TZ 93KA - 120	95	5	0
TZ 93KA - 122	85	15	0
R 85/ 1334	85	15	0
B80689	80	20	0
KQ228	85	15	0
EA 70-97	100	0	0
N25	85	15	0
MN1	80	20	0
MEAN	**86.9**	**13.1**	**0**

Way Forward

Collection of yield data for juice analysis

4.3 Project Title: Production of White scale predator, *R. lophanthae,* in screen house for field releases

Project code: CPE 2017 /03
Principal investigator: J. M. Katundu, F. A. Urassa, A. Yusuph and M. Mwinjumah
Collaborators: Y. Kalinga, N. Mlawa, M. Salum and National Biological Control
Start date: 2017/2018
Reporting date: 2018/19

Project Summary

A study on the production of Rhyzobius *lophanthae is being implemented in the screen house at TARI-Kibaha.* The objective is to produce *Rhyzobius lophanthae* for release in sugarcane fields infested with white scales. The surveys conducted at TPC showed that both and White scale and predators were not available as sources for screen house rearing.

4.3.1 Introduction

Whitescale has been a problem at TPC since 1968 which has caused losses up to 30% sugar loss per annum (TPC Agronomy report, 1970). The control of whitescale has mainly achieved by use of host plant resistance (self-trashing varieties) and natural enemies.
The predators (*Rhyzobius lophanthae)* has been effective in reducing whitescale infestation at TPC and therefore there is a need to introduce it to other newly whitescale infested area. This project aimed at producing the predator(*R Lophanthae*) in mass for release in whitescale infested areas such as Mtibwa, Kilombero, Kagera and other Sugarcane growing areas.

Main Objectives
The main objective of the project is to produce *Rhyzobiuslophanthae* in screen house for release in sugarcane fields infested with whitescale.

Specific objectives

a) To study suitable conditions for population buildup of the predator, *Rhyzobius lophanthae* (Coleoptera: Coccinalidae) in screen house and release sites.
b) To study the influence of pugnacious ant, *Anoplolepiscustodiens* (Hymenoptera: Formicidae) on establishment of white scale predator, *R. lophanthae* for control of the white scale in release sites.

Expected Output

- *Rhyzobiuslophanthae* will be mass produced sufficient for release in infested by white scale.
- Data on effect of pugnacious ant, *Anoplolepiscustodiens* (Hymenoptera: Formicidae) on biological control activity of *Rhyzobius lophanthae* (Coleoptera: Coccinalidae) will be available.

4.3.2 Materials and Methods
Sugarcane varieties (N25, MN1) susceptible to whitescale infestation were planted in February 2019 in the 20ltr capacity pots containing 20 Kg of sterilized soil which were placed in the screen house at TARI-Kibaha. Cuttings used were of two nodes collected from TARI-Kibaha sugarcane germplasm. For each variety, seven pots were arranged in single row. Three cuttings were planted in each pot. Sugarcane plants were fertilized and watered regularly to maintain the health of plants throughout the study.

Project status
The project is in progress

4.4 Project title: The Effectiveness of Prophylactic Soil Treatment and Foliar Applications of locally available insecticides for Yellow Sugarcane Aphids control at Kilombero Estate

Principal Investigator: J.M. Katundu, F. A. Urassa, A. Yusuph and M. Mwinjumah
Project code: CPE 2018/04
Collaborators: Y. Kalinga
Start Date: 2018
Reporting date: 2018/19

Project Summary

This study was carried out at Kilombero Sugar Estate fields in two sites (field 314 and field 325) to evaluate the effectiveness of Attackan, Actara, Drone, Pirimicarb and Abamectin in the control of YSA. Treatments were arranged in RCBD replicated four times. Mode of insecticide application were soil and foliar, applied at most two times on entire season. Results have indicated that on the average at field 314, Actara (8 WAP) + Drone (12 WAP), Piricab (8 WAP) + (12 WAP), Drone (8 WAP), and Attakan (8 WAP) were more effective than untreated plots. For field 325, Attackan (8 WAP), Actara (8WAP), Drone (8 WAP) Attackan (8 WAP + 12 WAP), Actara (8 WAP + 12 WAP) and Drone (8 WAP + 12 WAP) have all indicated percentage reduction 55.2% to 75.5% of YSA control. Neonicotinoids insecticides (Attackan, Drone and Actara) are highly effective in reduction of YSA population and damage on sugarcane.

4.4.1 Introduction

The Yellow Sugarcane Aphid (YSA), *Sipha flava* (Forbes) (Homoptera: Aphididae) invaded Tanzania in May, 2016 when the country had no registered insecticides for its control. Sugarcane growers in Kilombero have desperately used different insecticides which have been locally available but have no sugarcane label in controlling YSA. Among the products used by cane growers were Attakan 350 SC, Actara 250 WG which belongs to Neonicotinoids, and Piricab 50 WDG and Abanil 18 EC which belongs to carbamate and microbial families respectively.

Neonicotinoids insecticides act on the post-synaptic nicotinic acetylcholine receptors in the central and peripheral nervous systems, resulting in excitation and paralysis, followed by death of insect (Tomizawa and Casida, 2003). Many of these compounds are sufficiently xylem mobile to be suitable for soil application.

Carbamate insecticides are both acetylcholinesterase inhibitors, interfering with the transmission of nerve impulses across the synaptic gap between two nerve cells by preventing the breakdown of the predominant neurotransmitter, acetylcholine (Tomizawa and Casida, 2003). This results in tetanic paralysis that destroys the ability of insects and other organisms to respond to external stimuli.

Thus it was important for researchers to test these insecticides to determine their efficacies in the control of YSA so that they can also be included in the registration of chemicals recommended for management of YSA in Tanzania.

Main Objective
To find suitable prophylactic and augmentative insecticides to be used in soil and foliar applications for sustainable YSA management that have a reduced impacts on natural enemies.

Specific Objectives

a) To test the efficacy of insecticides available in local Agricultural Inputs Stores for YSA control
b) To study the effect of the tested insecticides on YSA natural enemies.

Outputs

- Four insecticides effective in managing YSA known
- Means of insecticide application identified
- Insecticides affecting natural enemies known

4.4.2 Materials and Methods

Two fields which had relatively high incidences of YSA infestation were selected for establishment of the trials at KSC. Randomized Complete Block Design was employed with four replications.

Insecticides tested in these trials are described in Table 4.6 below.
As a prophylactic treatment, Attakan 350 SC (imidacloprid) was soil applied at the rate of 2.0 L per ha at planting. Also Attakan 350 SC (2.0 L/ha), Actara 250 WG (thiamethoxam) at 800 g/ ha) and Drone 222 SL (acetamiprid) at 1.35 L/ha were tested as augmentative treatments by foliar application. Since the above three insecticides belong to the group of neonicotinoids, alternatively, Pirimicarb (Piricab 50 WDG) at 396 g/ha and Abamectin (Abanil 18 EC) at 300ml/ha, insecticides which belong to the carbamate and microbial families, respectively were also included in the trials.
Foliar applications were either fixed at approximately 8 Weeks After Planting (WAP) and 12 WAP or when the YSA infestation reached 20 – 30 % infested stools.
For field 314, the total number of treatments were nine which were: Attackan (8 WAP), Abamectin (8 WAP), Actara (8 WAP), Drone (8 WAP), Pirimicarb (8 WAP), Abamectin (8 WAP) + (12 WAP), Actara (8 WAP) + Drone (12 WAP), Pirimicarb (8 WAP) + (12 WAP), and Control (no foliar spraying).

Twelve treatments for field 325 were: Attackan (soil), Attackan (8 WAP), Abamectin (8 WAP), Actara (8 WAP), Drone (8 WAP), Pirimicarb (8 WAP), Attackan (8 WAP + 12 WAP), Abamectin (8 WAP + 12 WAP), Actara (8 WAP + 12 WAP), Drone (8 WAP + 12 WAP), Pirimicarb (8 WAP + 12 WAP), Control. The plot size was four rows by ten meter and space between plots was two meter.

Table 4. 6: Descriptions of the insecticides tested against the YSA

Trade name and formulation	Active ingredient	Active ingredient(a i) %	Application rate of formulation (L/Kg/Ha)	Application methods and Timing
Drone 222 SL	Acetamiprid	22.2%	1.35L per ha	Foliar
Attakan 350 SC®	Imidacloprid	35%	2.0 L per ha	Soil at planting and Foliar
Actara 250 WG	Thiamethoxam	25%	800g per ha	Foliar at 8 and 12 WAP
Piricab 50% WDG	Pirimicarb	50%	396 g per ha	Foliar at 8 and 12 WAP
Abanil 18EC	Abamectin	1.8%	300 ml per ha	Foliar at 8 and 12 WAP

SL: Soluble Liquid; SC: Suspension Concentrate; WDG: Water Dispersible Granules. WG: Wettable Granules; EC: Emulsifiable Concentrate; WAP Weeks after Planting

Statistical analysis

Data were analyzed using Genstat statistical package by one-way ANOVA. Means were separated by Duncan's Multiple Range Test (DMRT).

4.4.3 Results and Discussion

Experiment in Field 314

Table 4.7 shows that YSA control was achieved in most insecticides two weeks after application, except Abamectin treatments (both one and two applications) which were least effective. Foliar applications of Attakan at 8 WAP, Actara (8 WAP) + Drone (12 WAP), Actara (8 WAP) and Drone (8 WAP) were in descending order the most effective in reducing the YSA population in the trial (Table 4.7, Fig4.5 to Fig 4.7).

The different insecticides treatments have not been consistent in reducing YSA damage on sugarcane leaves although on the average, Actara (8 WAP) + Drone (12 WAP), Piricab (8 WAP) + (12 WAP), Drone (8 WAP), and Attakan (8 WAP) were significantly ($P \leq 0.05$) more effective than untreated plots. A similar trend was shown with all treatments yielding more than control. Attakan (8 WAP) had significantly ($P \leq 0.05$) highest TCH (143.6) and Tons Brix per ha (33.2) as compared to control (TCH 127.0 and 28.2 Tons Brix per ha).

Table 4. 7: Mean number of YSA colonies per stalk in different treatments and sampling periods (Log 10 (x + 1) Transf.))

Treatments	Sampling Periods									
	10.7 WAP	**13.3 WAP**	**15.6 WAP**	**17.7WA P**	**19.9 WAP**	**21.9 WAP**	**23.9 WAP**	**25.9 WAP**	**27.9 WAP**	**29.9 WAP**
Attackan (8)	0.498 a	0.088 ab	0.084 a	0.037 ab	0.00 a	0.207 a	0.020 a	0	0	0
Abamectin (8)	0.502 a	0.442 b	0.238 a	0.037 ab	0.0365 a	0.363 a	0.056 a	0	0	0
Actara (8)	0.467 a	0.112 ab	0.169 a	0.051 ab	0.0365 a	0.385 a	0.088 a	0	0	0
Drone (8)	0.502 a	0.238 ab	0.137 a	0.037 ab	0.0198 a	0.210 a	0.0 a	0	0	0
Pirimicarb (8)	0.473 a	0.371 b	0.245 a	0.0 ab	0.0198 a	0.323 a	0.071 a	0	0	0
Abamectin (8) +(12)	0.411 a	0.388 b	0.297 a	0.158 b	0.0198 a	0.397 a	0.0 a	0	0	0
Actara (8) + Drone (12)	0.298 a	0.107 ab	0.056 a	0.0 ab	0.0365 a	0.137 a	0.020 a	0	0	0
Pirimicarb (8) + (12)	0.557 a	0.299 ab	0.212	0.051 ab	0.051 a	0.343 a	0.020 a	0	0	0
Control (no foliar spraying)	0.461 a	0.409 b	0.259 a	0.076 ab	0.00 a	0.292 a	0.071 a	0	0	0
Mean	**0.463**	**0.273**	**0.188**	**0.05**	**0.0244**	**0.295**	**0.038**	**0**	**0**	**0**
SE	**0.1811**	**0.1546**	**0.1743**	**0.067**	**0.05939**	**0.197**	**0.0664**	**0**	**0**	**0**
LSD	**0.2643**	**0.2256**	**0.2543**	**0.0977**	**0.08667**	**0.2875**	**0.0969**	**0**	**0**	**0**
CV %	**39.1**	**56.7**	**92.4**	**135.1**	**242.9**	**66.7**	**173.2**	**0**	**0**	**0**

Note: WAP=Weeks After Planting

Table 4. 8: Mean percent infested leaves per stalk in different treatments and sampling periods

Treatments	Sampling Periods									
	10.7 WAP	13.3 WAP	15.6 WAP	17.7 WAP	19.9 WAP	21.9 WAP	23.9 WAP	25.9 WAP	27.9 WAP	29.9 WAP
Attackan (8)	24.78 a	18.01 a	17.19 ab	18.02 a	9.9 a	26.39 a	18.18 a	15.0 a	12.7 a	11.1 abc
Abamectin (8)	23.95 a	18.63 a	19.5 ab	18.96 a	8.8 a	29.76 a	18.38 a	12.11 a	10.3 a	2.7 ab
Actara (8)	20.41 a	20.33 a	15.27 ab	17.8 a	11.2 a	29.64 a	19.73 a	14.56 a	12.2 a	15.4 bc
Drone (8)	25.09 a	15.59 a	11.91 ab	14.82 a	15.1 a	27.53 a	13.52 a	12.01 a	20.1 a	19.9 bc
Pirimicarb (8)	25.49 a	20.8 a	14.61 ab	18.69 a	14.2 a	29.54 a	17.98 a	14.91 a	14.2 a	11.5 abc
Abamectin (8) +(12)	21.76 a	19.42 a	20.07 b	26.38 a	11.3 a	28.56 a	16.44 a	14.71 a	14.3 a	12.0 abc
Actara (8) + Drone (12)	17.4 a	16.96 a	10.12 ab	18.28 a	12.2 a	24.72 a	16.95 a	15.29 a	19.6 a	9.1 abc
Pirimicarb (8) + (12)	26.05 a	16.54 a	12.22 ab	15.14 a	9.2 a	28.44 a	18.53 a	11.52 a	10.1 a	13.0 abc
Control (no foliar spraying)	26.01 a	20.12 a	19.4 ab	20.72 a	5.1 a	25.42 a	17.05 a	14.33 a	18.1 a	21.9 c
Mean	**23.44**	**18.49**	**15.59**	**18.81**	**10.8**	**27.78**	**17.42**	**13.83**	**14.6**	**13**
SE	**5.03**	**4.02**	**5.837**	**4.966**	**6.2**	**5.081**	**4.978**	**3.319**	**7.37**	**7.61**
LSD	**7.341**	**5.867**	**8.519**	**7.264**	**9.04**	**7.415**	**7.265**	**4.844**	**10.76**	**11.11**
CV %	**21.5**	**21.7**	**37.4**	**26.4**	**57.5**	**18.3**	**28.6**	**24**	**50.4**	**58.7**

Note: WAP=Weeks After Planting

Table 4. 9: Mean percent damage leaves per stalk in different treatments and sampling periods on leaves per stalk

Treatment	Sampling Periods									
	10.7 WAP	**13.3 WAP**	**15.6 WAP**	**17.7WAP**	**19.9 WAP**	**21.9 WAP**	**23.9 WAP**	**25.9 WAP**	**27.9 WAP**	**29.9 WAP**
Attackan (8)	11.89 ab	28.2 a	22.3 abc	16.7 ab	14.2 a	42.69 a	28.5 a	22.0 a	11.0 a	13.4
Abamectin (8)	9.54 ab	34.6 a	24.0 abc	22.9 ab	13.5 a	46.12 a	26.9 a	20.1 a	14.4 a	4.6
Actara (8)	12 18 ab	25.9 a	21.8 abc	21.5 ab	11.0 a	46.0 a	27.4 a	24.1 a	19.0 a	22.1
Drone (8)	12.81 ab	24.9 a	12.4 abc	14.4 ab	16.4 a	43.87 a	18.9 a	16.1 a	20.4 a	17.8
Pirimicarb (8)	18.13 b	31.0 a	25.7 abc	18.4 ab	17.2 a	45.89 a	24.0 a	22.8 a	19.4 a	13.1
Abamectin (8) +(12)	10.17 ab	30.1 a	29.8 c	30.0 b	14.3 a	44.89 a	21.0 a	24.9 a	15.1 a	23.2
Actara (8) + Drone (12)	4.76 ab	21.8 a	11.3 a	17.6 ab	13.7 a	40.99 a	27.4 a	22.3 a	20.3 a	9.9
Pirimicarb (8) + (12)	13.55 ab	30.0 a	15.5 abc	17.6 ab	7.9 a	44.8 a	26.6 a	19.9 a	12.3 a	13.9
Control	11.95 ab	28.6 a	26.7 bc	25.3 ab	9.0 a	41.74 a	26.5 a	23.4 a	20.2 a	18.5
Mean	**11.7**	**28.41**	**21**	**20.5**	**13**	**44.1**	**25.2**	**21.8**	**16.9**	**15.2**
SE	**6.84**	**8.72**	**9.05**	**6.55**	**7.36**	**5.149**	**7.06**	6.59	**8.37**	**9.43**
LSD	**9.99**	**12.73**	**13.2**	**9.57**	**10.74**	**7.515**	**10.31**	**9.62**	**12.22**	**13.75**
CV %	**58.7**	**30.8**	**43**	**32**	**56.5**	**11.7**	**28**	**30.2**	**49.6**	**62.2**

Note: WAP=Weeks After Planting

Table 4. 10: Effects of Treatments on mean stalk population, Cane yield and Brix%

Treatment	Stalk Pop. per Ha	TCH	Ton Brix/ha
Attackan (8)	95841 a	143.6 a	33.2 a
Abamectin (8)	89799 a	134.7 a	26.6 a
Actara (8)	91605 a	131.0 a	26.4 a
Drone (8)	90285 a	129.6 a	26.4 a
Pirimicarb (8)	85007 a	133.2 a	23.9 a
Abamectin (8) +(12)	94938 a	132.4 a	25.2 a
Actara (8) + Drone (12)	97925 a	131.4 a	26.1 a
Pirimicarb (8) + (12)	88062 a	130.3 a	28.1 a
Control	82716 a	127.0 a	28.2 a
Mean	**90686**	**132.58**	**27.10**
SE	**15237.3**	**29.1**	**5.78**
LSD	**22237.3**	**42.47**	**8.4**
CV%	**16.8**	**22.0**	**21.3**

Table 4. 11: Ranking of seasonal performances of the insecticides treatments on YSA populations and damage parameters

Treatments	YSA colonies	% Infested leaves	% Damage	Ranking	
				Total	**Final**
Attackan (8)	2	4	4	10	2
Abanil (8)	8	3	5	16	6
Actara (8)	4	6	8	18	4
Drone (8)	3	5	2	10	3
Piricab (8)	5	7	6	18	7
Abanil (8) +(12)	9	8	9	26	8
Actara (8) + Drone (12)		1	1	3	1
Piricab (8) + (12)	6	2	3	11	5
Control (no foliar spraying)	7	9	7	23	9

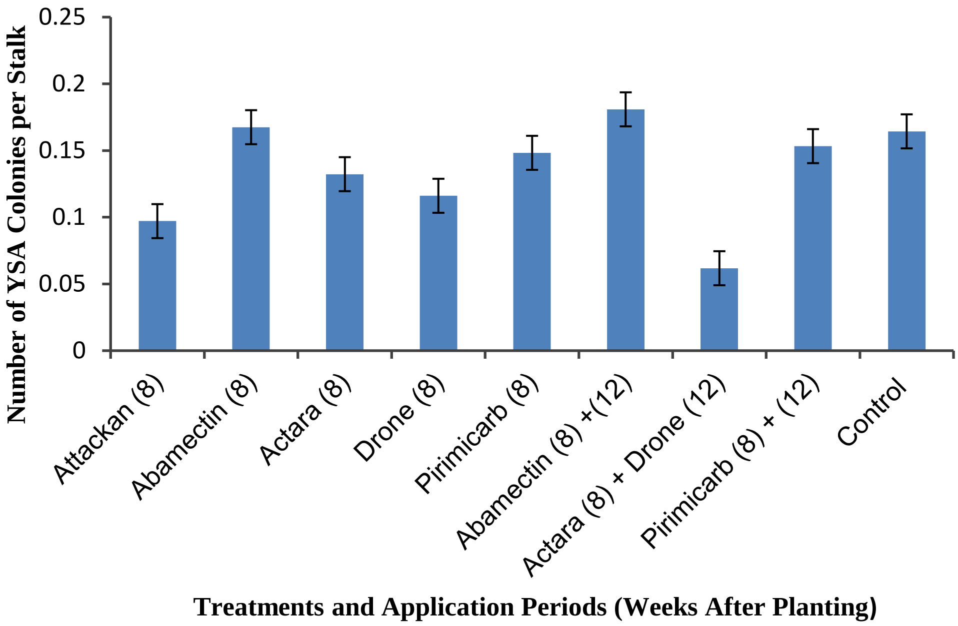

Figure 4. 3: The Mean Effects of Different Insecticides Treatments on YSA Population

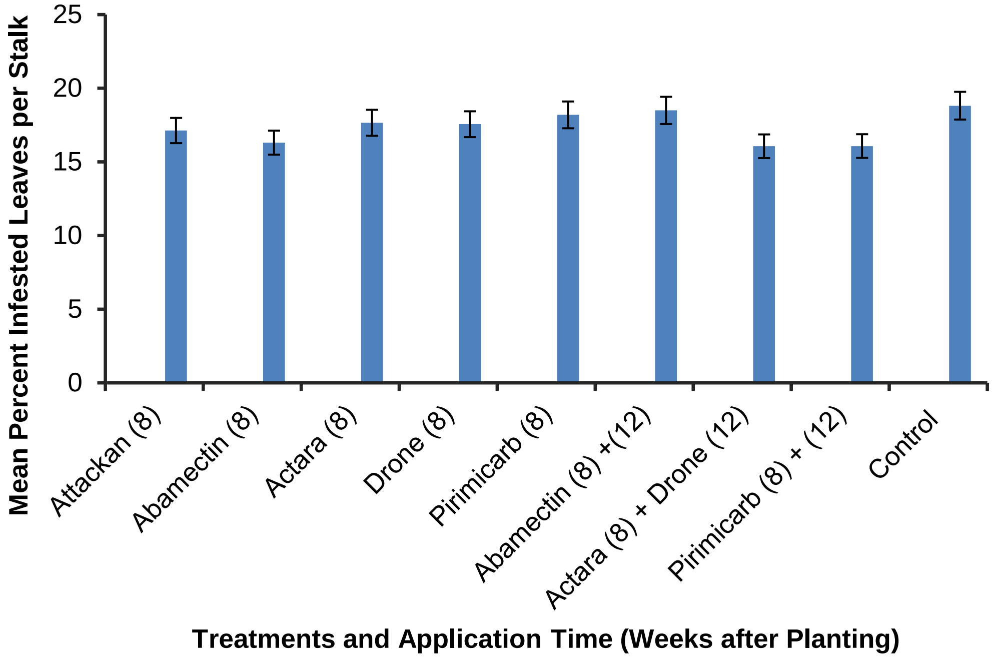

Figure 4. 4: Seasonal Mean Percent Infested Leaves in Different Insecticides Treatments

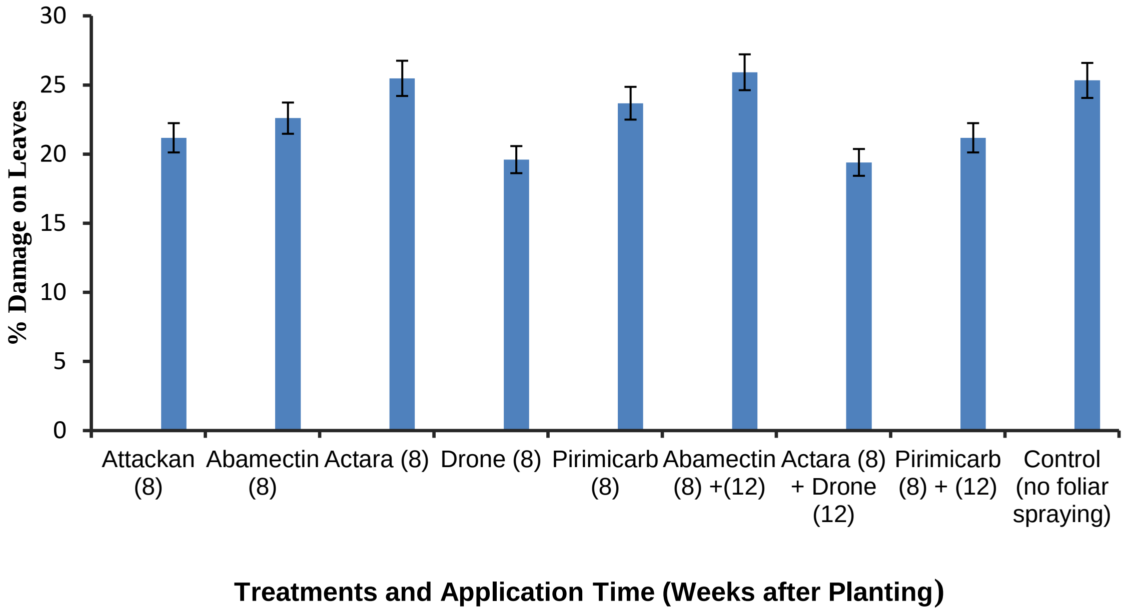

Figure 4. 5: Seasonal Mean Percent Damage on Leaves in Different Insecticides Treatments

Experiment in field 325

Considerable reduction in predator numbers was recorded in plots treated with Attackan (8 WAP), Drone (8 WAP + 12 WAP), Actara (8 WAP + 12 WAP) and Attackan (8 WAP + 12 WAP). Abamectin (8 WAP), Abamectin (8 WAP + 12 WAP). Attackan (soil), Pirimicarb (8 WAP), Pirimicarb (8 WAP + 12 WAP) and Drone (8 WAP) had comparable predator populations with control.

Attackan (8 WAP), Actara (8WAP), Drone (8 WAP) Attackan (8 WAP + 12 WAP), Actara (8 WAP + 12 WAP) and Drone (8 WAP + 12 WAP) have all indicated reduction ranging from 55.2% to 75.5% reduction of YSA control and as illustrated in Fig.4.9 only one application of these treatments may be sufficient in order to avoid their detrimental effects on predators. The same trends of effectiveness of the neonictinoids (Attackan, Drone and Actara) have been demonstrated in reduction of YSA damage on sugarcane leaves (Figures 4.14 and 4.15).

Table 4. 12: Mean number of predators per stool in different treatments and sampling dates

Treatments	Sampling Periods							
	10 WAP	**12.3 WAP**	**14.1 WAP**	**16.1 WAP**	**18.3 WAP**	**20.3 WAP**	**22.3 WAP**	**24.9 WAP**
Attackan (soil)	0.287 ab	0.075 a	0.811 a	0.790 ab	0.000 a	0.071 a	0.119 a	0.00
Attackan (8)	0.314 ab	0.000 a	0.345 a	0.389 ab	0.076 a	0.000 a	0.331 a	0.00
Abamectin (8)	0.151 ab	0.075 a	0.911 a	0.894 bc	0.051 a	0.110 a	0.075 a	0.00
Actara (8)	0.301 ab	0.000 a	0.445 a	0.639 abc	0.020 a	0.107 a	0.250 a	0.00
Drone (8)	0.420 ab	0.075 a	0.584 a	0.758 abc	0.051 a	0.084 a	0.250 a	0.00
Pirimicarb (8)	0.119 ab	0.075 a	0.584 a	1.118 c	0.051 a	0.037 a	0.075 a	0.00
Attackan (8 + 12)	0.345 ab	0.075 a	0.376 a	0.345 ab	0.107 a	0.064 a	0.000 a	0.00
Abamectin (8 + 12)	0.376 ab	0.362 a	0.791 a	0.314 a	0.071 a	0.056 a	0.270 a	0.00
Actara (8 + 12)	0.151 ab	0.000 a	0.581 a	0.464 ab	0.051 a	0.037 a	0.301 a	0.00
Drone (8 + 12)	0.464 b	0.000 a	0.464 a	0.464 ab	0.056 a	0.000 a	0.195 a	0.00
Pirimicarb (8 + 12)	0.000 a	0.119 a	0.886 a	0.548 ab	0.040 a	0.088 a	0.195 a	0.00
Control	0.376 ab	0.075 a	0.705 a	0.705 abc	0.102 a	0.076 a	0.476 a	0.00
MEAN	**0.275**	**0.078**	**0.624**	**0.619**	**0.056**	**0.061**	**0.211**	0.00
SE	**0.2597**	**0.1667**	**0.3349**	**0.3426**	**0.0848**	**0.0806**	**0.2985**	0.00
LSD	**0.3736**	**0.2398**	**0.4818**	**0.4928**	**0.1227**	**0.116**	**0.4295**	0.00
CV %	**94.3**	**214.4**	**53.7**	**55.3**	**151.4**	**132.7**	**141.3**	0.00

Note: WAP=Weeks After Planting

Table 4. 13: Mean number of YSA colonies per stalk in different treatments and sampling dates

Treatment	Sampling Periods							
	10 WAP	**12.3 WAP**	**14.1 WAP**	**16.1 WAP**	**18.3 WAP**	**20.3 WAP**	**22.3 WAP**	**24.9 WAP**
Attackan (soil)	0.389 a	0.719 d	0.887 b	0.258 a	0.125 ab	0.051 a	0.0198 a	0
Attackan (8)	0.412 a	0.112 a	0.277 a	0.105 a	0.064 ab	0.051 a	0.08	0
Abamectin (8)	0.535 a	0.673 cd	0.841 b	0.343 a	0.135 ab	0.119 a	0.00	0
Actara (8)	0.332 a	0.312 abc	0.779 b	0.19 a	0.177 ab	0.064 a	0.000 a	0
Drone (8)	0.392 a	0.037 a	0.444 ab	0.278 a	0.312 b	0.040 a	0.0198 a	0
Pirimicarb (8)	0.285 a	0.662 cd	0.861 b	0.349 a	0.120 ab	0.000 a	0.000 a	0
Attackan (8 + 12)	0.404 a	0.088 a	0.455 ab	0.251 a	0.000 ab	0.000 a	0.0365 a	0
Abamectin (8 + 12)	0.339 a	0.695 cd	0.731 ab	0.12 a	0.086 ab	0.000 a	0.0198 a	0
Actara (8 + 12)	0.237 a	0.306 abc	0.445 ab	0.086 a	0.198 ab	0.000 a	0.000 a	0
Drone (8 + 12)	0.378 a	0.243 ab	0.550 ab	0.075 a	0.020 ab	0.000 a	0.000 a	0
Pirimicarb (8 + 12)	0.433 a	0.624 bcd	0.680 ab	0.322 a	0.132 ab	0.061 a	0.0198 a	0
Control	0.376 a	0.682 cd	0.592 ab	0.151 a	0.207 ab	0.020 a	0.000 a	0
MEAN	0.38	0.429	0.6285	0.211	0.13	0.03	0.0159	0
SE	0.1983	0.2445	0.2877	0.1853	0.1484	0.0893	0.05212	0
LSD	0.2853	0.3518	0.4139	0.2666	0.2135	0.1284	0.07498	0
CV %	52.7	57	45.8	87.9	113	270.8	327.5	0

Note: WAP=Weeks After Planting

Table 4. 14: Mean percent infested leaves per stalk in different treatments and sampling dates

Treatment	Sampling Periods							
	10 WAP	**12.3 WAP**	**14.1 WAP**	**16.1 WAP**	**18.3 WAP**	**20.3 WAP**	**22.3 WAP**	**24.9 WAP**
Attackan (soil)	18.09 a	16.97 ab	23.46 b	22.09 cd	20.95 ab	14.01 ab	9.67 a	0
Attackan (8)	18.26 a	13.73 ab	19.87 ab	14.99 abc	17.16 ab	13.21 ab	4.22 a	0
Abamectin (8)	23.10 a	17.85 b	16.16 ab	28.11 d	24.20 b	12.56 ab	5.30 a	0
Actara (8)	17.91 a	13.64 ab	15.25 ab	18.07 abcd	18.70 ab	9.19 a	10.08 a	0
Drone (8)	18.48 a	15.64 ab	18.56 ab	9.87 a	20.98 ab	16.95 ab	7.33 a	0
Pirimicarb (8)	18.67 a	15.47 ab	22.61 ab	21.58 bcd	23.57 ab	12.43 ab	8.71 a	0
Attackan (8 + 12)	17.95 a	8.26 a	13.85 a	18.11 abcd	17.22 ab	8.96 a	8.22 a	0
Abamectin (8 + 12)	22.43 a	15.78 ab	23.07 b	19.51 abcd	22.60 ab	14.58 ab	4.88 a	0
Actara (8 + 12)	15.82 a	11.56 ab	24.21 b	19.10 abcd	19.53 ab	17.17 ab	5.21 a	0
Drone (8 + 12)	19.21 a	13.84 ab	24.37 b	10.65 ab	18.57 ab	18.40 b	7.61 a	0
Pirimicarb (8 + 12)	20.34 a	13.52 ab	23.18 b	21.77 bcd	20.83 ab	15.61 ab	4.03	0
Control	19.02 a	15.30 ab	24.51 b	19.50 abcd	16.74 a	14.30 ab	2.91 a	0
MEAN	**19.11**	**14.3**	**20.76**	**18.61**	**20.09**	**13 95**	**6.51**	0
SE	**5.117**	**5.226**	**5.498**	**6.698**	**4.278**	**5.354**	**6.572**	0
LSD	**7.361**	**7.518**	**7.909**	**9.636**	**6.154**	**7.702**	**9.454**	0
CV %	**26.8**	**36.6**	**26.5**	**36**	**21.3**	**38.4**	**100.9**	0

Note: WAP=Weeks after Planting

Table 4. 15: Mean percent damage on leaves per stalk in different treatments and sampling dates

Treatment	Sampling Periods							
	10 WAP	**12.3 W AP**	**14.1 WAP**	**16.1 WAP**	**18.3 WAP**	**20.3 WAP**	**22.3 WAP**	**24.9 WAP**
Attackan (soil)	29.5 a	26.0 b	27.99 cd	39.7 cd	38.5 ab	16.6 a	18.1 b	0
Attackan (8)	24.5 a	19.1 ab	16.76 ab	21.8 ab	30.9 ab	24.4 a	4.1 ab	0
Abamectin (8)	29.4 a	22.4 b	31.54 cd	42.2 d	40.6 b	20.5 a	7.9 ab	0
Actara (8)	25.5 a	12.8 ab	8.72 a	32.3 abcd	28.3 ab	13.4 a	13.2 ab	0
Drone (8)	29.1 a	13.6 ab	14.17 ab	15.9 a	39.3 ab	21.2 a	2.0 a	0
Pirimicarb (8)	26.4 a	18.9 ab	30.48 cd	37.1 bcd	38.8 ab	18.1 a	11.5 ab	0
Attackan (8 + 12)	24.1 a	6.4 a	9.95 a	24.1 abc	29.7 ab	13.3 a	8.9 ab	0
Abamectin (8 + 12)	39.7 a	23.0 b	33.21 d	32.0 abcd	41.9 b	24.9 a	2.9 a	0
Actara (8 + 12)	28.5 a	15.5 ab	22.74 bc	24.0 abc	33.3 ab	26.5 a	11.6 ab	0
Drone (8 + 12)	26.6 a	13.8 ab	16.12 ab	18.6 a	24.2 a	25.6 a	10.7 ab	0
Pirimicarb (8 + 12)	26.6 a	15.2 ab	27.26 cd	37.3 bcd	36.3 ab	24.2 a	7.3 ab	0
Control	28.3 a	23.1 b	34.52 d	27.3 abcd	33.1 ab	22.4 a	3.5 ab	0
MEAN	**28.20**	**17.500**	**22.79**	**29.400**	**34.60**	**20.90**	**8.5**	**0**
SE	**10.04**	**8.57**	**5.999**	**10.48**	**9.52**	**8.9**	**8.72**	0
LSD	**14.44**	**12.33**	**8.631**	**15.07**	**13.69**	**12.81**	**12.54**	0
CV %	**35.6**	**49**	**26.3**	**35.7**	**27.5**	**42.5**	**102 9**	0

Note: WAP=Weeks After Planting

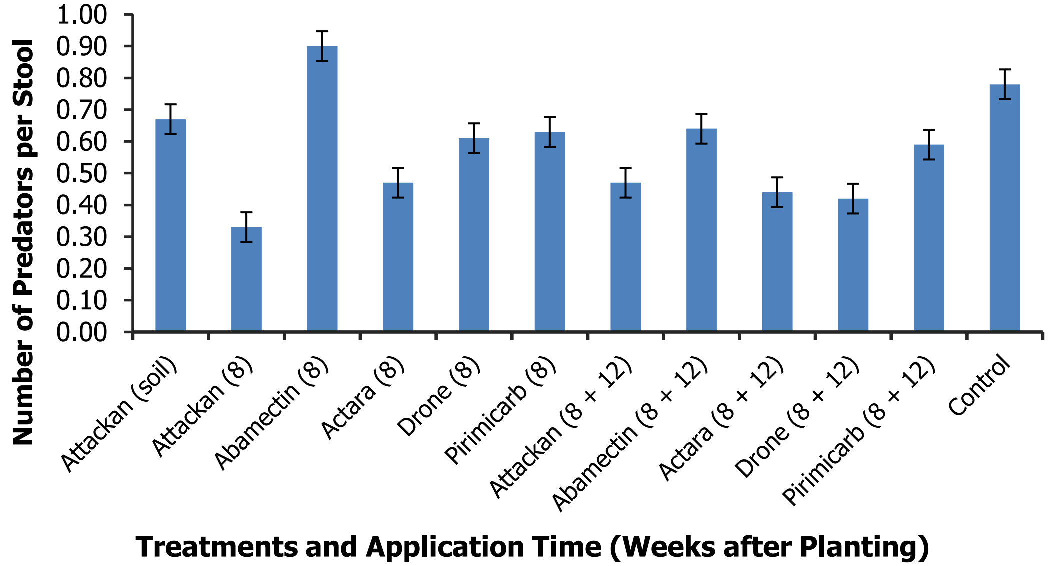

Figure 4. 6: The Effects of Different Insecticides Treatments on Predator Population

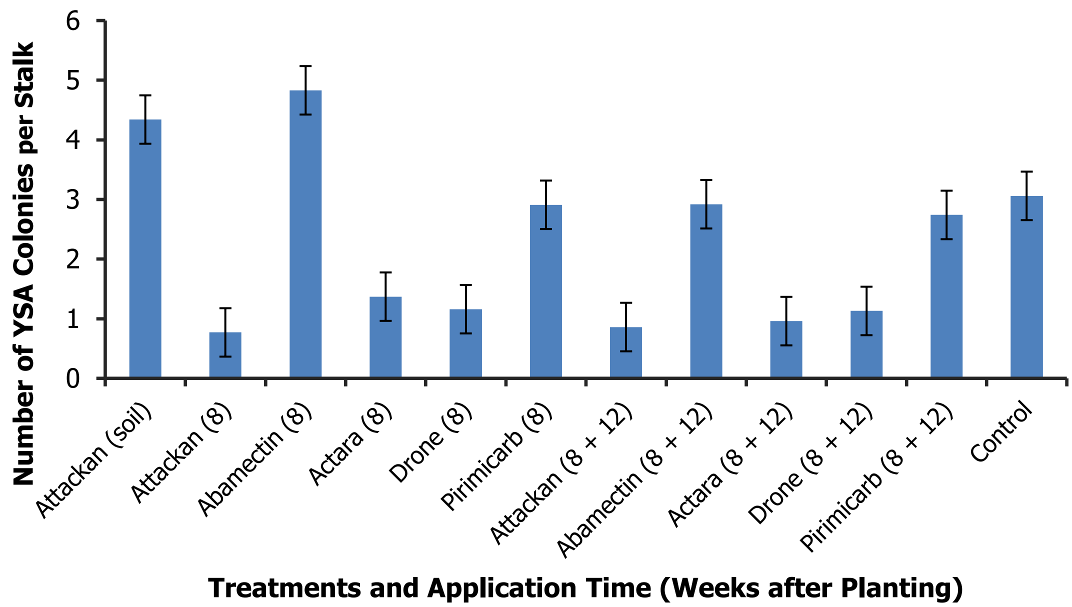

Figure 4. 7: The Seasonal Effects of Different Insecticides Treatments on YSA Population

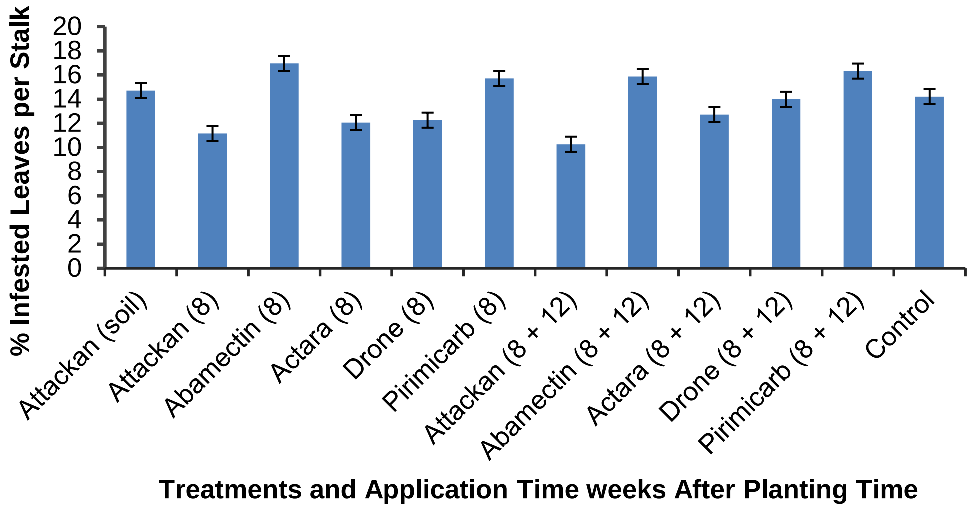

Figure 4. 8: The Mean Seasonal Effects of Insecticides Treatments on Percent Infested Stalks

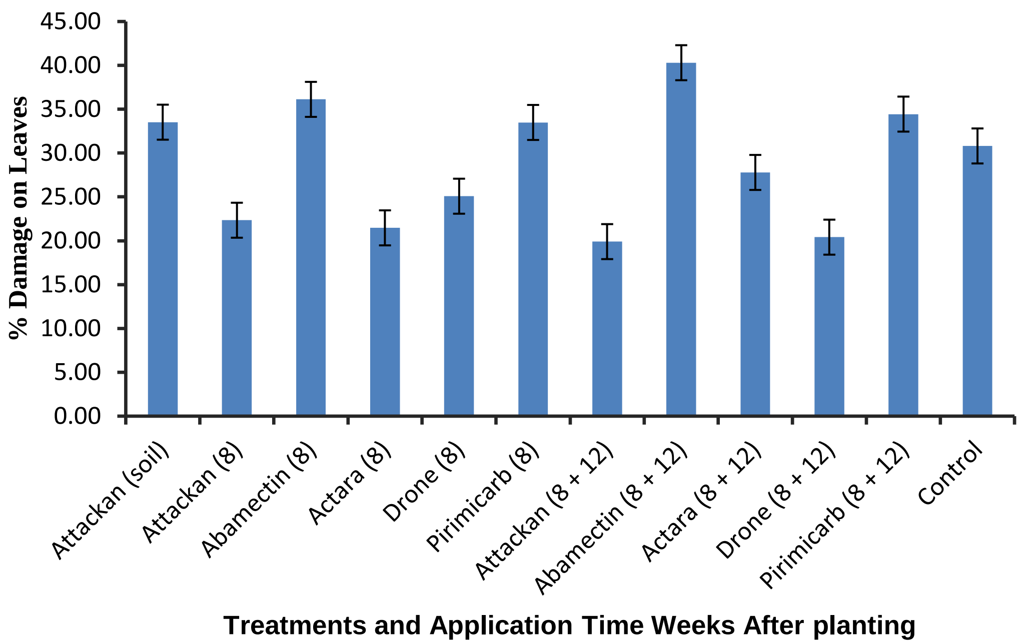

Figure 4. 9: The Seasonal Mean % Damage on Leaves in Different Treatments

Impact of insecticides applications on predator populations

All chemicals except abamectin has shown negative impacts on predators compared to untreated (Fig 4.12). Also soil applied attackan appears to preserve more predators compared to other treatments. Attackan soil applied had shown less reduction in number of predators than foliar applied Attackan.

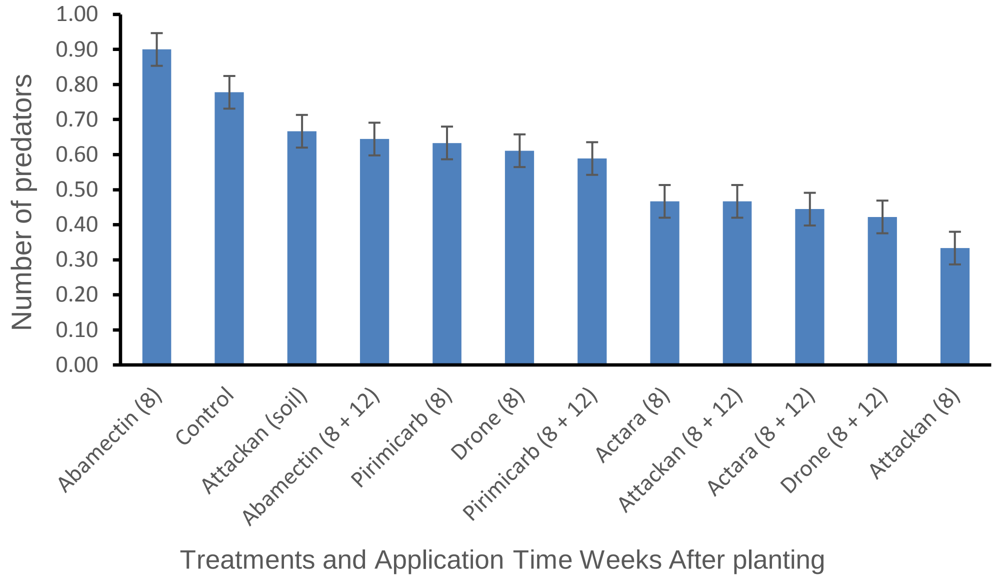

Figure 4. 10*: S*easonal mean number of predators per stool in different treatments

Conclusion

The two insecticides trials conducted at Kilombero have therefore demonstrated that the neonicotinoids insecticides (Attackan, Drone and Actara) are highly effective in reduction of YSA population.

4.5 Project Tittle: Impacts of predators on Population dynamics of Yellow Sugarcane Aphid in Kilombero and Kagera Estates

Project Number: CPE2018/05

Principal Investigators: J. M. Katundu, F. A. Urassa A. Yusuph and M. Mwinjummah.

Collaborators: Y. Kalinga, A. Nassoro

Reporting Period: 2018/2019.

Project Summary

Field surveys of seasonal changes in the abundance of Yellow Sugarcane Aphid (YSA) and predators, and exclusion cages were used to investigate the impacts of the resident generalist predators in reducing populations of the YSA in sugarcane. The mosquito netting with aperture size of 4.0 mm was used to allow entry of YSA and small predators and to exclude in the cage the large Coccinellidae and Syriphidae *species*.

The regular field surveys have shown strong associations and correlations between numbers of the YSA colonies and predators, and together with observations of actual feeding provided evidence of the role of these natural enemies on YSA population regulation. Also, results of the exclusion method have shown that YSA population could increase three to five times in the absence of the generalist Coccinellid predators. Predators suppress YSA populations in early part of the season and followed by the general decline in aphid infestation when the sugarcane plants get older.

4.5.1 Introduction

Aphidophagous predators are the most abundant generalist predators of aphid populations (Hodek, van Emden, and Honek, 2012). Since the occurrence of Yellow Sugarcane Aphid (YSA) in Tanzania several species of ladybirds, lacewings and hoverflies have been recorded to feed on YSA (Anonymous, 2016)

Several species of predatory insects in the families of Coccinellidae (ladybirds), Syriphidae (hoverflies), Chrysopidae (lacewings) and Forficulidae (earwigs) have been observed on sugarcane infested with YSA in Tanzania(Anonymous, 2016). Coccinellidae species including *Hippodamiavariegata* (Goeze), *Cheilomeneslunata* (F), *C. sulphurea*(Olivier), *C. propinqua* (Mulsant), and *Exochomus nigromaculatus*(Goeze) *and* Syriphidae species such as *Xanthogramma scutellareaegyptium* (Wied) have been found to be among the most dominant predators which are usually present earlier in the season when YSA densities are low.

These predators are usually found to be abundant in the fields but their effectiveness in controlling YSA has not been established. The present investigations studied the impacts of the resident adults and larvae of Coccinellid and Syriphid predators in reducing populations of the YSA in sugarcane by field surveys of seasonal changes in the abundance of prey and predator, and secondly by using a method of partial exclusion cages and open plots as per Dent (1991); and Hodek *et al.* (2012). Also to assess the impact of reduction of predator numbers by using insecticides on the YSA population on infested sugarcane.

Specific Objectives

a) To determine the effectiveness of predators on YSA control on sugarcane.
b) To study population fluctuations of the predators and YSA in sugarcane.
c) To study the effect of foliar application of the insecticides on predators, YSA and YSA resurgence.

Outputs

- Two (Physical and chemical) predator exclusion trials have been set up at Kilombero and Kagera.
- Data on the level of predators in control of YSA available.

4.5.2 Materials and Methods

This study involved two trials conducted in Kilombero and Kagera estates with cage and chemical treatments respectively.

Treatments:

First trial

- Cage (Physical exclusion of predators): Treatments - (A) Cage and (B)Open plots

Second Trial

Chemical exclusion: Five treatments - 4 insecticides Pirirmicarb (carbamate), Profenofos (organophosphate), Deltamethrin (pyrethroid), Acetamiprid (neonicotinoid) and untreated control.

First Trials: Physical exclusion of predators by using Cages

Investigations by using Partial Exclusion Cages were conducted in sugarcane fields at Kilombero (Field 682) and Kagera (Field DR3B) from August 2018 to March, 2019.Treatments were replicated four times in Randomized Complete block design. The plot and cage sizes were approximately 10 m^2 which varied according to plant spacing used in each field.

	Kilombero (Field 682)	**Kagera (Field DR3B)**
Plot size	3.6 m (2 rows) X 3.0 m	5 m (4 rows) X2 m
Space between plots	0 m (adjacent)	0 m (adjacent)
Spacing between rows	1.8 m	1.7 m * 0.7 m
Number of plots	8	8
Cage size (four cages, and four open plots)	3.6 m(2 rows) X 3.0 m X 2 m height	5 m (4 rows) X2 m X 2 m height

The cages were made by wooden frames with mosquito polyester netting of mesh size of ten holes per 1.0 sq. inch or aperture size of approximately 4.0 mm. The lower portion of the net sewn with a polythene tube material so that 15 cm was sunk in soil and covered. The mesh size of mosquito netting was selected to allow entry of YSA and small predators and to exclude in the cage the large Coccinellid and syriphid predators which are dominant, and assumed to be important in the regulation of YSA population in the field.

Second Trials: Investigations using chemical exclusion

This experiment was assessing the impact of reduction of predator numbers by using insecticides on the YSA population on infested sugarcane.

Four insecticides Pirimicarb (carbamate), Profenofos (organophosphate), Deltamethrin (pyrethroid) and Acetamiprid (neonicotinoid) were used in treated plots at field rates. These insecticides were reported by Ahmad *et al.* (2011) to be highly toxic to predators and could have either direct lethal effect or sub- lethal effects on the insect development and reproduction.

The data which included number of leaves per stalk, number of damaged leaves per stalk, numbers of predator per stool, number of YSA colonies per stalk and level of damage on leaves were taken, at two -weeks intervals, starting at one month after planting (MAP) or when the plants have about six leaves per stalk. The sampling continued up to 24 weeks after planting or when the sugarcane was just two meters high.

4.5.3 Results and Discussion

Seasonal YSA and predator population changes

The associations and correlations between numbers of the YSA colonies and predators are graphically represented in figures 4.13 to 4.15, together with observations of actual feeding by the adults and larvae of Coccinellids, are evidence of the impact of these natural enemies on YSA population regulation. There was no time-lag in the observed prey – predator population oscillations, apparently because as generalists, the predators could readily move from refuges (grass weeds) into sugarcane earlier when the YSA population was still low. The collapse of large populations of aphids is attributed to the action of large numbers of coccinellids associated with them (Hodek, van Emden, and Honek, 2012; Helmut F. Van Emden and Harrington, 2017).

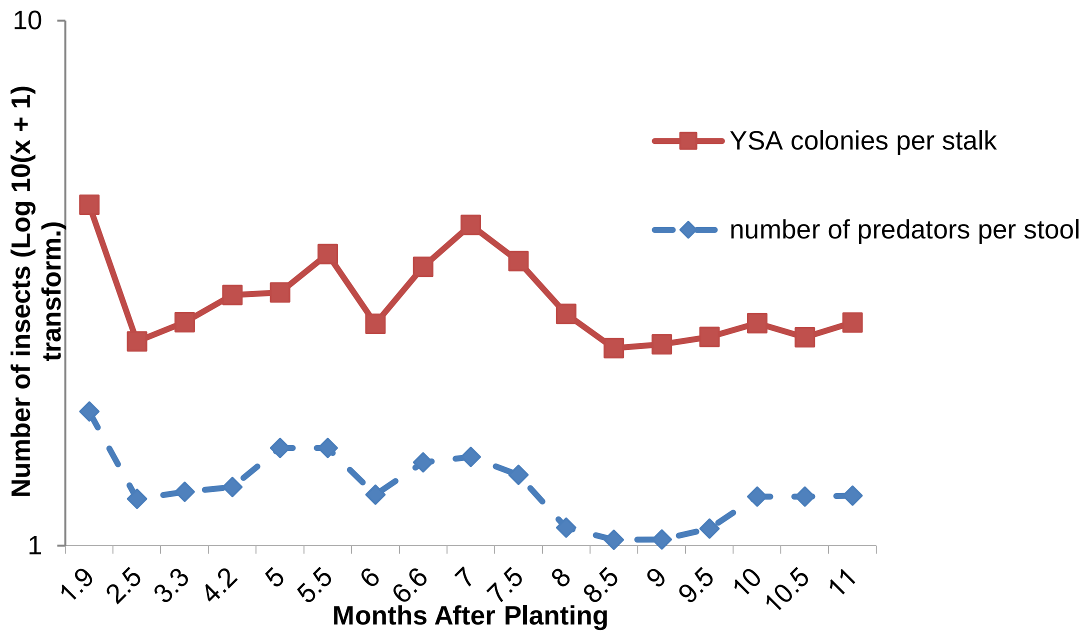

Figure 4. 11: Seasonal Changes in YSA and Predator Populations in Untreated Plots at Kagera - October, 2016

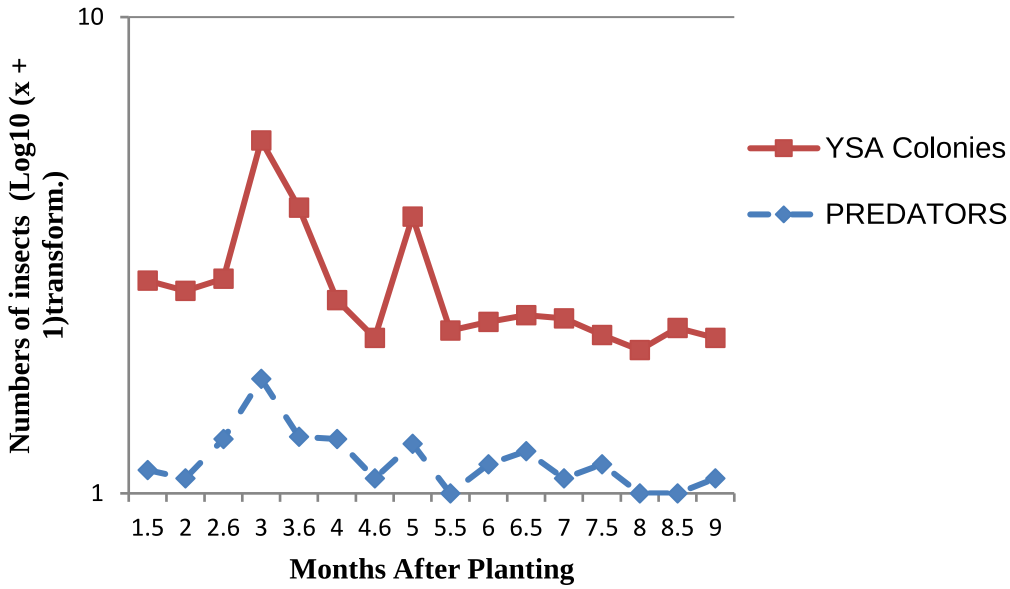

Figure 4. 12: Seasonal Changes in YSA and Predator Populations in Untreated Plots in Kagera (D23B) - October, 2017

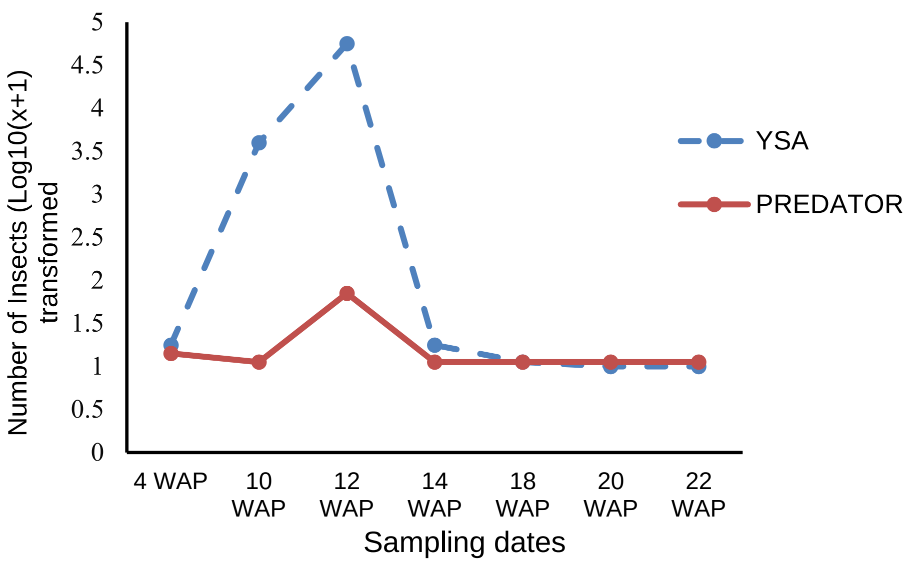

Figure 4. 13: Mean Seasonal Changes in Populations of YSA and Predators in Untreated Plots at Kilombero (Field 682) - August, 2018

Yellow Sugarcane Aphid population dynamics and damage on sugarcane plants inside and outside the cage

As illustrated in Figures 4.16 to 4.19, the YSA population has consistently reached its peak when the crop was between 3 to 4 months old (divergence phase), then followed by a decline phase after 4 or 5 months of plant growth. In the cage the peak numbers of YSA colonies per stalk were 12.1 and 22.1, and outside the cage (OPEN) were 2.5 and 4.9 at Kagera and Kilombero, respectively (Figures 4.14 and 4.15). Seasonal mean numbers of YSA colonies per stalk inside and outside the cage were in the ratios of 2.9:1 in Kagera and 5.3:1 in Kilombero (Table 4.16). The highest number of Aphids in the cage is due to the fact that predators were excluded from entering the cages.

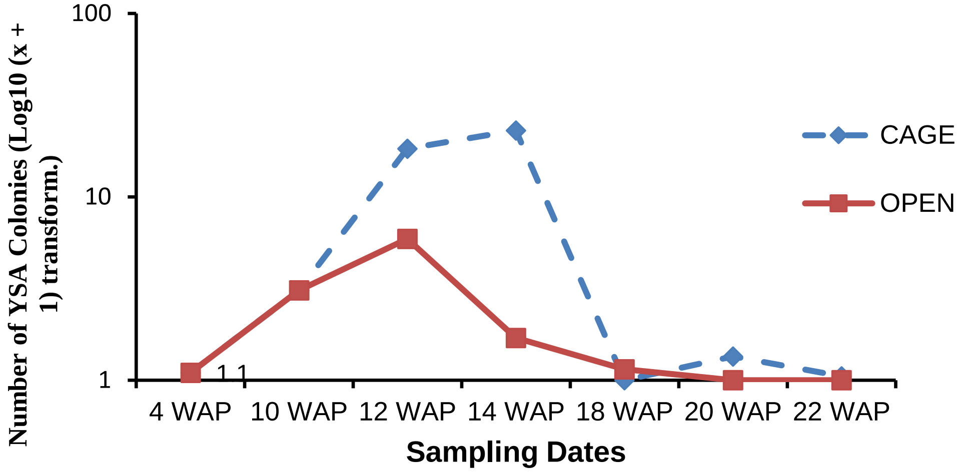

Figure 4.14: YSA Population Development inside Cages and Open Plots at Kilombero

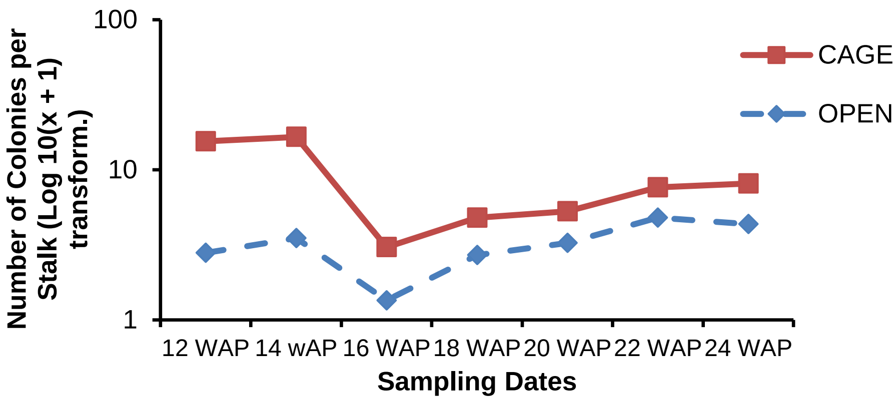

Figure 4. 15: YSA Population Development in Cage and Open Plots at Kagera

Table 4. 16: Seasonal Mean numbers of YSA colonies per stalk in cage and open plots

TREATMENT	KAGERA	KILOMBERO
CAGE	4.98571	5.99286
OPEN	1.71429	1.13571
RATIO (CAGE : OPEN)	2.9083	5.2768

Considering YSA damage on the leaves in Kilombero and Kagera investigations, the presence of predators could reduce percent infested leaves by 64.5 % and percent damage on leaves by 90.6 % (Figures 4.18 to 4.21).

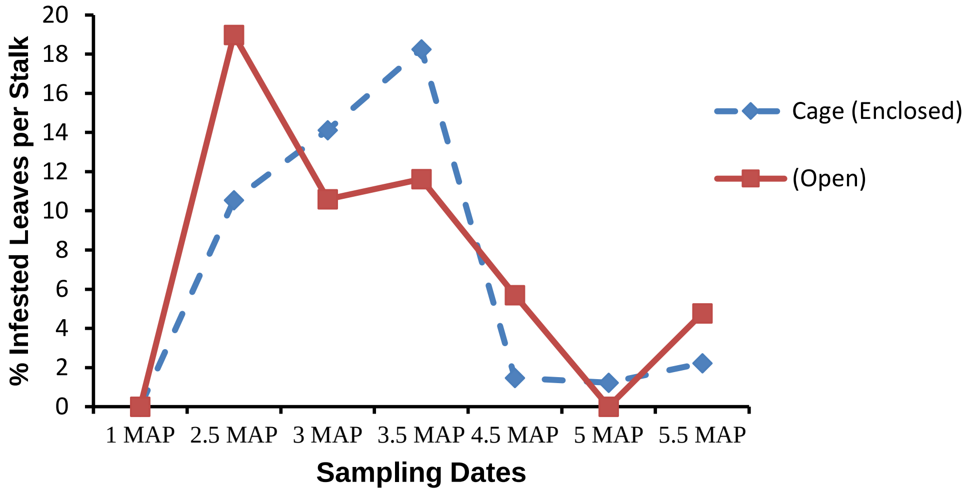

Figure 4. 16: Percent Infested Leaves per Stalk in Cage and Open Plots at Kilombero

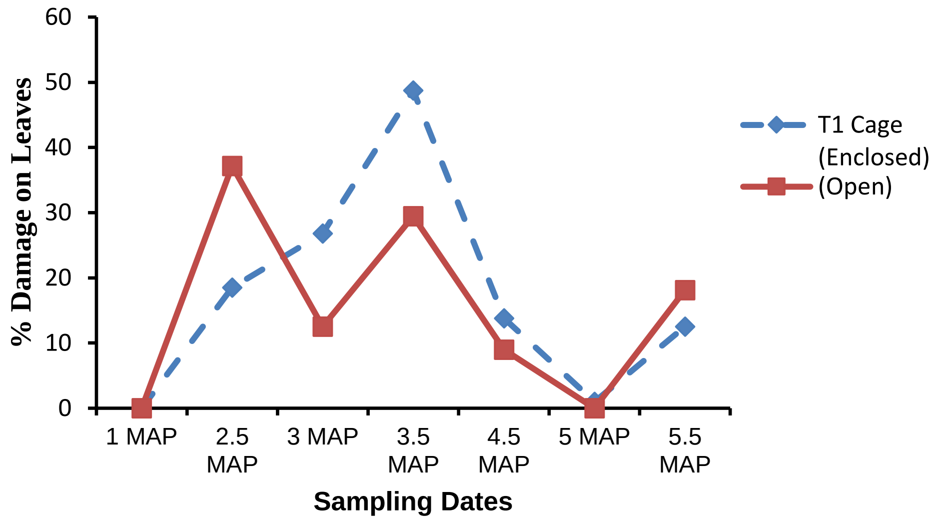

Figure 4. 17: Percent Damage on Leaves in Cage and Open Plots at Kilombero
MAP=Months After Planting

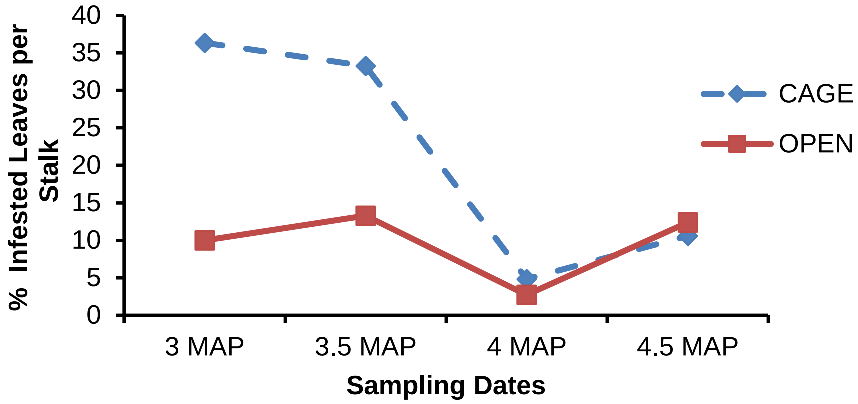

Figure 4. 18: Percent Infested Leaves per Stalk in Cage and Open Plots at Kagera

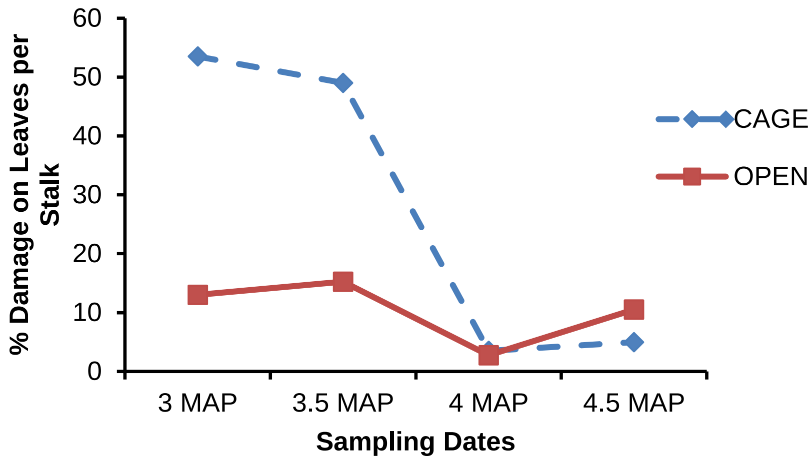

Figure 4. 19: Percent Damage on Leaves per Stalk in Cage and Open Plots at Kagera

Predator population

Although the plant growth and weather factors could be important in the general population changes, the differences in YSA abundance inside and outside cages could to some extent be attributed to predator actions. Table 4.17 is a summary of predator counts in OPEN plots which has demonstrated variable numbers in different sampling dates, from 0 to 1.75 (mean = 0.86) predators per 5 stools at Kilombero and 0 to 1.0 (mean = 0.43) predators per 5 stools at Kagera.

The low predator counts was observed because the visual sampling of predators is a quick method and it is highly influenced by the interactions of prey abundance, microclimate and host plant density and growth structure (Hodek, van Emden, and Honek, 2012). It is the highly active and visible individuals only which can be counted when temperature, sunshine and time of day are suitable for predator activity (Hodek *et al.*, 2012). Therefore, in these experiments, the recorded estimates of numbers of Coccinellid adults and larvae must have been much lower than the true predator abundance.

Table 4. 17: Predator population per five stools in open plots at Kilombero and Kagera on different sampling dates

KILOMBERO	21.09.18	16.10.18	02.11.18	13.11.18	13.12.18	24.12.18	21.01.19	MEAN
	0	0.25	1.75	0.5	1.75	0	1.75	**0.86**
KAGERA	**18.12.18**	**03.01.19**	**18.01.19**	**02.02.19**	**16.02.19**	**02.03.19**	**MEAN**	
	0	1	0.05	0.5	0.5	0.5	**0.43**	

Weather factors

During the present studies there have been no extreme changes of weather factors (mean maximum temp. of 29.0 -32.0 °C; mean minimum temp. 15.0 -21.0 °C and mean R.H. % of 71.7 – 72.1 %) in all sites (Tables 4.18 and 4.19).

Table 4. 18: Monthly weather factors at Kagera in June 2018 to January, 2019

Parameter	June,18	Aug, 18	Sep, 18	Oct, 18	Nov, 18	Dec, 18	Jan, 19	Mean
Max. Temp °C	28.5	29	29.6	28.8	29.1	27.9	28.7	**28.85**
Min. Temp. ° C	14.7	14.7	14.6	15.5	15.7	16.1	15	**15.03**
Mean R.H %	67.4	69.5	71.4	72.3	75.7	78.2	75.3	71.66
Rainfall (mm)	0.7	0.1	2	1	1.7	3.1	3.3	1.49
Rain days	1	3	11	8	15	13	12	8
Wind speed (km / hr)	NA	NA	NA	NA	NA	NA	NA	NA

Table 4. 19: Monthly weather factors at Kilombero in June 2018 to January, 2019

Parameter	June,18	Aug,18	Sep,18	Oct, 18	Nov, 18	Dec, 18	Jan, 19	Mean
Max. Temp °C	28.80	30.00	31.60	32.40	35.40	35.10	34.00	**31.99**
Min. Temp. °C	18.30	18.40	20.10	22.30	23.40	23.60	23.20	**21.00**
Mean R.H %	75.40	70.60	71.50	68.20	65.70	74.40	76.20	**72.14**
Rainfall (mm)	0.80	0.20	0.70	0.04	0.40	4.40	4,4	**0.98**
Rain days	5.00	1.00	3.00	1.00	2.00	9.00	12.00	**4.50**
Wind speed (km / hr)	2.80	2.30	3.10	3.10	3.40	2.80	2.90	**2.90**

The recorded temperatures at Kilombero and Kagera were below 40 ° C and could not be the cause of experienced sudden decreases of the populations of aphids and predators during the season. The cages which presumably allowed free air movement had minimal effects on sugarcane growth, but there was a reduction of hygrometer dry bulb temperature reading of 1.0 ^{o}C and increase in R.H. % of 12 units as compared with the records of the nearest weather station (Kagera B); thus the microclimate inside the cages appears to be cooler and more humid than outside them (Tables 4.19 and 4.20). Certainly, the prevailed mean maximum temperatures were above 24 ^{o}C which is optimal for development and survival of the YSA, an insect essentially of temperate and subtropical origin (Blackman and Eastop, 2000; Hentz and Nuessly, 2004).

Table 4. 20: Hydrogen dry bulb Temperature (^{o}C) reading at Kagera

	13.03.2019			**14.03.2019**			**15.03.2019**	**MEAN**
Station	AM	PM	Avg	AM	PM	Avg	AM	
Kagera B	19.0	29.0	24.0	18.0	25.0	21.5	23.0	**22.8**
Cage	18.0	28.0	23.0	17.0	24.0	20.5	22.0	**21.8**
Difference	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

Table 4. 21: Hydrometer Relative .Humidity % Readings at Kagera

Station	**13.03.2019**			**14.03.2019**			**15.03.2019**	**MEAN**
	AM	PM	Avg	AM	PM	Avg	AM	
Kagera B	95.0	58.0	76.5	95.0	68.0	81.5	79.0	**79.0**
Cage	100.0	77.0	88.5	95.0	91.0	93.0	91.0	**90.8**
Difference	**5.0**	**19.0**	**12.0**	**0.0**	**23.0**	**11.5**	**12.0**	**11.8**

The causes of the very rapid decline of YSA population inside as well as outside the cage when the crop is four to five months old was probably due many biotic and abiotic factors such as diminishing host plant quality, induced plant defense responses, development and emigration of winged forms of Aphids, fungal epizootics, high temperatures, wind and rain (Van Emden and Harrington, 2017).

Furthermore, in this study it has been observed that predators suppress YSA populations in early part of the season and followed by the general decline in aphid infestation when the sugarcane leaves mature. A combination of these facts has important implications on the strategic management of YSA in the country. Under these circumstances, it would be advisable that insecticides applications should be made only after scouting data show intolerable infestation levels and when the sugarcane have not reached five month old, and only one application may be necessary, otherwise the YSA population would decline as the crop matures later in the season.

The impacts of the insecticides sprays on YSA and predators

The impacts of the insecticides sprays on YSA and predators have been graphically illustrated in figures 4.18 and 4.19 for data from Kilombero experiment and figures 4.20 and 4.21 from Kagera.

At Kilombero where the insecticides were applied two times, the abundance of YSA was reduced in all plots so that the population could not recover to pre-treatment levels up to the end of observations, 26.6 weeks after planting (WAP). The insecticides have also caused a reduction in the abundance of predators in treated plots; compared with other insecticides treatments and control, profenofos appeared to have had the greatest impact (figures 4.22 and 4.23).and figures 4.24 and 4.25.

In Kagera where spraying was done at one time. All insecticides were very effective at about two weeks after treatment and acetamiprid had shown the highest efficacy. We observed differences in the abundance of natural enemies among the insecticides and control, but most reduction has occurred in profenofos treatment. The lowest population of natural enemies was observed for all treatments on the last sampling on 26.1 WAP.
However, the YSA population started to rebound at 24.3 WAP or 4 weeks after treatment so that at 6 weeks after treatment the untreated control had less YSA than insecticides treated plots.

The present results show that both YSA and predators were susceptible to all the insecticides through residual and/or contact exposure. However, the increase in YSA population in insecticides-treated as compared to untreated plots could be regarded as a case of insect pest resurgence due to reduced predator control. Similar results on insect resurgence have been reported by Chelliah S and E,A Henrichs (1984).

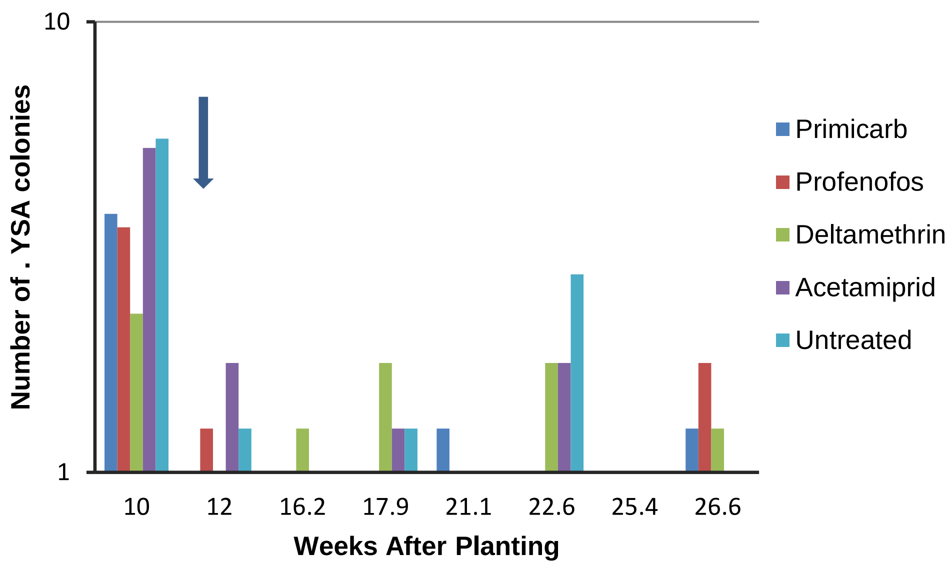

Figure 4. 20: YSA colonies in response to insecticides application in different sampling dates at Kilombero

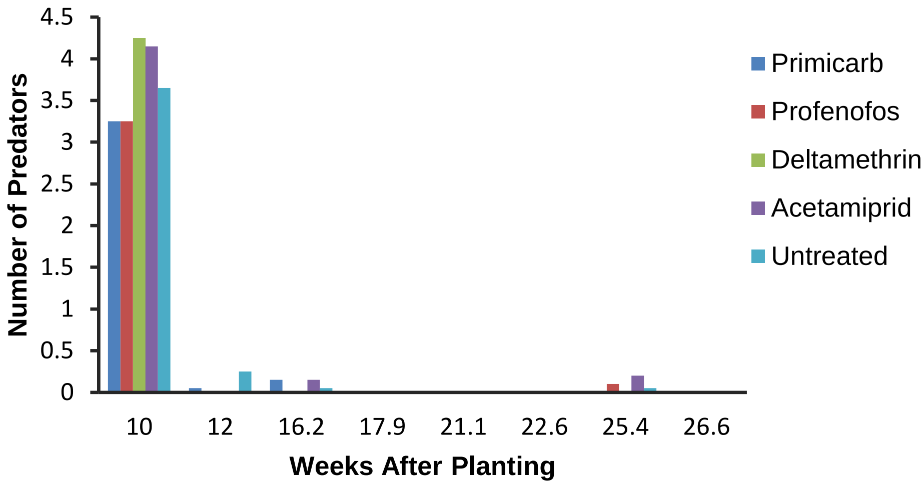

Figure 4. 21: Number of Predators in response to insecticides application in different sampling dates Kilombero

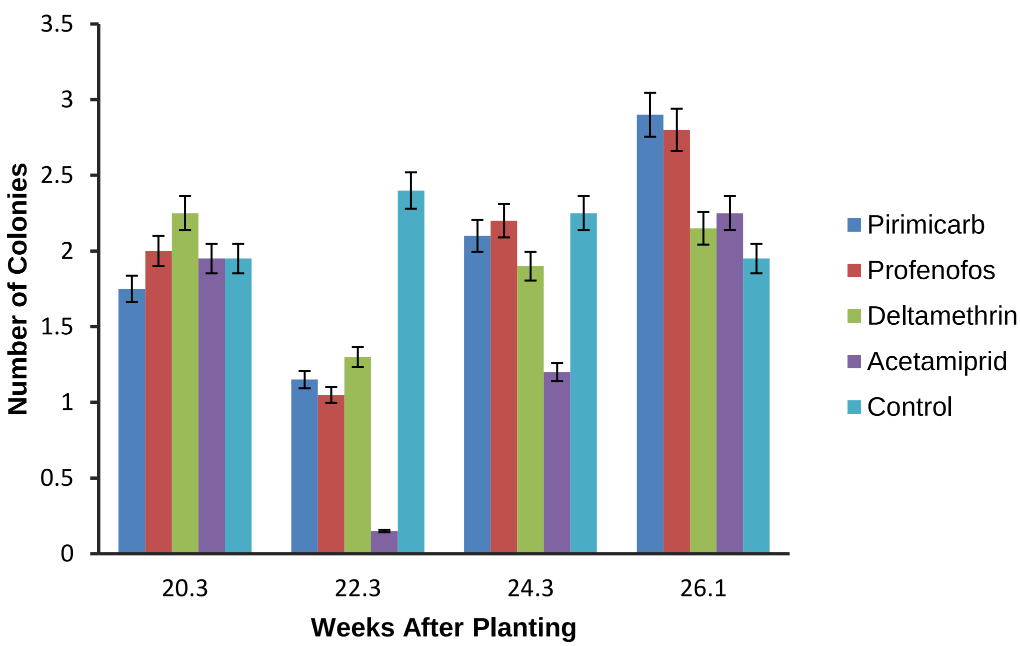

Figure 4. 22: YSA colonies in response to insecticides application in different sampling dates at Kagera

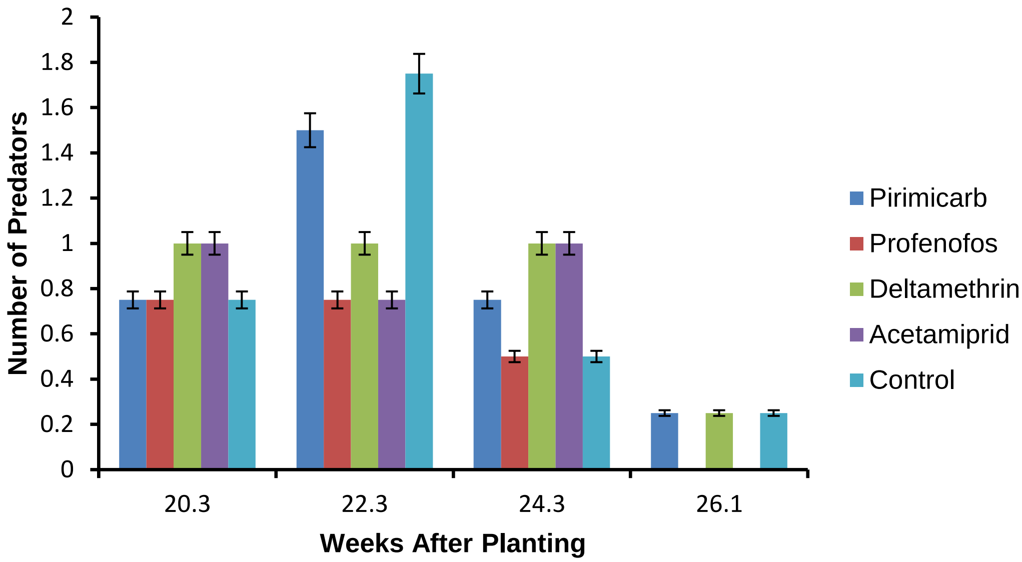

Figure 4. 23: Predator in response to insecticides application in different sampling dates at Kagera

Conclusion and recommendations

Cage Experiment

- Results of the exclusion method have shown that the YSA population could increase three to five times in the absence of the generalist Coccinellid predators.
- While predators would suppress YSA populations in the early part of the season there is a general decline in aphid infestation when the sugarcane leaves mature.
- In Tanzania weather factors (mean maximum temperature of 28 – 32 ^{o}C) could play an important role in reducing the development rate and survival of YSA on sugarcane.
- The regular surveys data have supported evidence for predation as a major regulating factor of YSA population development in sugarcane fields.
- Further investigations are required to understand the factors which determine the seasonal abundance of YSA which has typically shown rapid rise to peak abundance (3 – 4 months after planting) and then a rapid decline in mature plant leaves.

Chemical exclusion experiments

- Tested insecticides were not selective
- Both YSA and predators were susceptible to all insecticides
- The impact of insecticides on reduced abundance of predators may have caused the YSA resurgence (increased abundance) in treated plots.
- That before making a recommendation, insecticides must be thoroughly tested to determine their impact on predators and tendency for YSA resurgence.

4.6 Project Tittle: Evaluation of resistance of sugarcane varieties to Yellow Sugarcane Aphid infestation in cages

Project Number: CPE2018/06
Principal Investigators: J. M. Katundu, F. A. Urassa A. Yusuph and M. Mwinjummah.
Collaborators: Estates Agronomists
Reporting Period: 2018/2019.

Project Summary
This study aimed at investigating the reaction of sugarcane varieties against YSA infestation. The cage has been constructed at TARI-Kibaha, and sugarcane has been planted in containers.

4.6.1 Introduction
The Yellow Sugarcane Aphid (*Sipha flava*) has become one of the most damaging pest of sugarcane in all the major sugarcane growing areas of Tanzania. This insect causes damage to sugarcane by direct feeding on the sap and injection of a toxin which causes leaf discoloration, necrosis and death, thereby reducing the photosynthetic area of the plant. Early YSA infestation on the sugarcane crop may cause reduction in tillering.

Increased populations of YSA may eventually damage all mature leaves on plants < 6 months old which can reduce sugarcane yield at harvest time by 20% (Nuessly and Hentz, 2002). Experience from TPC and other infested areas have shown that different varieties react differentially to YSA damage. Therefore instead of relying on chemical control alone host plant resistance may be important in IPM programme in YSA management.

Main objective
To screen commercial sugarcane varieties for the resistance to YSA.

Specific objectives
a) To determine the effects of YSA on plant growth.
b) To study the population build-up of YSA in the test varieties.

4.6.2 Materials and Methods
Location: The experiment is being implemented in a screen house at TARI Kibaha.
Research design: RCBD with 4 replications. Each replicate have 20 varieties/clones arranged randomly.

Project Status
The project is in progress

4.7 References

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5.0`SUGARCANE PATHOLOGY

5.1 Project Title: Status of Ratoon Stunting Disease at Kilombero Sugar Company, Tanzania

Project Number: CCP 2017/01/01
Principal Investigators: M. Masunga, B. Kashando, R. Polin and Y. Mbaga
Collaborators: Y. Kalinga
Reporting Period: 2018/2019
Remarks: On going

Summary
Ratoon stunting disease (RSD) is one of the key sugarcane disease in Tanzania. The objective of this work was to monitor the status and diagnose RSD at Kilombero Sugar Company (KSC) sugarcane fields. Disease diagnosis is one of the key component for disease management thus a training of staffs on identification of RSD was conducted at TARI-Kibaha. Moreover, a survey was done at KSC where 20 fields comprised of 6 sugarcane varieties; N19, N25, N41, N30, R570 & R579 from plant cane to 4th ratoon crop with sugarcane plant aged 9 -11 months were sampled. The xylem sap was extracted by a compressor and the bacteria identified using both Phase contrast microscope at 1000x magnification and Immunoflorescence Microscope at 100x magnification. The results indicated the absence of RSD for twenty sampled fields which implies that KSC has strengthern management against RSD. Regular monitoring to check the status of RSD on sugarcane fields is recommended.

5.1.1 Introduction

Ratoon stunting disease (RSD) , caused by a gram positive-bacteria *Leisfonia xyli* subsp. *xyli* is the most widespread disease and it is considered to cause high yield losses than any other disease in sugarcane fields worldwide (Grisham., *et al* 2007) .The pathogen is xylem-limited produces gelatenious materials which plug the vascular vessels of sugarcane plant thus imparing translocation of water resulting into stunting growth of the plant (Gao *et al.,* 2008). The disease does not produce distinct external symptoms rather than stunting and lowers yield from 5% up to 50% depending on the susceptibility of the variety and weather conditions (Philip, 2016). RSD is a systemic and primarily transmitted by planting infected seedcane and transmissison from infected to healthy plant is through wounds caused by farm implements especially those used during planting or harvesting for example cane knives (Pan *et al.,* 2007). According to Mcfarlane, (2003) sugarcane is the only known host of *Leisfonia xyli* subsp *xyli* in nature.
In Tanzania , sugarcane estate normally control RSD through the use of resistant varieties, disease-free planting materials (hot-water treatment of seedcane at 50°C for 2 hours) and adherence to phytosanitary practices such as disinfencting farm implement (cane knives) used during planting or harvesting. Despite all these efforts, ratoon stunting disease is still a major challenge in all sugarcane producing areas in the country. This is contributed by inadequate farmers knowledge about the disease, difficult to distinguish the disease since RSD has no distinct

external symptom and prolonged drought period. Therefore, to prevent spread of ratoon stunting disease effective and effiecient diagnosis is very important for the control of the disease which can only be achieved by having competent staff to perform the analysis. Moreover, the identification of RSD is normally done by Phase contrast microscope (PCM) at KSC and confirmation of the results is done by immunofluorescence microscope which is believed to be 10 times sensitive than PCM (Mcfarlane, 2003). Therefore, this work was undertaken to check the presence or absence of the bacteria causing RSD on sugarcane fields at Kilombero Sugar Company for the purpose of preventing spread of RSD within and nearby fields.

General objective

Monitoring the status of ratoon stunting disease in sugarcane fields at KSC

Specific objectives

- To build capacity of staffs on RSD identification.
- To determine the presence or absence of a bacteria (*Leisfonia xyli* subsp *xyli)* in sugarcane fields at KSC.

Output

- 13 staffs trained on RSD diagnosis
- One immunoflurescent microscope purchased and installed
- 20 sugarcane fields at Kilombero Sugar Company (KSC) were monitored for RSD infestation
- Report on the status of RSD at KSC is available

5.1.2 Materials and Methods

A training on RSD identification using Immunoflorescence Microscope (IFM) was done at TARI Kibaha from 22nd-24th January 2019 and a total of 13 staffs were trained. The trainees were 10 TARI staffs (Scientist (7), laboratory technicians (2) and 1 field officer, 2 Kilombero Sugar Company (KSC) staffs and 1 staff from TPC. A trainer was RSD speciality Mr. Solen Subramoney from SASRI, South Africa (Figure 5.1).

Figure 5. 1: Training on identification of ratoon stunting disease on sugarcane samples held at TARI-Kibaha on 22nd to 25th January 2019

Monitoring and detection of RSD in sugarcane fields
Location and sampling
The activity was done at KSC on December, 2018 and a total of 20 fields were assessed for the presence or absence of the bacteria. The fields were selected randomly whereas 6 sugarcane varieties; N19, N25, N41, N30, R570 & R579 with the age range from 9 to 11 months (age suitable for RSD sampling) and crop cycle from plant cane to 4th ratoon were also included in the sampling. For each field, 20 mature stalks were collected from different points per field neatly bundled and tied together. Thereafter the samples were taken to KSC lab for further processing.

Selection and cutting of internodes for diagnosis
Immediate after collection from the field, each bundle of stalks which comprised of 20 stalks per field, was divided into 5 sub-bundles each with 4 stalks of which the lowest undamaged internode about 1 cm was cut from each stalk and placed into one clean container. The knives and chopping board washed with disinfectant after each stalk cut to avoid cross contamination.

Extraction of xylem sap and preparation of microscope slides
The sap was extracted from xylem vessels of stalk pieces by a positive air pressure method using compressor. The blowing air from compressor forced out the xylem sap which was collected using disposable pipette and a small drop was placed on the microscope slide (76mm x 26mm) and the cover slip (18mm x 18mm) placed over the sap for view under PCM microscope at 1000x magnification. Also a duplicate samples were placed on 10 multiwel slides and air dried,

thereafter, were packed properly and transported to TARI-Kibaha for detection of the bacteria using IFM.

Detection using Phase contrast microscope (PCM)

A drop of immersion oil was placed on the cover slip before viewing on Phase contrast microscope at 1000x magnification and results were recorded per field. This was done at Kilombero Sugar Company laboratory.

Detection using immuno -fluorescence microscope (IFM)

A protocol of Davis (2008) was used for detection of RSD. The slides containing xylem sap were processed at TARI-Kibaha using different reagents correctly and a specific antiserum to *Leisfonia xyli* subsp *xyli* was used to detect the bacteria under using immunofluorescence microscope (OPTIKA-Italy, B-383LD2) under 100x magnification and the results recorded accordingly.

Data analysis

No statistical analysis was done since all fields were negative on IFM and PCM method.

Results

Capacity building

A large number (72 %) of the trainees were from TARI-Kibaha, 21 % from Kilombero Sugar Company and 7 % from TPC. During the training hands-on-skills related to field sampling, Sample preparations for both IFM & PCM, preparation of buffers for IFM, preparation of IFM slides using different reagents correctly, recording of results, healthy and safety issues were covered (Figure 5.2).

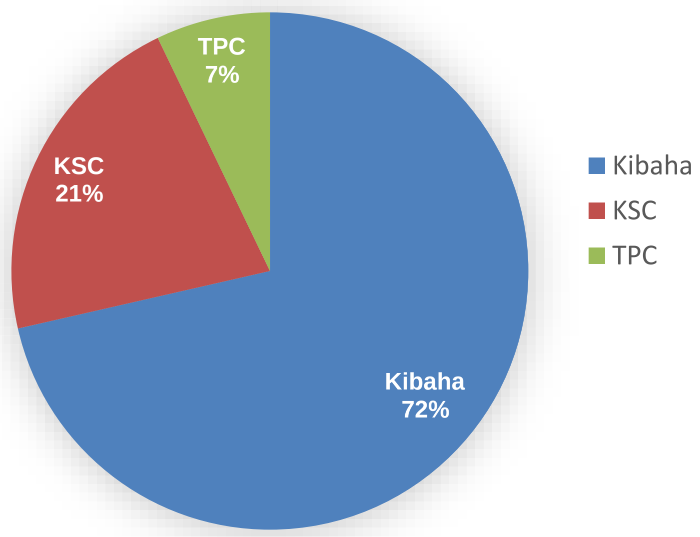

Figure 5. 2: Participants for RSD training conducted at TARI-Kibaha, January 2019

RSD diagnosis

The results in table 5.1 indicate that all 20 fields that were sampled for detection of the bacteria *Leisfonia xyli* subsp *xyli* was not detected in any field regardless of the variety, age and crop cycle on both phase contrast and immunofluorescence microscope.

Table 5. 1: RSD diagnosis for KSC estate

Location	Field	Variety	Crop	Age	Detection method	
					Phase Contrast	Immunofluorescence
Ruaha	358	N41	1	11	0	0
Ruaha	349	N25	4	10	0	0
Ruaha	359	N25	4	10	0	0
Ruaha	302	R570	1	11	0	0
Ruaha	303	R570	2	10	0	0
Simba	419	N25	5	11	0	0
Simba	429	N25	7	11	0	0
Simba	428	N25	6	10	0	0
Simba	481	N41	1	10	0	0
Simba	480	N19	2	10	0	0
Magombera	629	N41	4	11	0	0
Simba	416	R579	1	6	0	0
Magombera	643	N41	3	10	0	0
Magombera	639	N41	4	11	0	0
Msolwa	504	R579	4	11	0	0
Msolwa	504	R579	4	11	0	0
Msolwa	507	R579	3	11	0	0
Ruembe	104	R570	1	11	0	0
Ruembe	101	R570	2	11	0	0
Nyamvisi	244	N30	1	11	0	0
Nyamvisi	210	R579	PC	9	0	0

Discussion

Disease diagnosis is a key component on disease management which requires competent personel to perform accurate disease diagnosis. During RSD training, a large number (72 %) of the trainees were from TARI-Kibaha purposely to strenghern institutional capacity on RSD diagnosis using Immunoflorescence microscope of which previously were perform at SASRI, South Africa. After the training the partcipants were able to person the analysis on IFM from the samples that were collected from KSC.

Therefore, on this season 2018/2019 all sampled fields had no RSD infestation for both methods i.e PCM and IFM. The absence of ratoon stunting disease in the sugarcane fields is associated with the use of disease-free planting materials obtained through hot-water treatment, use of resistant varieties, and adherence to sanitation measures. Likewise, Mutonyi & Nyongesa, (2016) reported that maintenance of good agricultural practice in the sugarcane fields lead to reduction of different diseases in the fields including RSD. Also, the use of resistance varieties against *Leifsonia* *xyli* Subsp. *Xyli* prevent the penetration and multiplication of the pathogen into sugarcane plant (McFarlane, 2013)

Also, RSD was absent on the fields planted N 25 & N30 which are known to be susceptible to RSD infestation. A report by Mcfarlane (2003) indicated that N25 & N30 are highly susceptible to *Leifsonia xyli Subsp. Xyli* but this results did not indicate the presence of RSD on all fields planted with these varieties. This could be due to sugarcane plant adaption to different climatic condition and its reaction against certain diseases which can lead to increase its resistance or become tolerance (Tiwari *et al.*, 2012).

Conclusion and recommendations

RSD incidence at KSC has decreased as compared to previous seasons which implies that the estate strengthened RSD management programme. However, regular monitoring to check the status of RSD on sugarcane fields is recommended. Since TARI- Kibaha has established molecular lab, DNA-based method will also be used for RSD diagnosis starting from next season. Also, studies on genetic diversity of the bacteria causing RSD to identify physiological races of the pathogen is necessary. Lastly, extending RSD monitoring to other estates and outgrowers fields is important to prevent disease spread.

5.2 Project Title: Assessment on the incidence of sugarcane smut on estates and Outgrowers fields in Tanzania

Project code: CCP 2017/01/02
Principal Investigators: M. Masunga, Y. Mbaga, R. Polin and M. Mziray
Collaborators: Nassoro Abubakari, Nasser Mlawa, Mohamed Salum, Joseph Kitali, and Issa Mdemu
Reporting Period: 2018/2019
Remarks: On going

Summary

Sugarcane smut is a fungal (*Sporisorium scitamineum*) disease that cause negative effect on sucrose accumulation, fiber content and juicy quality. The aim of this work was to assess the incidence of smut on estates and out-growers fields. A total number of 113 fields consisting of 20 sugarcane varieties from plant cane to 8th ratoon were assessed for smut infestation both on estates and out-growers fields. The higher smut infestation was observed on out-growers fields (86 %) as compared to estates (51 %). For estates, Mtibwa Sugar Estate had higher smut infestation, followed by Kagera Sugar Limited and the least smut incidence encountered at Tanganyika Plantation Company Limited. Also, NCO 360 and Co 617 had higher smut incidence than other varieties. Similarly, ratoon crops had higher smut incidence compared to plant cane. Therefore, MSE need to look over their disease management programme but also replacing NCO 376 & Co 617 with smut resistant varieties is recommended.

5.2.1 Introduction

Sugarcane smut is caused by a basidiomycete fungus, *Sporisorium scitamineum* Sydow (Benevenuto *et al.*, 2016). It is an important disease of sugarcane that has spread to all over the cane growing areas of the world causing insiginificant to significant quality and yield losses (Schaker *et al.*, 2017). The disease cause negative effect on sucrose accumulation, fiber content and juicy quality (Marques *et al.*, 2017). The fungus infects plant through buds on the standing stalks or germinating buds on the soil and then growths with the plant in close association with the growing region (Magarey, 2013). Infected plants produce whip-like structure that forms at the growing point of the plant. The whip has a thin membrane that breaks and release a mass of black spore (Marques *et al*., 2017). The disease spread through wind blown spore, planting infected seed cane or contaminated cane cutting implements (Su *et al.,* 2016). The disease is systemic and its control is through the use of resistant varieties, hot water treatment of seed cane, regular monitoring, roughing of smut affected stools and avoidance of ratooning of smut affected fields. In Tanzania, smut is a major problem affecting sugarcane production in both out growers and estate fields. Therefore, this work was undertaken to monitor the incidence of smut on sugarcane fields at estates (KSL, KSC & MSE) and outgrowers (Kagera and Kilombero Mill Areas).

Specific objectives
To determine the status of smut disease on sugarcane varieties and crop cycles

Output

- A total of 113 sugarcane fields assessed for smut infestation
- 20 sugarcane varieties assessed for smut infestation
- 5 sugarcane crop cycles (plant cane to 4th ratoon) evaluated for the level of smut infestation
- 3 estates and 2 outgrowers Mill Cane Areas assessed for their status on smut incidence

5.2.3 Materials and methods

Description of the survey area
A survey in sugarcane fields to asses smut was carried out from October 2018 to January 2019 both on estate and out grower's fields. A total number of 113 fields were assessed for smut where by at Kagera estate 33 fields and 22 fields outgrowers, Kilombero out grower's fields -20, Mtibwa estate-18 and TPC were 20 fields.

Survey procedure
A field was divided into five points and each point had ten rows of 50 metres. One meter represented one stool and for that reason one row had 50 stools and one point had a total number of 2500 stools. The parameters assessed were variety, crop cycle, age and irrigation regime in relation to smut incidence.

Therefore, percentages of smut incidence were calculated based on the formula below;

$$\text{Percentage of smut infection} = \frac{\text{Total number of smutted stools in a field} \times 100}{\text{Total number of stools per field}}$$

On commercial fields smut infestation level greater than 4% meaning the disease is above economic threshold and uprooting and replanting is the only management option. Below 4 % roughing is recommended.

Data collected

- Data on percentage of smut incidence
- Data on smut incidence on sugarcane varieties
- Data on smut incidence over crop cycle across site

Results

Status of smut incidences on estates and out-growers fields

A total number of 113 fields were assessed for smut infestation this season 2018/2019 where by 71 fields on estate and 42 outgrowers. For outgrowers, Kilombero mill area all (100%) fields assessed had smut infestation while Kagera 72.7 % of assessed fields had smut infestations. For estates, 77.8% of fields surveyed at MSE had smut, 48.5% for Kagera Sugar Limted and 30% for TPC (Table 5.2).

Table 5. 2: Status of smut infestation on sugarcane fields both estates and outgrowers

Location	Number of fields	Percentage smut
KSL	33	48.5
TPC	20	30.0
MSE	18	77.8
OG-Kagera	22	72.7
OG-Kilombero	20	100.0

Assessment of smut Incidence on sugarcane varieties

TPC

A total of 20 fields planted with 8 sugarcane varieties were assessed for smut infestation at TPC. Four varities N25, R575, M700/86, R579 and N41 were found with smut infestation below the economic threshold of 4%. The higher smut incidence was on variety N25 (3.8%) and least incidence of smut was on variety N41 (0.2%). The other 4 varieties N30, R585, R579 and R85/1334 smut was not observed (Figure 5.3)

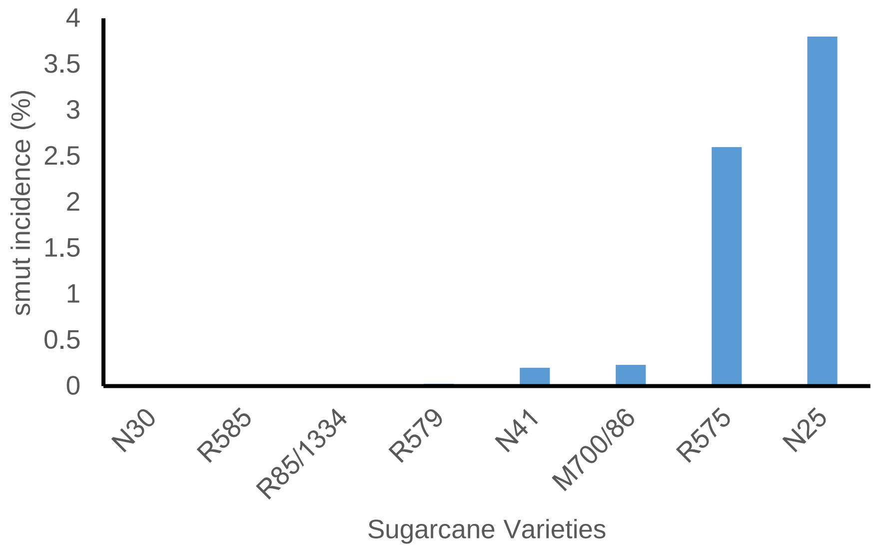

Figure 5. 3: Smut incidence on sugarcane varieties at TPC

At Kagera Sugar Limited (KSL)

Smut infestation was observed on fields planted with varieties; Co 617, R579, N49, MN1, N47 and variety Co617 had higher smut symptoms as compared to other varieties. Only two varieties N19 and N25 smut was not encountered (Figure 5.4)

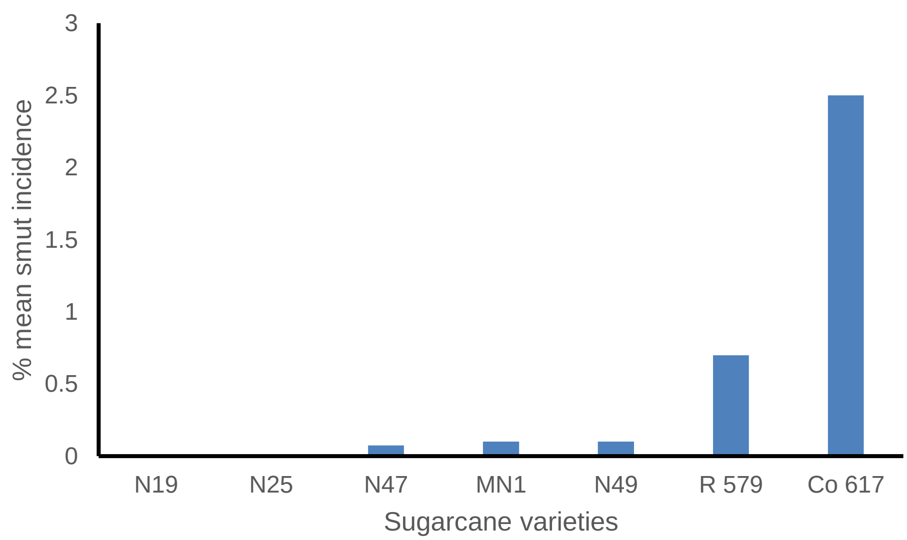

Figure 5. 4: Smut incidence on sugarcane varieties at KSL

At Mtibwa Sugar Estate (MSE)

Six varieties (N12, N32, N41, NCo 376, R570, R575) out of 7 had smut infestation where as three N32, Nco 376 and R 575 the smut infestation was > 4% which is above the economic threshold. Only one variety R579 smut symptoms was not observed (Figure 5.5)

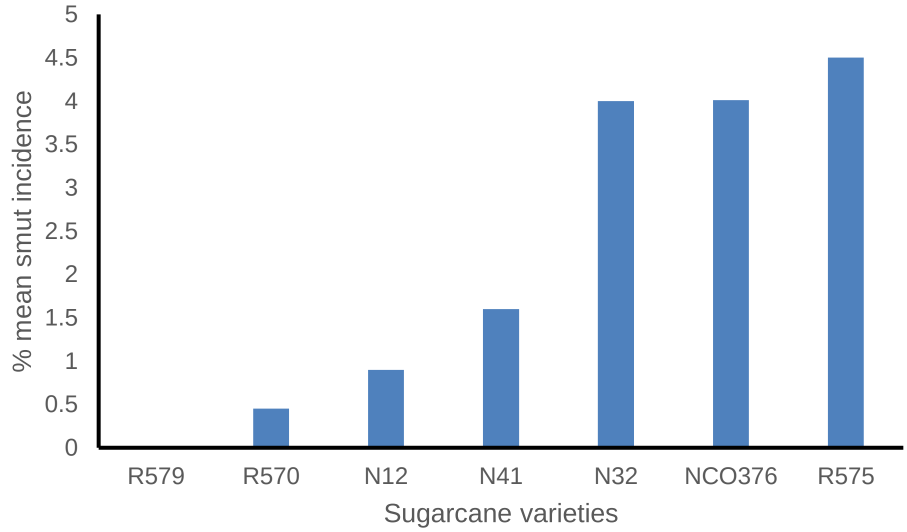

Figure 5. 5: Smut incidence on sugarcane varieties at MSE

Assessment of Smut incidence on sugarcane crop cycle at out growers fields

Kagera Mill Area

Only one variety CO 617 is cultivated by sugarcane out growers at Kagera, unfortunately smut incidence were observed on 21 fields out of 22 fields equals to 95 % of all surveyed fields had smut. The results also indicates that plant cane had no smut infestation as compared to ratoon crops. Higher smut infestation were encountered on second and third ratoon crop which had mean smut incidence of 1.6% while first ratoon crop had mean percentage of smut infestation of 1.4 %. Also out o f 22 fields that were surveyed only one field had no smut infestation which was plant cane (Figure 5.6)

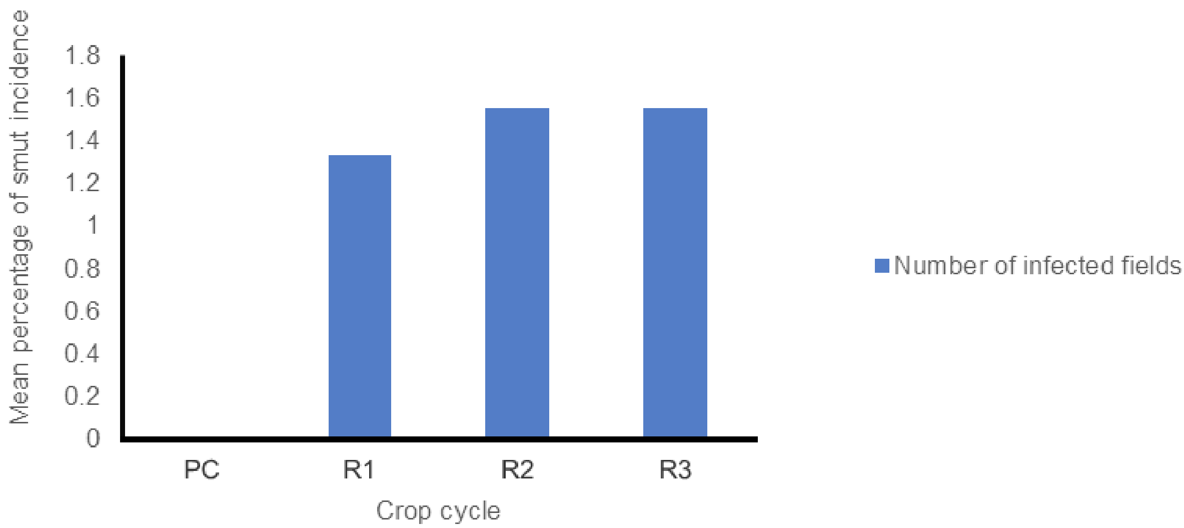

Figure 5. 6: Mean percentage smut incidence on sugarcane crop cycles at Kagera mill area

Outgrowers at Kilombero

A total of 20 fields were surveyed at Kilombero outgrowers, varieties NCO 376 (16 fields) and N41(6 fields) assessed for the level of smut incidence. Results shows that for NCO 376 smut infestation is higher on ratoon crop especially on ratoon R2, R3 and R4 with the smut incidence of 1.6, 1.4 and 1.6 respectivelly. For N 41, smut was observed even on both plant cane and ratoon (R4) with the mean smut infestation of 1.39 % and 1.13 % (Figure 5.7).

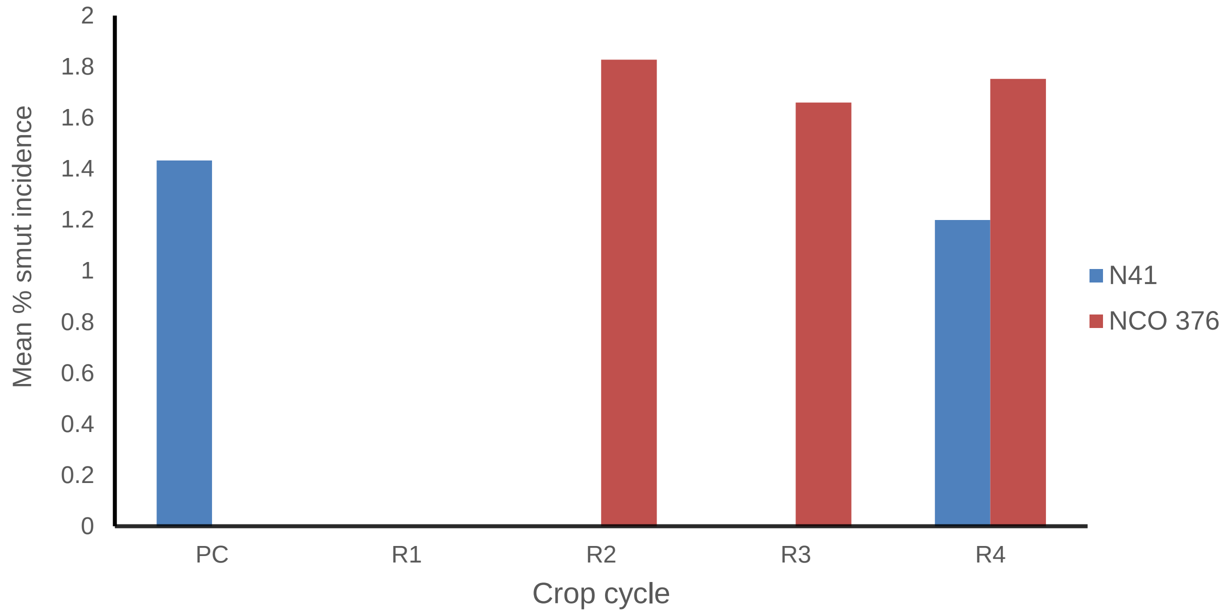

Figure 5. 7: Mean smut incidence on sugarcane varieties at Kilombero in outgrower fields

Percentage of smut infestation on both sugarcane estates and outgrowers fields

In total, 86% of the out growers fields assesse at Kilombero and Kagera Mill area have smut infestation and only 14% of the fields smut was not found while on estates 51% of the fields assessed had smut infestation and 49% smut was not observed (Figure 5.8)

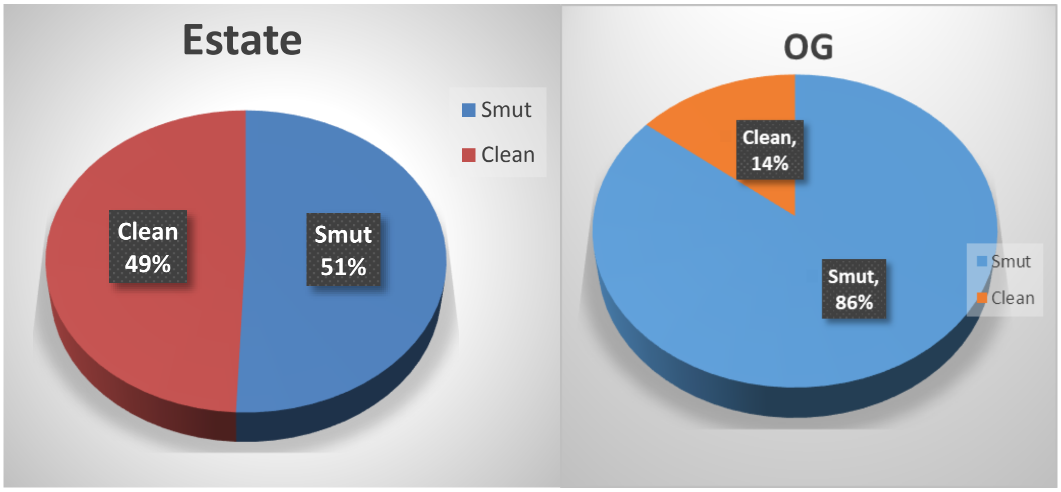

Figure 5. 8: Percentage of smut infestation on outgrower Vs esta

Discussion

The survey on smut assessment conducted this season (2018/2019) revealed that smut disease is still prevalent both on estate and out growers fields (TPC, KSL, MSE, Kagera and Kilombero Mill are as). In Tanzania different smut-resistant varieties such as R579, R570, N 41 N 25 has been adopted and selected for cultivation on estates since most of them are irrigated varieties. The use of smut-resistant sugarcane varieties is the most economical and effective measure for disease prevention and control (Sundar *et al.,* 2012).

Moreover, studies have shown that the evolution of new races of *Sporisorium scitaminea* may have broken the resistance of sugarcane varieties to smut making it possible for the resistant varieties getting infected (Sundar *et al.,* 2012; Schaker et al., 2017 & Marques et al., 2017). Additionally, Su *et al.,* (2016) reported that sugarcane smut resistance is influenced by three major factors; sugarcane genotype, the pathogen, and the environment. Therefore, these could be the explanation for the observed smut on resistance varieties on three surveyed estate (KSL, TPC & MSE). Also, a study done by Nzioki *et al.,* (2010) identified the presence of physiological races of sugarcane smut and the results suggested possible existence of ten smut races in Kenya. Results showed smut infection on resistant varieties such as R579 & R570. Since no study has been done on the genetic diversity of sugarcane smut in Tanzania, there is possibility of having smut races which are more virulent in sugarcane fields surveyed.

Also, there was an increase on smut incidence from plant cane to ratoon crop which could be attributed by the increased inoculum on the successive ratoon. The highest smut incidence were recorded on 4th ratoon as compared to plant cane (figure 8) this was observed both on estates and out growers field. Similarly, studies conducted on different countries confirmed that ratoons are the most susceptible crop cycle to sugarcane smut than plant cane because sugarcane smut is a systemic, and thus its incidence might be increased in successive ratoons because of the increased amount of inoculum (Mcfarlane, 2003; Hadush Hagos, 2015 & Schaker et al., 2017).

Generally, the prevalence of smut was higher on outgrowers fields as compared to estates whereby 86% of outgrowers and 51 % of estates fields had smut infestation (Figure 7). The higher smut incidence encountered on outgrowers fields is contributed by the use of susceptible varieties; NCO 376 and Co 617 which are planted at Kilombero and Kagera mill areas respectively. Other countries has eradicated the use of NCO 376 due to its susceptility to smut infestation as one of the control strategy (Nzioki *et al.*, 2010).Therefore, to prevent more spread of the disease the use of smut resistant variety is the key on controlling smut and earlier management of the disease such as earlier roughing of smut infected stools before higher spread occurred is most important to increase sugarcane yield. Also, uprooting of the fields with smut infestation > 4% to avoid build up and carry over the disease into the next season. However, replanting of sugarcane fields with fresh clean seedcane each year has been an effective management tool for smut in Louisiana as compared to repeated ratooning, which encourages smut build up (Zekarias *et al.*, 2011) .

Therefore, estate need to strengthen smut management with the emphasis on using hot-water treatment and earlier roughing of smutted stools. Also, replacing susceptible varieties (NCO 376 & Co 617) with smut resistant varieties is necessary to avoid disease spread and minimising the level of smut incidence in sugarcane fields that will contribute to increasing sugarcane yields.

Conclusion and Recommendations

In general, smut disease is still prevalent on both estate and out-growers field. For estate, the highest smut incidence observed at MSE followed by KSL and TPC had lowest percentage of smut infestation. It is advised for estates to strengthen the management of sugarcane smut such as the use of hot-water treated seedcane, early roughing and replanting of severely infested fields. Also, it is suggested to replace Co 617 and NCO 376 at KSL and MSE respectively with smut resistant varieties.

Also smut incidences observed on fields planted with smut-resistant varieties (N41, R575, R579, MN1, N49, R570, N12 & N12) at TPC, MSE and KSL estates which suggests the possibility for the presence of *Sporisorium scitamineum* physiological races in Tanzania. Therefore a study on genetic diversity of smut pathogen is recommended to identify the number of physilological races of smut fungal that might be available. Also there was higher percentage of smut infected fields (86%) in out-growers fields as compared to estate (51%). TARI-Kibaha is in process of releasing drought tolerant with smut resistant trait which could help to minimise the level of smut infestation on out-growers fields. On other hand, farmers should continue with early roughing of the infested stool to minimize the number of inoculum on their fields.

In addition, TARI-kibaha to continue with systematic and regular monitoring of smut on sugarcane fields to monitor the incidence of smut in all major sugarcane growing areas in Tanzania and the information obtained will allow the industries to strengthern management strategies to reduce the risk of smut epidemics. Lastly, establishment of Pest and disease (P&D) committes in local area to monitor the spread of diseases in a respective areas is recommended.

5.3 Project Title: Factors Influencing Disease Spread on Sugarcane Outgrowers fields in Tanzania

Project Code: CCP 2018/01/05

Investigators: M. Mziray, M.Kinyau, B. Kashando, R. Polin and M. Masunga and A. Mwenisongole

Collaborators: J. Kitali, W.Bajwala, E.Mutakyawa and A. Kazimuheza

Reporting Period: 2018/2019

Project Summary

Diseases infestation contributes in yield losses from outgrowers fields on sugarcane crop in Tanzania. Assessment of outgrowers knowledge on diseases in the sugarcane growing areas was very important in order (i) to evaluate farmers' awareness and current practices on managing diseases on sugarcane and (ii) to identify management challenges for development of an efficient integrated disease management approach on sugarcane. A total of 276 respondents from Kagera, Kilombero and Mtibwa were randomly selected for interview using a structured questionnaire. Results show gender imbalance where male representative was higher by 79.3% compared to 20.7% female. About 80.8% of the respondents were aware on smut disease in sugarcane compared to other diseases between the locations ranging from 90.7% Kilombero, 86.1% Kagera to 61.6% Mtibwa. Factors that influencing the spread of sugarcane diseases includes source of

planting materials, high price of clean planting materials and inadequate knowledge on the use of clean seedcane were identified.

5.3.1 Introduction

The contribution of sugarcane production from outgrowers (OG) fields to the factory has been decreasing year after year. Report by Chongela (2015) indicated the low contribution of sugarcane from OG about 40 tons/ha which is low compared to those attained by large estate (70-90 tons/ha) and also below the attainable yield potential of more than 100tons/ha. One of the reason that contributes in yield losses from OG fields is the infestation of sugarcane diseases such as Ratoon Stunting Disease (RSD) and Smut that causes yield loss from 5-60% (Gao *et al.*, 2008) and 12% – 75% (Lemma *et al.*, 2015). However, the spread of diseases in OG sugarcane fields is generally caused by various factors including; availability of clean planting materials and inadequate knowledge on the use of clean planting materials. Moreover, high price of the clean seed cane, low income, biotic, abiotic, lack of improved varieties with drought tolerance, limited access to credits to acquire inputs and shortage of extension services are reported to be important constraints to sugarcane production. On –other hand socio economic factors such as gender, age, education level, farm size and income also accelerate disease spread (Livingston *et al.,* 2011). The aim of this study was to identify determinants for spread of sugarcane diseases at Kagera, Kilombero and Mtibwa mill cane areas.

Specific objectives

1. To assess farmers' knowledge and practices on managing of diseases on sugarcane
2. To identify factors influencing diseases spread on out grower's fields.

Achieved outputs

- A total of 276 farmers interviewed
- At least 3 factors that influences the spread of sugarcane diseases were identified.
- Information on farmers' knowledge on sugarcane diseases from 3 sugarcane growing areas (Kagera, Kilombero and Mtibwa) are documented.

5.3.2 Methodology

Location

The survey was conducted in three out growers' fields at Kagera Sugar Limited (KSL), Kilombero Sugar Company (KSC) and Mtibwa Sugar Estate (MSE). The areas were selected because majority of the people involves in sugarcane cultivation and most of their incomes are generated from sugarcane.

Sample selection

This research was focused to sugarcane outgrowers farmers from Kagera, Kilombero and Mtibwa areas. The selection was based on the wards with high population of outgrowers involving in sugarcane cultivation and most of their income are largely generated from sugarcane crop. Another criterias for sample selection were; OG responsibilities for decision making regarding the cultivation of the crop, control of sugarcane diseases and their availability during the survey. Number of respondents surveyed during the interview is summarized in Table 5.3.

Table 5. 3. Number of respondent

Region	Ward		Number of interviews
Kagera	Nsunga		15
	Kakunyu		18
	Kassambya		45
	Kyaka		23
Subtotal Kagera		**101**	
Kilombero	Ruhembe		63
	Kidodi		34
Subtotal Kilombero		**97**	
Mtibwa	Diongoya		39
	Sungaji		20
	Mtibwa		19
Subtotal Mtibwa		**78**	
Total interviewed farmers			**276**

Data collection

Data were collected by using a structured questionnaire administered face to face to 276 respondents selected randomly from two regions (Kagera 101 and Morogoro 175, where 97 were from Kilombero and 78 from Mtibwa) as indicated in table 1.

Socio-economic characteristics such as gender, age, education, farm size and income were collected. Also data on the knowledge and awareness of sugarcane as well as factors influencing diseases spread were also captured.

Statistical analysis

Data variables were coded and analysed by Statistical Package for Social Science (SPSS v16.0) program where mean and percentages were calculated.

5.3.4 Results

Socio economic characteristics of the respondents

Gender

The results indicate that majority of households were male and the distribution was: 85.1% male and 14.9% female for Kagera, 71.1% male and 28.9% female for Kilombero and for Mtibwa respondents, 82.1% were male and 17.9% were female (figure 5.9)

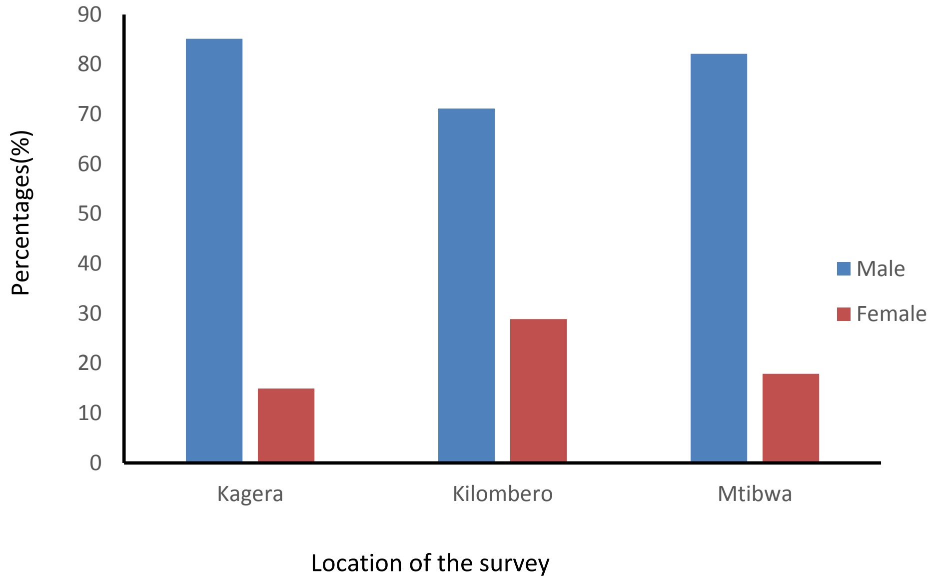

Figure 5. 9: Gender of respondents

Age
Figure 5.10 represents the age of the respondent and most of them had an age between 36-53 with 59.4% from Kagera, 66% from Kilombero and 47.4 from Mtibwa.

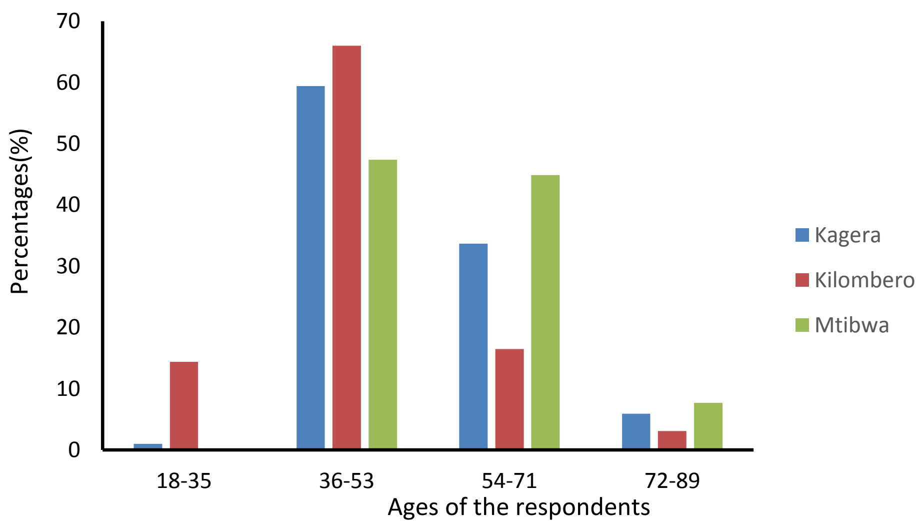

Figure 5. 10. Ages of the respondents

Education level
The results also observed that 72.1% of the respondents had primary education while 14.1% has secondary education as indicated in figure 11.

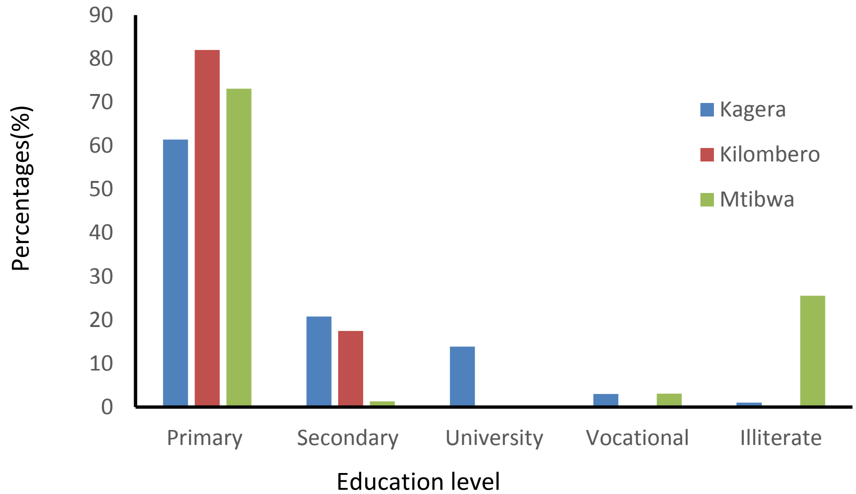

Figure 5. 11: Education level of the respondents from the surveyed areas

Farmers' knowledge on sugarcane diseases.

Knowledge on sugarcane diseases

Majority of the respondents are aware about smut sugarcane disease compared to other diseases suchas ratoon stunting diseases as indicated in figure 4 where 86.1% were from Kagera,90.7% from Kilombero and 61.5% from Mtibwa.(figure 5.12)

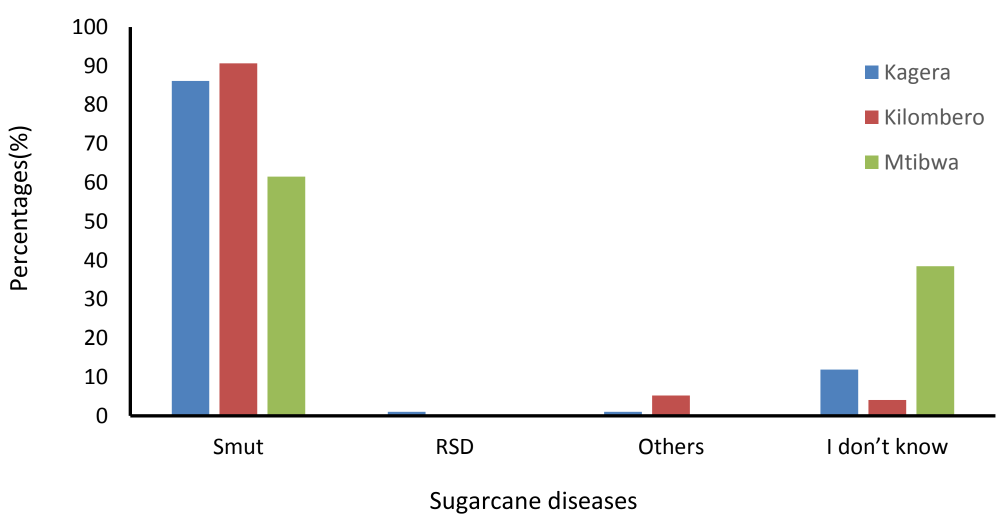

Figure 5. 12: Farmers knowledge on different sugarcane diseases

Results on figure 13 represent farmers' knowledge based on the symptoms of different sugarcane disease with the following distribution: (a) smut:86.1% Kagera,90.7 Kilombero and 61.5 Mtibwa) (b) RSD:1% Kagera,0% Kilombero and Mtibwa etc. However, the following respondents 15.8%

Kagera, 6.2% Kilombero and 4.1% Mtibwa were not aware about any symptom of sugarcane diseases.

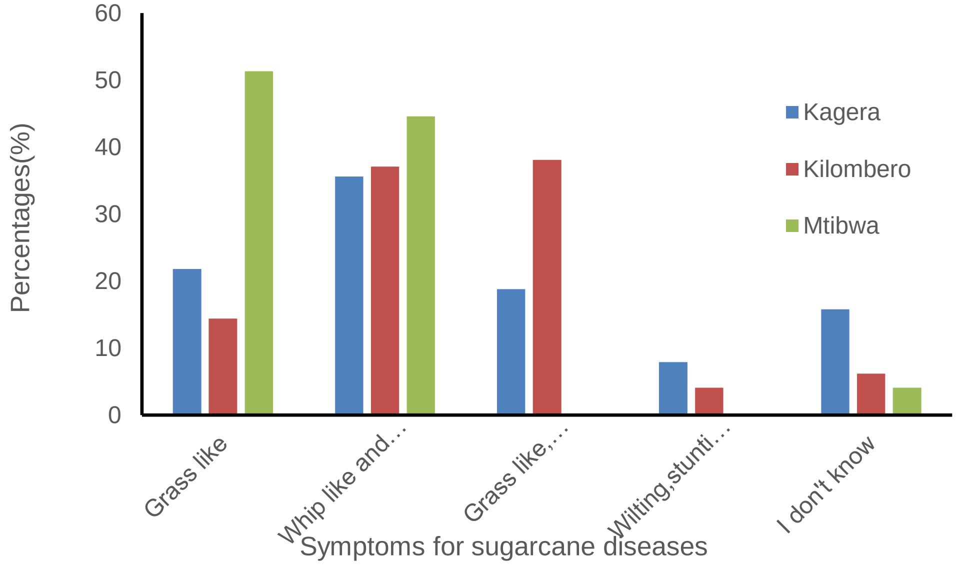

Figure 5. 13: Different symptoms different sugarcane diseases

Farmers practices for controlling sugarcane diseases

Farmer's awareness was also evaluated based on the methods used to control sugarcane diseases. Majority of the farmers were aware on controlling smut as shown in figure 6. The response was as follows; by roughing (84.2%) from Kagera, (77.3%) from Kilombero and (29.5%) from Mtibwa (Figure 5.14)

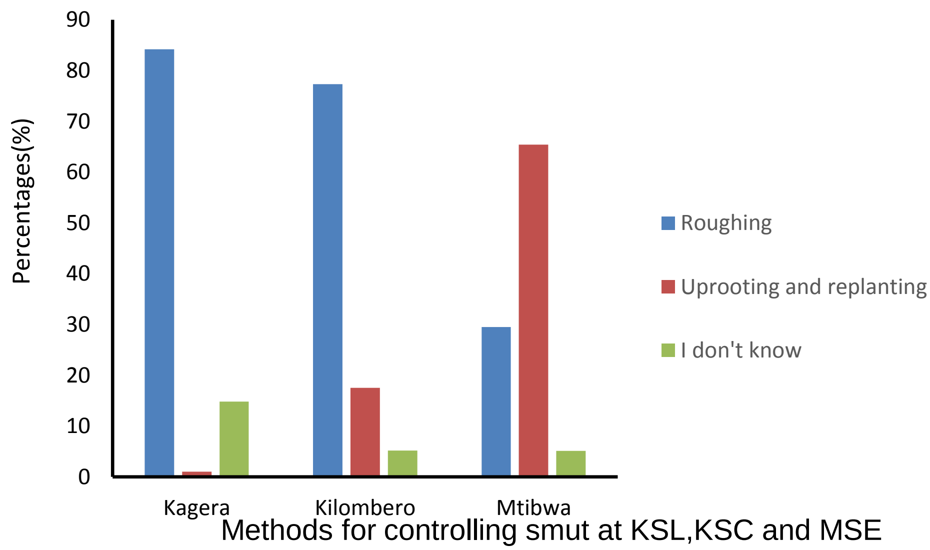

Figure 5. 14. Methods used to control smut

Factors that influence the spread of sugarcane diseases

Sources of planting materials

The research observed the main source of planting materials acquired from neighbours with 83.5% from Kilombero, 51.3% from Mtibwa and 46.5% from Kagera (Figure 5.15). Another observed source is from outgrowers own sources 48.7% from Mtibwa and 15.8% from Kagera. On the other hand, few 30.7% OGs from Kagera use clean planting materials from Kagera Sugar Limited.

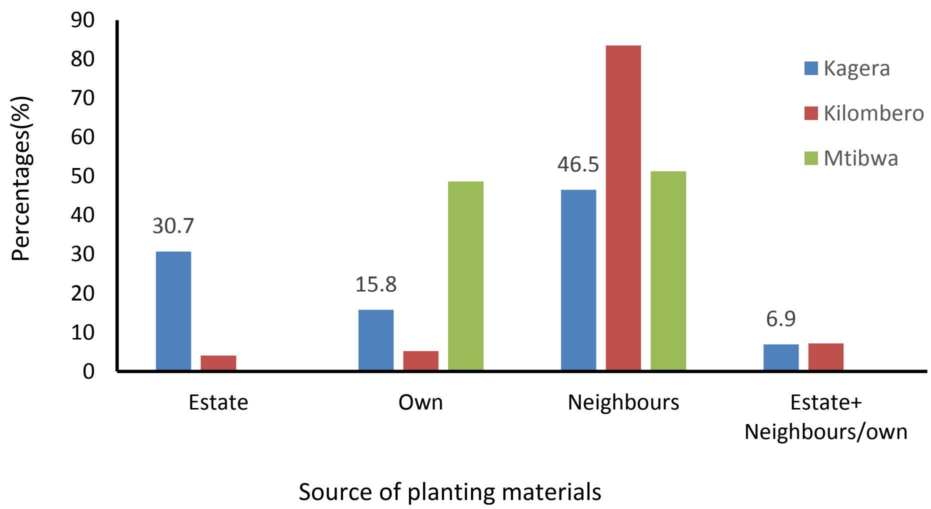

Figure 5. 15: Sources of planting materials for OGs at KSL, KSC and MSE

Price of clean seedcane

Results in figure 5.16 shows factrors that contributes in the spread of sugarcane disease at KSL, KSC and MSE. The factors are: high price of clean seedcane with high percentages (61.9%) from Kilombero, Inadequate knowledge with (46.6%) from Kagera and low income with 68.7% from Mtibwa.

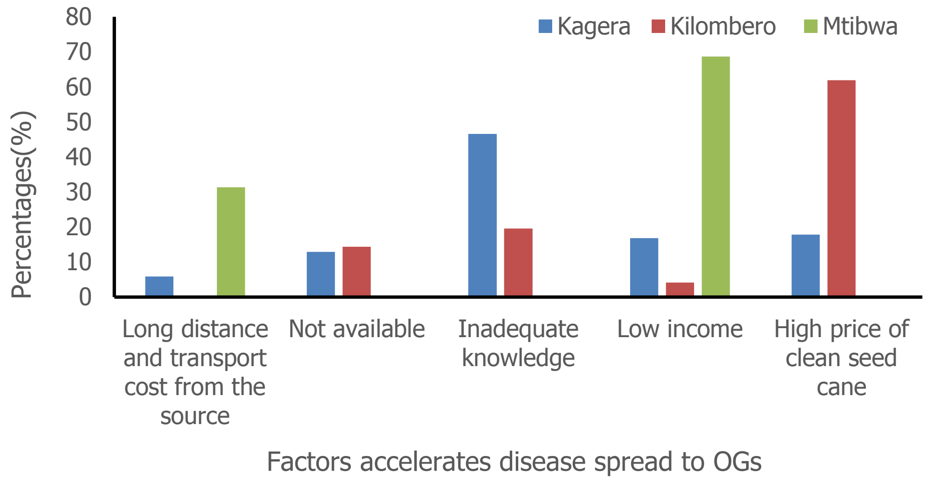

Figure 5. 16: Factors influencing the spread of sugarcane diseases from OGs fields in the surveyed areas

5.3.5 Discussion.

Socio economic characteristics of the respondents

The over representation of men was influenced by the selection criteria used in the survey that targeted the head of the household. This is because sugarcane is considered as a male crop. This show that sugarcane farming is more of men role and also males play a big role in making decisions on agricultural investment at house hold level.Dominance of men on sugarcane crop/ commercial crops has also been reported by (Dancer & Sulle, 2015) who found ownership of sugarcane crop dominated by men.

Also, majority of the respondents were aged between 36-53 years. This is because this group of age is energetic, well matured and have family responsibilities and therefore can face and resolve any challenge they will encounter in sugarcane activities.

The study revealed that majority of sugarcane farmers are literate with primary school education which implies that if trained there is possibilities for them to adopt and practice technologies depending on the suitability of the technology. Similarly, education level reported to determine one's ability to comprehend and analyse issues before taking any action (Ong *et al.,* 2016). In Tanzania, any person with primary school education and above is considered as literate and on the other hand, any one with non-formal education is considered as illiterate (www.tradingeconomics.com,2019). Literacy is the group of people with ages from 15 years and above who can, with understanding, read and write a short, simple statement on their everyday (https://www.indexmundi.com/tanzania/literacy.html visited on May 2019).

Farmers' knowledge on sugarcane diseases.

The survey observed that, majority of the respondents interviewed are aware about smut sugarcane disease compared to other diseases as shown in Figures 2,4 and 4. The disease was witnessed by most of the respondents in their own farms and few had seen it on neighbouring farms. This indicate that smut disease is a major challenge to sugarcane outgrowers fields in the sugarcane mill areas. Similar results on response and knowledge of farmers in relation to smut disease were reported in Western Kenya (Khan *et al.,* 2014). At Mtibwa mill cane area 38.5% of the farmers had no knowledge on sugarcane diseases which suggest that, there is a need of training on sugarcane diseases to OG farmers to minimize number of those who have scant knowledge of disease.

It was also evidenced that majority of the respondents were aware on smut symptoms compared to other diseases symptoms because the disease is very common in sugarcane growing areas. On the other hand, few OGs were observed with inadequate knowledge on symptoms of sugarcane diseases with high percent from Kagera. It is therefore suggested to capacitate farmers on different symptoms for different sugarcane diseases

It is also noted that most of the respondents were aware on the methods used to control smut which are roughing followed by uprooting and replanting. However, few respondents didn't have any idea on how to control sugarcane diseases. Therefore, there is a need for training on proper methods for disease control such as use of clean seedcane and adherence to sanitation measures.

Factors that accelerates the spread of sugarcane diseases

The study revealed that farmers use planting materials from their neighbours and own sources. Normally, these materials are not free from diseases, which accelerate the diseases spread from and within sugarcane fields. Similarly, the study by (Ong *et al.,* 2016) showed that the prevalence for farmers whose seedcane wer sourced from factory was lower than the seedcane that were sourced from neighbours and self-grown,. Furthermore, the use of clean planting materials to minimize disease infection especially for vegetativelly propagated crops have also been recommended on cassava (McQuaid *et al.*, 2016). Also farmers were not able to afford to use clean planting materials due to long distance and high transport cost from estate to their vicinity which could explain the reason for not using clean seedcane.

This implies that, there is a need of establishing seedcane nursieries nearby farmers with affordable price nearby farmers' fields to minimize the spread of sugarcane diseases. CGIAR, (2012) report indicated similar approach of making clean seed cane available nearby farmers' fields with low cost to reduce the risk of disease spread on roots, tuber and banana crop.

Inadequate knowledge on the advantages of using clean planting materials and criteria used to select clean seed cane is also witnessed as another factor contributing in spread of sugarcane diseases. This indicate that, farmers require knowledge on the importance of using clean planting materials. Research on the use of clean cane production technology and environmental sustainability has largely reduced the incidence of disease infestation in sugarcane production (Doorasamy, 2017).

Conclusion and Recommendations

The study has revealed that smut is the only sugarcane disease which is familiar to majority of the sugarcane outgrowers at Kagera, Kilombero and Mtibwa. Other determinant factors for disease spread in sugarcane fields were poor availability of clean seedcane, long distance and high transport cost from estate and inadequate farmer’s knowledge on sugarcane disease.

- Its therefore recommended to establish nursery B nearby outgrowers fields to minimize the spread of sugarcane diseases to OGs, train farmers on sugarcane diseases, to have a regular field visit for monitoring and backstopping and develop an efficient integrated disease management technique for sugarcane out growers.

5.4 Project Title: Monitoring of Plant Parasitic Nematode in sugarcane growing area of **Tanzania**

Project code: CCP 2017/02/01

Principal Investigators: B. Kashando, R. Polin, Y. Mbaga, M. Mziray, M. Masunga, and N. Luambano,

Collaborators: N. Abubakari, N. Mlawa and M. Salum, Y.Kalinga

Reporting Period: 2018/2019

Remarks: On going

Project summary

Plant parasitic nematodes involves complex of species with different feeding habits and various degree of pathogenicity which cause losses in different crops including sugarcane. Nematodes monitoring was done in Kagera sugar, Kilombero sugar, Tanganyika Planting Company limited and Mtibwa Sugar. A total of 129 samples of root and soil were collected from 43 fields, in every field three samples were collected and mixed to make a composite sample. Nematodes were extracted from roots and soils amples based on available protocols.

The aim was (1) to assess availability of plant parasitic nematodes in all sugarcane growing areas (2) to identify key plant parasitic nematodes of sugarcane and classify type and number based on their difference from based on their location.

Pratylenchus spp found in all sugarcane fields while *Rotylenchulus* spp, was only at TPC estate. The low population of *Pratylenchus* (less than 250) found at TPC medium (250-2000) found at Mtibwa and Kilombero sugar while Kagera sugar was high (above 2000). However, *Meloidogyne* is the most pathogenic species on sugarcane, but restricted to sandy soils appear to have low population (less than 200) in all fields.

5.4.1 Introduction

Sugarcane production is affected by number of factors including paste and diseases, one of the known pest is plant parasitic nematodes (Yoshida *et al.*,2014). The monoculture of sugarcane can foster the accumulation of diverse nematode communities which accelerated by presence of more than one crop cycle in sugarcane production (Bond et al., 2000).

According to Bhuiyan *et al.* (2016) sugarcane yield can be reduced up to 5-20% in field affected with nematodes in Australia. The above symptoms for field affected with nematodes appear to have patches and below symptoms the tip of the roots form galling for the presence of *Meloidogyne* spp and root necrosis for the presence of *Pratylenchus* spp. .

This study was undertaken to gather information on the abundance and distribution of plant parasitic nematodes in all sugarcane growing area which is important for management of spread of plant parasitic nematode (PPN) from one field to another. Also this data can be used to indicate type and number of nematodes which are of significant importance and used to assess yield losses associated with nematodes and designate suitable management's strategies.

General Objectives

Monitoring population density of plant parasitic nematodes in the sugarcane fields on estates.

Specific Objectives

a) To assess occurrance of plant parasitic nematodes in all sugarcane estates
b) To identify key plant parasitic nematodes associated with sugarcane and their population density.

Output

- At least 2 information on the level of estates affected by nematodes known
- At least 12 key plant parasitic nematode identified to genus level
- 43 fields monitored for plant parasitic nematodes.

5.4.2 Materials and Methods

Nematodes sampling

The study was conducted from November 2018 to April 2019 at Tanganyika Planting Company Limited, Kagera sugar limited, Kilombero sugar and Mtibwa Sugar Company. Random sampling was done by collecting soil and root samples from all sugarcane fields in all estates mentioned above. During sampling attention were given in the fields with symptoms caused by presence of plant parasitic nematodes.

A total of 129 samples of root and soil were collected from 43 fields, in every field three samples were collected and mixed to make a composite sample. The information on plant age (months), number of ratoons and varieties were also collected (see attachment in appendix1). Samples were kept in a plastic bag well labelled and sent to nematology laboratory at TARI- Kibaha.

Extraction of nematodes was accomplished by using a modified Baerman method as described by (Coyne *et al.*, 2007). By using dissecting and compound microscope, nematodes were identified up to genus level and images were captured using camera connected to a microscope. The key plant parasitic which cause yield losses to sugarcane were described and identified, data obtained were summarized in excel 2013.

Results

Nematode occurance

During sampling sugarcane fields appear to have above symptoms caused by plant parasitic nematodes such as patches. Nevertheless the below symptoms which associated with nematodes problems includes visible root galling at the tip of the roots and feeder roots were present, this is caused by presence of *Meloidogyne* spp. Also, root necrosis which indicates the problems caused by presence of *Pratylenchus* spp (Figure 5. 17).


Figure 5. 17: Symptoms of root knot (Meloidogyne spp) Figure 2: Symptoms of root lesion (Pratylenchus spp)

TPC

The results were given in three part as per sampling schedule, in Northern, Eastern and South parts as follows;

Southern

In fields 6D with variety N19 ratoon 1, and aged 8 months the main isolated nematodes were *Pratylenchus*. In the soil *Rotylenchulus* spp found to be the most abundant (Figure 5.18). In field 10K planted variety N25 ratoon 1 and aged 4.9 months. Field B1 harbour survival of different plant parasitic nematodes such as *Pratylenchus* spp, *Rotylenchulus* spp, *Scutellonema* spp and *Helicotylenchus* spp. The sugarcane variety planted in B1 was R579, ratoon 2 and aged 4.7 months.

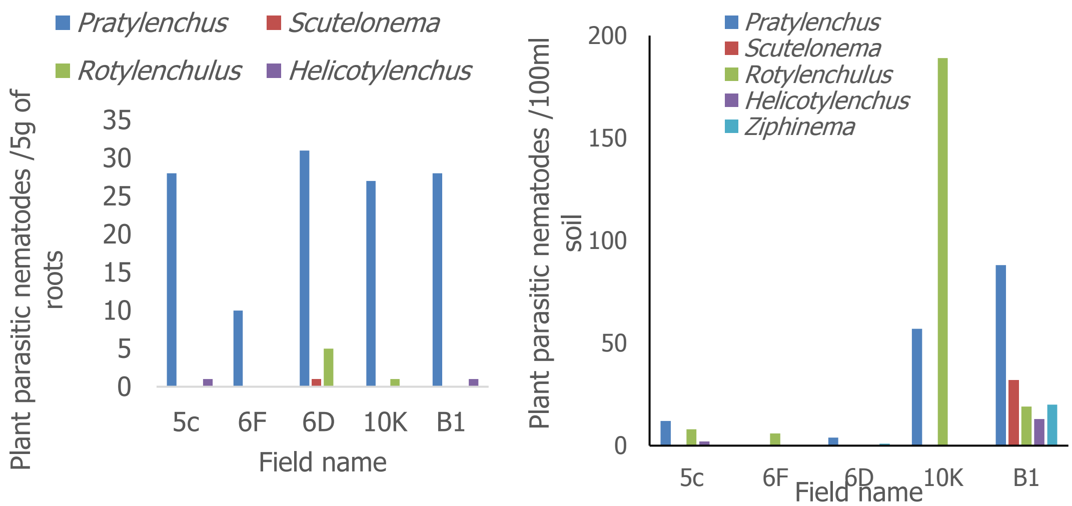

Figure 5. 18: Nematodes population isolated in the root and soil samples in the Southern part of TPC.

East

Low (less than 250) population of plant parasitic nematodes were isolated in both roots and soil However population of *Pratylenchus* spp dominate other type of nematodes which were present in the roots, KH19 and D34 fields (Figure 5.19).

Field KH19 during sampling it was planted variety N25 with ratoon 4 and aged 3 months but field D34 it was variety R579 aged 2 months with ratoon 3. FieldKH7 has *Pratylenchus* spp and it was planted variety N25, with ratoon 4, and aged 11 months (Figure 5.19). Other plant parasitic nematodes isolated in different fields include *Rotylenchulus* spp, *Hemicycliophora* spp, *Tylenchorynchus* spp and *Xiphinema* spp.

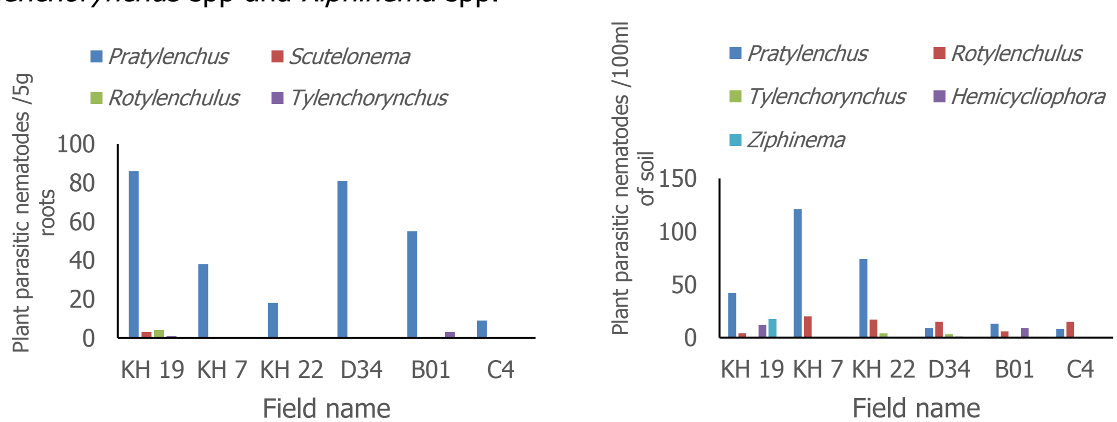

Figure 5. 19: Pratylenchus population in the roots and soil in sugarcane fields in the East of TPC

Northern

In the roots population of *Pratylenchus* spp was abundance in the field M3 than any other nematodes, and field M3 the variety planted was R579, ratoon 1 and aged 3months (Figure 5.20). In the soil similar result was observed for the case of *Pratylenchus* spp in field M3 as seen in the roots. However low population density of plant parasitic nematodes were observed because they were less than 250 based on hazard index key.

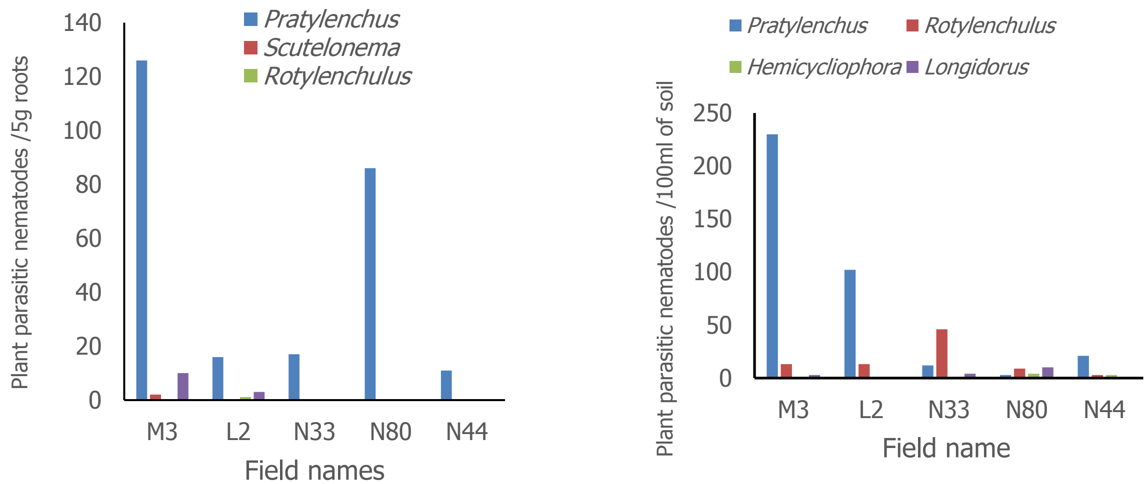

Figure 5. 20: Pratylenchus population in the roots and soil in fields sampled in the northern part of TPC

Kilombero sugar

Medium population of *Pratylenchus* spp (250-2000) and low population of *Meloidogyne* spp (low less than 200) were isolated in both roots and soil samples collected in the sugarcane fields. In the roots the most abundant plant parasitic nematodes of sugarcane was *Pratylenchus* spp followed by *Meloidogyne* spp (Figure 5. 21) in field F251 has planted R579 variety aged 9months and ratoon 1.

The population of *Pratylenchus* spp was more widespread in the soil dominate population of *Meloidoyne* spp in the roots. Field F226 had medium population density (250-2000) compared to other fields (Figure 5.21)

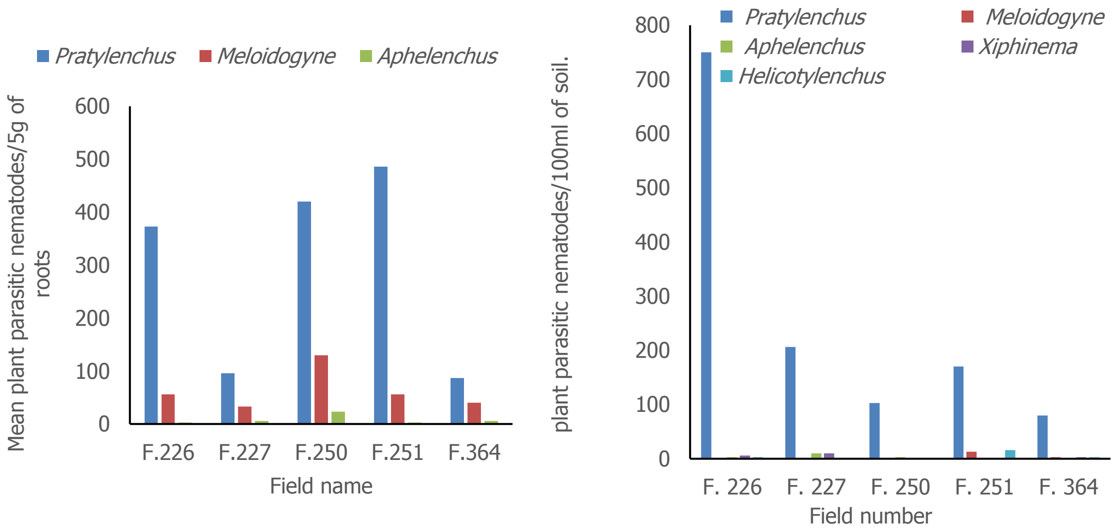

Figure 5. 21: Population of plant parasitic nematodes found in the in sugarcane roots and soil sample collected from Kilombero sugar.

Mtibwa sugar

Medium population of *Pratylenchus* spp (250-2000) and low population of *Meloidogyne* spp (less than 200) were isolated in both roots and soil samples collected in the sugarcane fields. In the root, *Pratylenchus* spp found in field M4 variety NCO 376, ratoon 2 and aged 8 months (Figure 5.22). The soil sample higher abundance of *Pratylenchus* spp in field 131(a) planted variety N41, aged 5 months and it was plant cane. *Meloidogyne* spp were present in more than one fields sampled in the roots than in the soil.

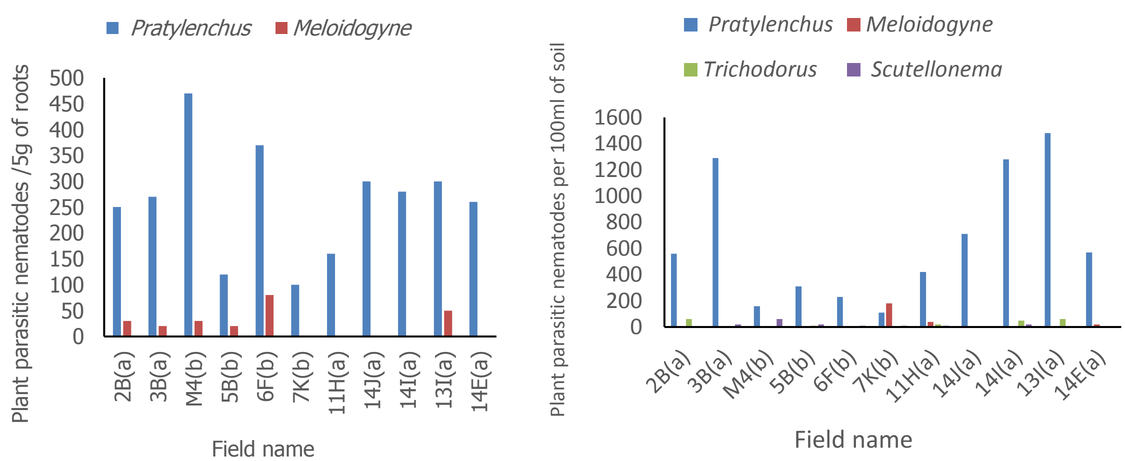

Figure 5. 22: Population of plant parasitic nematodes in the roots and soil found in the sugarcane fields sample collected from Mtibwa sugar

Kagera sugar

In the roots medium population of *Pratylenchus* spp were present other nematodes includes *Hemicycliophora* spp and *Trichodorus* spp. (Figure 5.23) in field AP11C planted variety N25 with ratoon 4 and aged 5 months.
In the soil high populati of *Pratylenchus* spp (more than 2000) dominate population of other nematodes *in the* field CP2B planted variety MN, ratoon 3 and aged 7months.

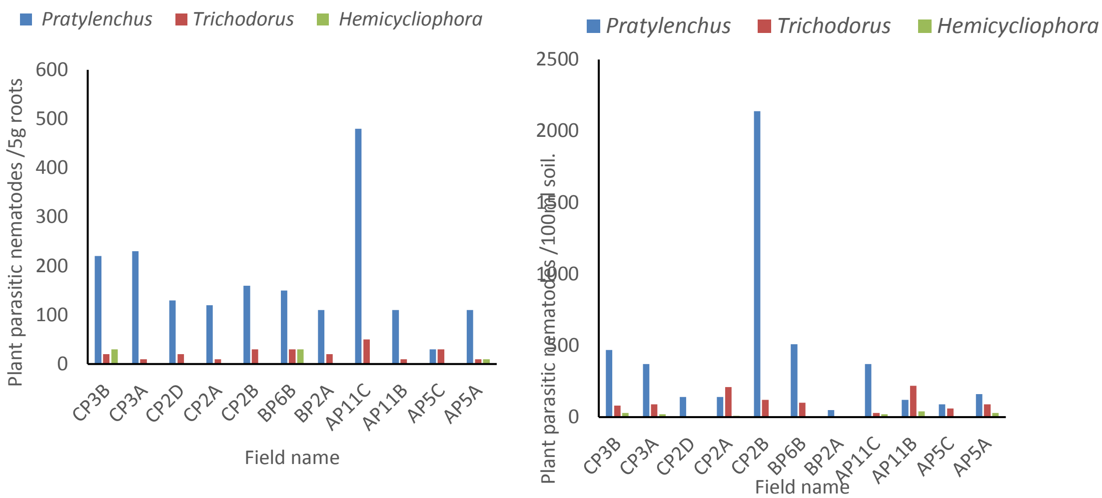

Figure 5. 23: population of plant parasitic nematodes in roots and soil found in the sample collected from Kagera sugar

Discussion

Twelve nematode genus *Pratylenchus* spp*, Meloidogyne* spp*, Xiphinema* spp*, Scutellonema* spp*, Helicotylenchus* spp *Tylenchorynchus* spp, *Rotylenchulus* spp *(*only TPC*) Aphelenchus* spp*, Hemicycliophora* spp*, Aphelenchoides* spp*, Longidorus* spp and *Trichodorus* spp was identified and the most dominant was *Pratylenchus* spp followed by *Meloidogyne* spp which which are among the key nematode species in sugarcane. According to Stirling & Blair, (2000) the most pathogenic and widespread nematodes in sugarcane are *Pratylenchus* spp and *Meloidogyne spp* particularly in sandy soil. The low population (< 250) of *Pratylenchus* spp was observed at TPC which could be attributed by soil salinity.
The high population (above 2000) of *Pratylenchus* spp was observe in Kagera sugar Limited of which could be contributed by sandy soil that influence movement, survival and multiplication. This observation was similar to the study of (Rott *et al.*, 2000) on the estimates of likely hazard to sugarcane of various nematodes population density. Plant parasitic nematodes can cause high reduction above 20% but the extent of losses depend on the soil type and standard of crop management (Rott *et al.*, 2000).
The abundance of *Pratylenchus* spp in the roots and soil fluctuation was associated with the mode of life because they are migratory nematodes (Fontana *et al.*, 2015).

Medium population *of Meloidogyne* spp 200-500 were isolated in the roots than in the soil. In sugarcane production the presence of *Meloidogyne* spp can cause yield losses up to 30% of the losses equivalent to 15 t cane/ha per year.(Cadet & Spaull, 2003). The existence of *Meloidogyne* spp and *Pratylenchus* spp in the same field decrease the population of *Meloidogyne s*pp and increase population of *Pratylenchus* spp this is caused by the mode of feeding, because *Pratylenchus* spp has a tendency of destructing the feeding sites established by *Meloidogyne* spp in the roots (Fontana *et al*., 2015).

Conclusion and Recommendations

Generally, *Pratylenchus* spp and *Meloidogyne* spp which are key nematode was most wide spread but the population of *Pratylenchus* spp out peak other nematodes. Moreover, *Rotylenchulus* spp was found only at TPC sugarcane fields especially at southern part. Thus it is recommended to do regular monitoring and establish proper nematode management plan.

5.5 Project title: Screening for the best control of nematodes in sugarcane production using integrated pest management

Project code: CCP 2018/02/02
Principal Investigators: B. Kashando, R. Polin, Y. Mbaga, M. Mziray, M. Masunga, and N. Luambano,
Reporting Period: 2018/2019
Remarks: On going

Project summary

Plant parasitic nematodes affect roots of sugarcane, these nematodes can be managed by different organic amendments. On the other hand nematicides have being widely used to control nematodes in order to improve the growth of sugarcane on the sandy soils. Therefore the objective of this study was to use integrated pest management by screening organic amendments includes; Filter cake, Mucuna beans and Lablab and sunn hemp.

The objective of this study In this study we will screen the best method to manage nematodes and increase yield in sugarcane production. The experiment was done at Kagera sugar limited in a Filed IR14F started January 2019. Randomized Complete Block Design (RCBD) with 4 replications, each replication consist of 6 plots. The trial consist of 5 treatment and a control and a total of 24 soil samples were collected prior to treatment application.

5.5.1 Introduction

Plant-parasitic nematodes (ppn) affect crop in the field by feeding using spear -like mouth parts to puncture plant roots and obtain nutrients. The effect may occur either directly from root deformation caused by nematode feeding or indirectly from predisposition to infection by other pathogens that results from nematode penetration into the roots (Wanga *et al*., 2007). The study conducted by Fontana *et al*. (2015) revealed the widespread of, *M. javanica* and *P. zeae* that suppress yield by 20 to 30% in the first harvest in susceptible varieties. Likewise, the research carried out by TARI Kibaha observed the high population of *Pratylenchus* spp and *Meloidogyne* spp in the sugarcane growing areas of Tanzania.

Different methods have been used to manage nematodes to the lowest threshold (at what level) which does not affect production. The management practices include nematicides, rotation with plants that are non- hosts of plant-parasitic nematodes, using resistant plants, soil solarization, organic amendments, trap crops, microbial bio-control agents (Stirling *et al.*, 2011; Spaull & Cadet, 2003; Mashela *et al.*, 2017). On the other hand nematicides have being widely used to control nematodes in order to improve the growth of sugarcane on the sandy soils. Nematicide should be used where the clay content of the soil is less than 6% and when symptoms of nematode damage observed on the previous cane crop harvested (Spaull, 1997). However, the most used commercial nematicides are expensive and can be harmful by producing residual toxicity. Therefore the objective of this study was to use integrative pest management by screening between oxamly granule nematicides and other soil amendments like Filter cake, Mucuna beans (*Mucuna pruriens*), and Lablab (*Lablab purpureus*) and sunn hemp (*Clotararia Juncea*). In this study we will screen the best method to manage nematodes and increase yield in sugarcane production.

General objective

To evaluate the efficient of different organic amendment in management of plant parasitic nematodes in sugarcane.

Specific objective

1. To identify an efficient integrated pest management (IPM) against nematodes on sugarcane production

Expected output

- At least 2 organic amendment will be identified

5.5.2 Material and methods

Location

Two trials established at Kagera Sugar Limited and Kilombero Sugar Company.

Intergrated pest management was done to screen the best organic amendment used such as Sunn hemp (*Clotararia Juncea*), Mucuna Bean (*Mucuna pruriens*) *Lablab purpureus,* and Filter pressmud (filter cake) in a comparison with Foxamyl granule 110G.

Experimental design

The experiment was done at Kagera sugar limited in a Filed IR14F with dual layout design on 03 Janury 2019. Complete Randomized Block Design (CRBD) with 4 replications, each replication consist of 6 plots. The trial consisted of 5 treatment and a control. Treatment one was Sunn hemp

(Clotararia Juncea), treatment two Mucuna Bean (Mucuna pruriens) treatment 3 Lablab purpureus**,** treatment 4 Foxamyl granule, treatment 5 Filter pressmud (filter cake) and treatment 6 was a control. The space between one replication and another was 1.7m and between plot was 2m. Average spacing between cane row was 1.2m, therefore total number of plot was 24. Total area of the plot was 31 square metre (10mx3.1), and a total experimental area consisted of 1546.6 sqm (20.9mx74m). Clean sugarcane variety N41was planted and the treatment selected for nematodes management were applied in the field depend on the design per plot.

Treatments

i. Sunn hemp

38.75g of sunn hemp was applied per plot which consisted of four cane rows. In each row of 10 metre 9.69 g was spread along single cane row.

ii. **Mucuna pruriens**

Plots with treatment number 2, at interval of 20 cm Mucuna pruriens was planted, and space between Mucuna pruriens lines is 60cm.

iii. Lablab purpureus

Plots with treament number 3, at interval of 20 cm *Lablab purpureus* was planted, and space between line Lablab purpureus is 60cm.

iv. Foxamly Granule nematicides

93g of Foxamly Granule nematicides was applied per plot which consist four cane rows. In each row of 10 metre 23.25 g was spread along single cane row.

v. Filter cake

93kg of Filter cake was applied per plot which consist four cane rows. In each row of 10 metre 23.25 kg was spread along single cane row.

Data collection

A total of 24 soil samples were collected prior treatment application. Sample were collected at 20 cm depth and kept in plastic bag, well labelled, kept in cool box and sent to TARI Kibaha for nematode analysis. Extraction was done by using modified Baerman technique (Coyne *et al.*, 2007). Nematode identification was accomplished using Leica 2500 under 100x magnification.

Data analysis

The data obtained will be subjected to analysis of variance (ANOVA) using GenStat program

5.5.3 Results

Based on the preliminary results, seven population of Plant parasitic nematode were identified in the soil of experimental area prior to application of treatments. The identified nematodes were *Helicotylenchus* spp,*Meloidogyne* spp, *Paralongidorus* spp, *Pratylenchus* spp, *Scutellonema* spp, *Trichodorus* spp and *Xiphinema* spp.Mean population of *Pratylenchus* spp indicates medium population 250-200 and the remaining nematodes found to have low population less than 250 in the soil. These finding will be used to compare the effect of each treatment based on the number of nematodes Table 5.4.

Table 5. 4: Mean population of plant parasitic nematodes isolated in the soil prior to application of different integrated pest managements.

Mean population of plant parasitic nematodes in soil before application of treatments							
Treatment	*Helicotylenchus*	*Meloidogyne*	*Paralongidorus*	*Pratylenchus*	*Scutellonema*	*Trichodorus*	*Xiphinema*
2	3	5	5	372	0	0	0
3	0	50	10	508	0	15	0
4	5	35	0	400	0	5	3
5	5	38	8	320	3	3	3
6	3	25	3	208	5	8	0
Lsd	8.75	81.8	12.75	287.7	6781,0	15.6	4.3
CV (%)	202	191.5	187.2	60.2	365.1	204.2	364.4
P	0.837	0.893	0.606	0.12	0.539	0.349	0.564

Note: Similar trial was set at Kilombero Sugar Company but it was terminated due to some treatment fail to germinate.

Way forward

- Second data collection on the experimental area after the incorporation of organic amendment will be done next season. The results obtained after the analysis will be used to compare the population of nematodes before and after incoperation of organic amendments in term of type of nematodes and quantity.
- To repeat the same experiment at Kilombero Sugar company

5.6 Project title: Study on yield losses associated with key plant parasitic nematodes affecting sugarcane in Tanzania

Project code: CCP 2017/02/03
Principal Investigators: B. Kashando, R. Polin, Y. Mbaga, M. Mziray, M. Masunga, and N. Luambano,
Collaborators: N. Abubakari, N. Mlawa and M. Salum, Y.Kalinga
Reporting Period: 2018/2019
Remarks: On going

Project summary
Based on the study which was accomplished by TARI Kibaha from different sugarcane estate revealed the presence of different plant parasitic nematodes the key nematodes was *Pratylenchus* spp followed by *Meloidogyne* spp. These nematodes can cause different loses in sugarcane production as describe in different literatures. However in Tanzania no information on the losses caused by plant parasitic nematodes in sugarcane production. Therefore the aim of this study is to assess yield losses associated with plant parasitic nematodes on varieties R570, R579 and Co 617 by using pots experiment in screen house. The experiments will be conducted at TARI Kibaha arranged in a completely randomized design. To date only multiplication of inoculum has being initiated in the laboratory.

5.6.1 Introduction
Yield losses caused by plant parasitic nematodes which affect sugarcane production differ from one place to another. The study of Fontana *et al.*,(2015) indicated that yield losses associated with plant parasitic nematodes especially for very susceptible varieties and high nematode population densities, may reach 50% on sugarcane crop.
Following the study conducted by TARI Kibaha in collaboration with Tanganyika Planting Company, Kagera sugar Mtibwa sugar and Kilombero Sugar Company on monitoring of plant parasitic nematodes on sugarcane fields, the widespread of *Pratylenchus* spp and *Meloidogyne* spp were observed. These plant parasitic nematodes affect different sugarcane cultivars and cause yield losses which differ from one place to another. However the effect caused by single genus of plant parasitic nematodes either *Meloidogyne* spp or *Pratylenchus* spp and the presence of co-existence of both genus in the sugarcane fields in Tanzania is unknown. Therefore the aim of this study is to assess yield losses associated with plant parasitic nematodes on varieties R570, R579 and Co 617 using pots experiment in screen house.

Specific objective
To determine the effect of single genera of nematodes and competition among *Meloidogyne* spp and *Pratylenchus* spp on sugarcane growth.

Expected output
- At least economic threshold level for 2 Plant Parasitic Nematode will be established

5.6.2 Materials and Methods

Three experiments will be conducted in the greenhouse at TARI Kibaha arranged in a completely randomized design. *Pratylenchus* spp which were extracted from sugarcane roots will be multiplied in the carrot disc under sterilised laboratory condition. Adult and juveniles will be collected in a distilled water and used as inoculant. Multiplication of *Meloidogyne* will be done in tomato seedling using Cal J variety which is suceptible to nematodes. To get combined treatment of *Pratylenchus* and *Meloidogyne* equal number of population will be introduced in one tube before inoculated in the pot.

The first experiment will use autoclaved soil with inoculum of *Pratylenchus* in a rate of 0, 500, 1000 and 1500 per 5kg pot of soil. *Pratylenchus* will be induced around the roots via a straw after the sett was planted.

The second experiment will consist of autoclaved soil plus *Meloidogyne* in a rate of 0,500, 1000 and1500 per 5kg of soil in a pot. *Meloidogyne* will be induced around the roots via a straw after the sett was planted.

Third experiment will comprise autoclaved soil plus known amount of *Pratylenchus* and *Meloidogyne* in a rate of 0,500, 1000 and1500 per 5kg of soil in a pot. Half population *Pratylenchus and* half of *Meloidogyne* will be induced around the roots via a straw after the sett was planted.

Mature stalks of sugarcane cultivar R570, R579 and Co 617, will be selected and each with three replications, with a cut of two buds nodes (sett). The sett will be immersed in water at 50^{o}c for 3 hours as a treatment for RSD and any other diseases. Sterilised soil about 4kg will be placed in 5kg pots with 3 drainage holes. During planting and after 30 days pot will be fertilized by applying fertilizer DAP and urea to the surface and the pot will be arranged in CRD in the screen house. After nine months from inoculation, the cane stalks will be harvested by separating the roots from the tops.

Data collection

Soil and root samples will be collected for analysis of nematodes Nematode extraction will be done using modified Baerman technique. The dry weight of root and shoots, the length of primary shoots to the top leaf collar and number of shoot will be measure. Multiplication rate of nematodes =Pi/Pf, and at harvest tch and brix will be measured.

Statistical analysis

The data obtained will be subjected to analysis of variance (ANOVA) using Gen Stat program

Progress

At this stage we have started mass multiplication of nematodes in the laboratory.

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APPENDIX 1: SMUT INCIDENCE AT KAGERA SUGAR LIMITED

SN	Field	Variety	Age	cc	Area	% smut incidences
1	IRID	CO617	6	3	25	4.2
2	OR2D	CO617	4	4	28	3.3
3	ER10D	CO617	8	3	4	0.1
4	DR3	CO617	5	3	3.9	0
5	JR11D	CO617	3	3	24	2.3
6	JR12A	CO617	2	4	25	2.7
7	JR12C	CO617	8	2	25	0.7
8	H24	CO617	3	3	10	1.3
9	H19A	CO617	3		10	3.2
10	H14	CO617	2		25	1.8
11	BR3C	CO617	2	2	8	4.1
12	KR3A	MN1	2	4	10.7	0.2
13	GP5D	MN1	2	3	25	0
14	BP2B	MN1	4	2	2.5	0
15	BR4A	N19	4	2	4.6	0
16	DP10C	N25	0	3	24.7	0
17	BP7C	N25	1	2	25	0
18	TR8A	N47	1		5	0
19	IR8A	N47	1	4	24	0.3
20	H20	N47	3	2	2	0
21	GP5C	N47	2	2	25	0
22	KR3E	N49	0	3	3.7	0
23	ER4D	N49	0	3	14.2	0
24	IR11C	N49	1	2	22.5	0.2
25	FP3D	R579	2	2	9.3	0
26	TP3B	R579	2	3	19	0.1
27	TP8A	R579	2	2	17.7	0
28	FP9A	R579	1	3	6.5	0
29	H16	R579	2		25	0.2
30	AR12D	R579	2	3	14.7	0.4
31	AP2A	R579	3	2	6.3	0
32	AP2B	R579	3	2	6.3	0
33	BP7D	R579	1	4	25	0

APPENDIX 2: SMUT INCIDENCE AT TPC SUGAR LIMITED

SN	Variety	Crop cycle	Age (Months)	Area (Ha)	Location	%Infestation
1	M700	1	3.2	9.9	East	0
2	M700/86	1	2.6	5.29	South	0
3	M700/86	1	2.7	7.82	South	0.7
4	N25	1	3.8	9.83	East	0
5	N30	6	2.7	30.76	North	0

6	N30	6	1.7	25.35	North	0
7	N41	0	4	18.8	East	0
8	N41	2	1.5	21.67	East	0.4
9	R 575	0	2.5	24.9	North	0
10	R 575	5	2.6	25.52	North	0.9
11	R 575	1	3.1	21.36	South	0.6
12	R 575	1	3.2	15.54	South	8.9
13	R 579	1	3.8	24.9	East	0
14	R 579	4	3.3	18.74	East	0
15	R 579	4	3.2	19.15	East	0.1
16	R 579	1	3.2	21.78	South	0
17	R 579	1	2.6	11.48	South	0
18	R 585	1	2.7	6.68	South	0
19	R 85/1334	1	2.6	2.7	South	0
20	R 85/1334	1	2.7	7.04	South	0

APPENDIX 3: SMUT INCIDENCE AT MTIBWA SUGAR ESTATE

S/N	Field	Variety	Crop cycle	Age (Months)	Area (Ha)	Location	% Infestation
1	E11(b)	R 570	1	3	15	Dakawa 1	0.3
2	9A(a)	N41	6	2.7	13.2	Central	0.9
3	A4(b)	R570	2	3.5	14.05	Dakawa 1	0.5
4	DO9(b)	R579	1	2	17.7	Dakawa 2	0
5	11A(a)	NCO376	3	3.1	13	South	4.02
6	A3(a)	NCO376	3	4	15.8	Dakawa 1	4
7	C8A	R 575	4	4	15.85	Dakawa 1	4.5
8	D8(a)	R579	4	3	15.8	Dakawa 1	0
9	C12 ©	R579	PC	3.5	24.5	Dakawa 2	0
10	1A(b)	R570	2	2.5	13.4	Central	0.4
11	11A(b)	N41	3	3	13	South	1.5
12	2D	R 579	1	2	2	Central	0
13	M8(a)	N12	PC	1.7	12.9	North	0.4
14	M9(a)	N41	4	2.2	13	North	2.3
15	A4(a)	NCO376	2	3	15.85	Dakawa 1	4.1
16	14A	N12	1	3.8	10	South	1.4
17	J6B	N32	3	3.4	5.1	North	4
18	16B	N32	4	3.4	10	North	4

APPENDIX 4: SMUT INCIDENCE AT KAGERA OUTGROWERS FIELDS

FIELDS	VILLAGE	VARIETY	CROP CYCLE	AGE/MONTH	%SMUT INFESTATION
1	Kyaka	C0617	R3	2	2
2	Kyaka	C0617	R1	3	2

3	Kyaka	C0617	R1	2.5	0
4	Kyaka	C0617	R2	4	3.3
5	Kyaka	C0617	R3	3	1.5
6	Bubale	C0617	R2	2	0.3
7	Kasambya	C0617	R3	3	0
8	Mabuye	C0617	R2	3	2.4
9	Mabuye	C0617	R2	3	0
10	Mabuye	C0617	PC	2	0
11	Mabuye	C0617	R2	3	3.4
12	Mabuye	C0617	R3	3	3.8
13	Mabuye	C0617	R1	3	2
14	Mabuye	C0617	R3	3	3
15	Mabuye	C0617	R3	3	4.2
16	Kakindo	C0617	R2	3	1.5
17	Kakindo	C0617	R2	3	0
18	Kakindo	C0617	R3	3	0.7
19	Kakindo	C0617	R3	3	0.3
20	Kakindo	C0617	R3	3	0.6
21	Kakindo	C0617	R3	3	1
22	Kakindo	C0617	R3	3	0

APPENDIX 5: TPC field sampled

Southern

No	Field	Variety	Ratoon	Age/months
1	5C	mixed	1	3.8
2	6F	R585	2	9.3
3	6D	N19	1	8.3
4	**10K**	**N25**	**1**	**4.9**
5	**B1**	**R579**	**2**	**4.7**
	East			
6	KH 19	N25	4	3
7	**KH 7**	**N25**	**4**	**11.3**
8	KH 22	R579	4	3.9
9	D34	R579	3	2.4
10	B01	R579	3	2.4
11	C4	N41	3	2.7
	Northern			

12	**M3**	**R579**	**1**	**3**
13	L2	N30	7	3.9
14	N33	R575	6	3.8
15	N80	NCO	0	10.9
16	N44	N30	6	9.5

APPENDIX 6: Kilombero sugarcane field sampled

Field no	Variety	Crop cycle	Age/month
226	**R579**	**R1**	**9**
227	R570	R1	4
250	R579	R1	8
251	**R579**	**R1**	**9**
364	MN1	R1	7

APPENDIX 7: Mtibwa sugarcane field sampled

Farm	Field Name	Variety	AGE/MONTHS	Crop cycle
CEN	2B(a)	R570	2	R1
CEN	3B(a)	R570	4.967105	R1
NOA	**M4(b)**	**NCO 376**	**7.993421**	**R2**
CEN	5B(b)	R570	4	PC
CEN	6F(b)	N12	4.342105	PC
CEN	7K(b)	N12	9.144737	R1
SOA	11H(a)	R570	6	PC
SOA	14J(a)	R579	3	PC
SOA	14I(a)	N25	2.203947	R1
SOA	**13I(a)**	**N41**	**5**	**PC**
SOA	14E(a)	N41	4	R2

APPENDIX 8: Kagera sugarcane field sampled

Field Name	Variety	Age/months	Crop cycle
CP3B	N19	5	R2
CP3A	N47/N41	6	R3
CP2D	N47/N41	9	PC
CP2A	N47/N41	8	PC
CP2B	**MN1**	**7**	**R3**
BP6B	N41	5	PC
BP2A	N25	8	PC
AP11C	**N25**	**5**	**R4**
AP11B	R579	5	R4

AP5C	N25	12	R4
AP5A	N25	7	R5

6.0 TECHNOLOGY TRANSFER

6.1 Project Title: Strategies to Improve Extension Services to Sugarcane Growers through Farmers Field School (FFS) in Kilombero and Mtibwa

Investigators: John Msemo, Diana S. Nyanda, Magreth Kinyau
Collaborators: Farmers, VAEO's, DAICO, Local Area Officer, KSE and Farmers' Organizations
Reporting time: 2018/2019

Summary
Farmer Field School (FFS) is a forum where farmers and trainers debate on observations and apply their previous experiences and present new knowledge gained. The objective was to enhance sugarcane production technologies for improved productivity through farmer field school, specifically aim to empower farmers with knowledge and skills of sugarcane production practices and also empower farmer's ability in making informed decisions which results to sustainable sugarcane farming production and productivity. In year 2017/2018 and 2018/2019, three FFS was established at Kilombero and Mtibwa whereby a total of 55 farmers which comprises 33 males and 22 females were participated and trained on the uses of clean seedcane from nursery B, fertilizer recommendation (N_{100}, P_{25}, K_{100}) and herbicides combination and rates of 4litre per hectare and empowered with decision making skills.

6.1.1 Introduction
Several agriculture extension approaches from top down to more participatory have been tried in Tanzania among of that is farming system approach (FSA), conventional extension system and training and visiting. Some fails of these approaches fails to meet the goals, however the most recently used is farmer field school.
Farmer field schools (FFS) is a group-based adult learning approach that teaches farmers how to experiment and solve problems independently, sometimes called "schools without walls". It's a learning approach that emphasizes problem solving and discovery based learning. FFS aims to build farmers' capacity to analyze their production systems, identify problems, test possible solutions, and eventually encourage the participants to adopt the practices most suitable to their farming systems (FAO, 2013). Improving decision making capacity of farming communities and stimulating local innovation for sustainable agriculture (R. Braga *et al* 2011). Also provide an opportunity for farmers to practice and test technologies. In FFS groups of farmers meet regularly with a facilitator, observe, talk, ask questions and learn together. It is a participatory approach to extension, whereby farmers are given opportunity to make a choice in the methods of production through discovery based approach. FFS aims to increase the capacity of groups of farmers to test new technologies in their own fields, assess results and their relevance to their particular circumstances and interact on a more demand driven basis with the researchers and extension officers looking to these for help where they are unable to solve a specific problem amongst themselves.

Objective

To enhance sugarcane production and productivity through farmer field school (FFS)

Specific Objectives

i) To empower farmers with knowledge and skills of sugarcane production practices
ii) To empower farmer's ability in making informed decisions results to sustainable sugarcane farming.

Outputs achieved

Two (2) FFS established at Mtibwa for the year of 2017/2018 and one (1) FFS for 2018/2019 in the villages of Kisala and Mzambarauni and Lumango at Kilombero mill area respectively. 55 farmers trained on sugarcane practices where by male were 33 and female were 22.

6.1.2 Methodology

Farmers that participated in FFS were selected through village meeting by listing of those village households that express interest in participating and fulfil the selection criteria. According to the farmer trainers and villagers, this process often leads to listing of exactly 25 households for the FFS. A total of 55 farmers (33 males and 22 females) identified. Criteria for selection based on the fact that the farmers must be sugarcane growers and be in groups and able to attend the class session each week in the field selected.

The land for FFS was acquired through voluntary basis from the member of the groups and will be used as field for training and farmers meet once per week. In any case if there is something special or activities which needs farmer to meet more than weekly, then timetable will be changed.

Farmers generate their own learning materials, from drawings of what they observe to the field trials themselves. These materials are always consistent with local conditions are less expensive to develop, are controlled by the learners and can thus be discussed by the learners with others. The input for training like seedcane, fertilizers, and herbicides were provided by TARI-Kibaha but implementation was done by farmer groups themselves like planting, weeding, fertilizer application. Before starting season farmers were trained on three packages namely; fertilizers N_{100} P_{25} K_{100}, clean seed cane from nursery B and recommended herbicide (volmuron at rate of 4 liters per ha) developed by TARI Kibaha.

 

Figure 6. 1 FFS at Mzambarauni village Mvomero and Lumango village Mvomero

6.1.3 Results and Discussion

Two (2) FFS established at Mtibwa mill area for the year of 2017/2018 in villages of Kisala and Mzambarauni and one FFS established in the year of 2018/2019 at Kilombero in the village of Lumango. A total of 55 farmers trained on sugarcane agronomical practices including the use of clean seedcane from nursery B and variety used was NCo376, fertilizer recommendation was (N_{100}, P_{25}, K_{100}) and herbicides combination and rates (Volmuron 4lts/ha) and empowered with decision making skills. Awareness materials was printed and distributed to farmer's groups and this was essential as supporting materials for their classes of FFS.

The results also show that the yield from farmer field school (FFS) were higher as compared to farmers practice and the yield of farmers practice were from 20.8 to 67 TCH as compared to yield of 80 to 89 TCH on farmer's field school as shown in the figure below (figure 6.2).

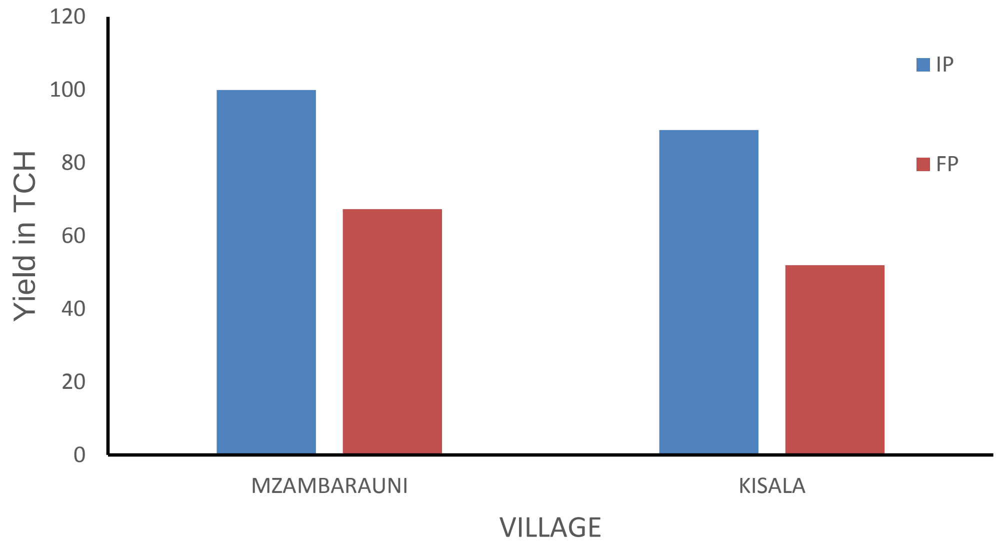

Figure 6. 2 Figure Yield of FFS 2017/18 at Mtibwa mill area

The farmers were able to participate in all activities which are essential in agricultural activities like planting, weeding, fertilizer application and herbicides, farmers were able to meet once per week and recorded all the important things like insect pest, weeds and diseases.
The majority of the technologies presented and discussed during FFS appeared to be very relevant to farmers. From the interviews carried out with farmer trainers it appeared that they have a clear understanding of the objectives of FFS and recognize the importance of it in the training of the farmers to become capable decision makers. When visiting the sugarcane field with FFS participants, it was evident that the FFS sessions practiced and participants understood the concept taught.

Conclusion

FFS participants appreciated the hands-on, practical approach of FFS with demonstrations in fields and the use of live samples of diseases and pests with participation of activities including planting, weeding, herbicides application which makes it easy to understand and memories. Fertilizer application and herbicides was considered the most useful session and was very popular.

6.2 Project title: Establishment of Demonstration plot in Mvomero, Kilosa and Kilombero Districts

Project code: TT 2018/19/02
Investigators: John Msemo, Diana S. Nyanda, Magreth Kinyau
Collaborators: VAEO's, DAICO, Local Area Officer, and Farmers' Organizations
Reporting Period: 2018/2019

Summary

Demonstration plots are one of the tools for effecting desirable changes in the behavior of farmers and explores the technologies available and developed. In view of these in the year 2018/19, nine (9) demonstration plots were established at Mang'ula, Lumango, Kunguru mwoga, Msolwa ujamaa, Mfilisi and Sonjo at kilombero mill area. Furthermore, Kisala, Mzambarauni and Lungo villages at Mtibwa mill area. Three packages were demonstrated which are the use of clean seedcane from B nursery, recommended fertilizer packages N_{100} P_{25} K_{100}, herbicides volmuron 4 liters/hectare (combination and rates) and good agronomic practices such as land preparation, planting, weeding, planting, gap filling, fertilizer and herbicide application. Farmers were able to see, learn and to apply technologies to their fields. The demonstration plot was also compared to other plot which uses farmers practice and the yield data were captured after harvest. The yield ranges from 87 TCH to 111 TCH as compared to farmers practice which ranges from 63 to 75 TCH in both sites of Kilombero and Mtibwa mill area. About 522 farmers were learned demonstration plots at kilombero and 260 at Mtibwa mill areas through visiting.

6.2.1 Introduction

Demonstration plot is one of the methods to disseminate improved technologies. This method is used to sugarcane growers as a tool for effecting desirable changes in the behavior of farmers, arranging the best learning situations, and providing opportunities in which useful communication and interaction take place between extension workers and farmers.

The use of demonstration plots for technology transfer is perceived as means of improving effectiveness in knowledge transfer (Mirani and Memon 2011). Depending on the context, demonstrations can be referred to as on-farm or field demonstrations and they constitute an important tool for enabling farmers to learn first-hand about improved agricultural production practices. (Khan *et al.,* 2009).

Figure 6. 3 Demonstration plot at Kungurumwoga village

Objectives

- To disseminate improved technologies of sugarcane production
- To demonstrate the use of clean and high quality seedcane for increased sugarcane productivity

Outputs achieved

- Nine (9) demonstration plots established
- 522 farmers/visitors accessed demo plots in Kilombero and 260 for Mtibwa mill area

6.2.3 Methodology

Sugarcane growers were selected purposively with an ability and track record in best cane growing practices and who follow the improved technologies developed by researchers. Criteria for selection of demonstration plots includes the following conditions: The area should be passable throughout the year, the land should be selected in places where people can see and learn easily, and the land should reflect typical ecological situations of sugarcane crops.

6.2.4 Results and Discussion

Nine (9) demonstration plots established in 2018/19. Where by 522 farmers/visitors accessed demonstration plots at Kilombero and 260 for Mtibwa mill areas. The yields of 9 demonstration plots for (2017/18) increased compared to farmer practice. The yield ranges from 87 TCH to 111 TCH as compared to farmers practice which ranges from 63 to 75 TCH in both sites of Kilombero and Mtibwa mill area.

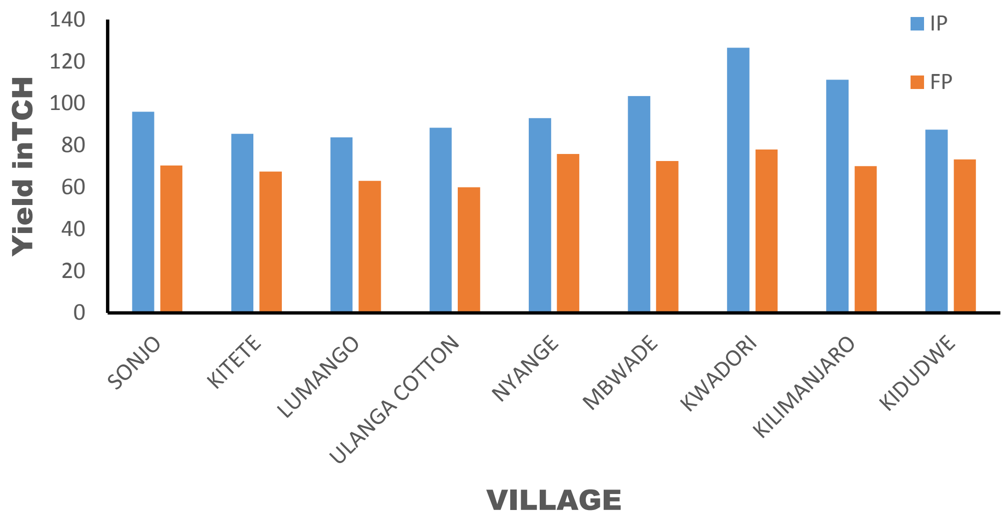

Figure 6. 4 The yield of the demonstration plot

Conclusion

Demonstration plots are one of the methods to improve yields. These methods are used as tools by the extension workers to effect desirable changes in the behavior of rural population, arrange the best learning situations, and provide opportunities for useful communication and interaction that take place between researchers who developed technologies and extension workers who implement and farmers who adopt improved technologies.

6.3 Project Title: The multiplication of clean seedcane at Kilombero, Kagera and Mtibwa Mill Area

Code: TT 2018/03
Investigators: Diana S. Nyanda, John Msemo, Magreth Kinyau
Collaborators: Farmers, VAEO's, DAICO, Local Area Officer, KSC, KSL, MSE Estates and Farmers' Organizations
Reporting Period: 2018/2019

Summary

Economical sugarcane yield potential depends on factors that contribute to increase yields to farmers; the use of clean seed cane, use of recommended fertilizer, and use of recommended herbicides as well as the use of good agronomic practices such as proper land preparation, recommended spacing and timely weeding. The accessibility of the clean seedcane is the biggest challenge that most of farmers face in Kilombero, Kagera and Mtibwa mill area which resulting to low productivity. To solve the problem, the multiplication of nursery B was established at

sugarcane mill areas with a total area of 38.5 acres planted with CO 617, NCo376, N 47 and R 570 varieties from Estate nursery 'A'. A total of 23 acres of seedcane nursery was planted to growers at Missenyi district; (11 Nsunga, 6 Kasambya, 3 Kyaka and 3 Bubale), 9 acres in Kilosa district (5 Ilundo, 1 Mfilisi, 3 Bulima farm.), 3 acres in Mvomero district (3 Kidudwe). Furthermore, a total of 3.5 acres was planted at TARI Dakawa. The seedcane multiplication fields were owned and managed by farmers. TARI Kibaha supported the farmers with 4 tones clean seedcane/acre from A nursery and inputs (basal fertilizer and herbicides). The observation and monitoring was done by researchers and agriculture extension officers.

6.3.1 Introduction

The cane growers in Tanzania face many problems in attaining the potential yields (Tarimo and Takamura, 1998). The main problems leading to low yields include the use of the poor quality seedcane, transportation cost and high price of seedcane, unavailability of seedcane near their premises. These make most of the farmers depend on the seedcane from neighbors imposing the risks of continuing spreading the pests and diseases such as ratoon stunting disease (RSD), smut and eldana as a results causing low sugarcane productivity. Planting good quality seedcane reduces the risk of pest or disease outbreaks in commercial fields which lead to adversely low sugarcane productivity.

General Objective

To establish multiplication of clean seedcane through Nursery B to sugarcane growers

Specific Objectives

1. To ensure farmers accessibility of clean seed cane from Nursery "B"
2. To determine the economic potential of using clean seedcane to cane growers

Output achieved

- Multiplication of 38.5 acres of nursery B farms established

6.3.2 Methodology

The multiplication sites were selected differently in Missenyi district; Area chosen were at Kasambya, Bubale, Kyaka and Nsunga, In Kilosa district the sites were at Ilundo, Bulima and Mfilisi, while in Mvomero district the site located was at Kidudwe village. The main sources of seedcane was from nursery "A" in Kilombero, Kagera and Mtibwa estates. Purposive sampling was done to identify reliable farmers with the ability and track record in best cane growing and an attitude of cooperation with partners who follow the recommendations under protocol developed for seedcane multiplication. Amount of seedcane was 4 tons/acre and varieties used was NCo376, R 570, CO 617, and N 47.

The approach used was TARI Kibaha supported the growers with 4 tonnes clean seed cane and inputs (basal fertilizer and herbicides) enough to cover one acre. The farmers were supposed to repay loan to TARI Kibaha in monetary form equivalent to the market price of 4 tons of seedcane. Then extension officers and Local Area Officer (LAO) of the particular area were helping in managing the multiplication plot.

6.3.4 Results and Discussion

A total of 38.5 acres of seedcane nursery B were established at Missenyi, Kilosa and Mvomero district as shown in table below.

Table 6. 1 The area of seedcane planted 2018/19

S/n	District	location	Area planted (acres)
1	Misenyi	Nsunga	11
		Kasambya	6
		Kyaka	3
		Bubale	3
2	Kilosa	Ilundo	5
		Mfilisi	1
		Bulima farm	3
3	Mvomero	Kidudwe	3
		TARI- Dakawa	3.5
		Total	**38.5**

Way forward

- Sensitization to farmers on the use of clean seedcane established from nursery B

6.4 PROJECT TITLE: Scaling up sugarcane production technologies through training and development of extension materials

Project code: TT 2018/04
Investigators: John Msemo, Diana S. Nyanda, Magreth Kinyau
Collaborators: Farmers, VAEO's, DAICO, Local Area Officerand Farmers' Organizations
Reporting Period: 2018/2019

Summary

The sugarcane growers face many problems in production of sugarcane, one of them is inadequate knowledge and access to information on the available technologies for improvement of sugarcane production. Therefore, the intended project tried to use methods of developing research materials like banners, posters, flyers, brochure and training manuals. A total of 6 new recruited staff of Sugar Board of Tanzania (SBT) and 7 prison officers of Mbigiri was trained on sugarcane production. The training was covered both theory and practical sessions. Apart from

that a total of 350 posters, 7000 flyers, 7000 Brochure and 200 books Swahili version have been developed and printed. Furthermore 2820 flyers, 2300 brochures and 328 posters have been distributed to cane growers and other stakeholders during nanenane exhibition, farmers' day in Kilombero and Kilosa district. Also distribution was done at TARI office during visiting day of government members of parliament committees for agriculture livestock and fisheries. Also in nanenane exhibition a total of 4676 people attended sugarcane pavilion with 2045 female and 2631 male and were asking for sugarcane technologies.

6.4.1 Introduction

Technology development and dissemination of agricultural extension materials is very important because the ratio of agriculture extension officer is low compared to household family, thus make it difficult to visit farmers in time. Therefore, the intended project tried to use methods of developing research training materials like banners, posters, flyers, brochure and training manuals, also conducting training to farmers and other stakeholders involved. The training including field demonstrations, capacity building of stakeholders/farmers through field visits on concept of integrated sugarcane farming, Climate change adaptation, Good Agriculture Practices such as site selection, land preparation, proper spacing, proper weeding and proper harvesting.

Training of trainers (TOT) is the prerequisite for an effective implementation of technical solutions in the field and an important step for their dissemination. It follows a specific curriculum of basic crop management skills and field practical such as planting and weeding. It is a core activity in extension process and is the effective way to help bring extension workers up to date on newly developed technologies. The knowledge gained will enable them to organize Farmers in the production of sugarcane in the particular area (Braga et al, 2011).

Main Objective

The development of the research materials for improved sugarcane production, diffusion and capacity building.

Specific Objectives

- Backstopping of sugarcane stakeholders on agronomical packages of sugarcane
- Dissemination of sugarcane production technologies

Outputs Achieved

- A total of 350 posters, 7000 flyers, 7000 Brochure and 2000 training books have been developed and printed for sugarcane growers and other stakeholders.
- A total of 2820 fliers,2300 brochures and 328 posters have been distributed
- A total of 13 SBT staff and prison staff attended the training on the principal of sugarcane production. Furthermore, 16 agriculture extension officers were capacitated on sugarcane agronomic practices and new improved varieties developed by researchers.

- A total of 4676 attended sugarcane pavilion with 2045 female and 2631 female during nanenane.

6.4.2 Methodology

The development of training materials was done to all unit which are breeding, pathology, entomology, nematodes, agronomy and technology transfer. The aim was each section to develop the user friendly output for leaflets and brochures. The process of production was based on the available technologies which developed in each unit. Training of trainers and farmers were done by using manual prepared by researchers.

6.4.3 Results and discussion

The training was done with TARI team with a total participation of 6 SBT new recruited staff and 7 prison officers of Mbiligiri. The training was covered in all aspect related to sugarcane production technologies and it covered both theory and practical session.

Figure 6. 5 SBT staff during training – practical session and graduation.

Printing of Training Materials

During 2018/19 season, 7 banners, 350 posters, 7000 flyers, 7000 Brochures and 200 training manuals were printed and distributed to farmers at sugarcane mill areas (Kilombero, Kagera and Mtibwa), nanenane exhibition, and during the visit of members of parliament committees for agriculture livestock and fisheries.

Nanenane Exhibitions

Nanenane is also sometimes called "Farmers' Day". It's a time when the contribution of farmers and all involved in agriculture of all kinds throughout Tanzania are appreciated.
A week-long national Nanenane day fair takes place each year, but the location varies and rotates. There are seven regional level fairs for Nane nane that are put on simultaneous to the National fair. The fairs start on 1 August and run till 8 August. The agriculture shows conducted every year. During eight days of exhibition we had people who were looking for a technology

solution for specific production problems

Figure 6. 6 Former president Dr. J, M. Kikwete was one of participants of nanenane exhibition

The materials developed was printed and distributed to Nanenane exhibitions, which is an events make the different stakeholders of agriculture, meets and sharing the information on the agriculture development technologies.

Table 6. 2 The number of participants attended at Sugarcane pavilion Morogoro

Day	Female	Male	Total
1	34	56	90
2	34	61	95
3	38	72	110
4	46	78	124
5	180	320	500
6	531	601	1132
7	573	720	1293
8	609	723	1332
Total	**2045**	**2631**	**4676**

Conclusion and recommendation

Backstopping training and development of training materials are the user friendly knowledge sharing materials. It is very important in the dissemination of the technology to farmers. The preliminary results show that technologies were successful promoted using extension materials and nanenane exhibition.

Way foward

- To continue using the nane nane exhibition for technology transfer

- To make evaluation of the developed training materials

6.5 Project Title: Promotion of Sugarcane Production Technologies to Sugarcane Growers by Mass Media

Code: TT 2018/05
Investigators: John Msemo, Diana S. Nyanda, Magreth Kinyau
Collaborators: Farmers, VAEO's, DAICO, Local Area Officer, KSC, MSE Estates and Farmers' Organizations
Reporting Period: 2018/2019

Summary

It is well known that radio play a significant role in transferring information to many communities. Statistics show that if radio is used effectively can help to narrow the gap between the extension officer and family households in obtaining information of agriculture technologies, In view of this the implemented project aimed at transferring knowledge of sugarcane technologies to growers at Morogoro mill areas by using radio. Prior to implementing the radio program, a preliminary study of indigenous farmers knowledge was conducted at Madizini village in Mvomero , Kitete village in Kilosa and Nyange village in Kilombero. Using Participatory rapid appraisal (PRA) and Focus Group Discussion (FGD) techniques. Tools used were transect drive, crop calendar, pairwise ranking and score. Pairwise and ranking showed that most preferred radio in all location was Abood FM was also supported by transect drive. Thereafter the two workshop was conducted at Kibaha and Morogoro and came up with 26 episodes which covered production to harvesting. At end of seasons a total of 96 calls was received so far from listeners and about 3175 messages received, this indicate that the radio has potential impact in transferring technologies and narrow the gap between of extension officers and household's community on knowledge and information

6.5.1. Introduction

It is well known that the ratio of agriculture extension officers and farming families is low as compared to number of farmers which increases every year. The gap will continue to exist as the ratio of recruitment of new staff is low compared to the growth of population.

Radio plays the most significant role of any communication technology in the transfer of information in African countries because spoken word on broadcast radio is the principal means of information transfer where literacy rates are low (Yahaya, M. K *et al*., 2012)

In Tanzania Radio has been considered as the most important and most preferred tool in communication as compared to other means of transferring technologies (FRI 2008). Statistics have shown that radio receivers are at least ten times more common than Television (TV) set in developing countries (Okelo J. 2007)).

In Tanzania farmer's extension groups(FRG) which are groups of farmers that are working with extension on the verification of recommended messages and option has been used for past year to evaluated the research message through recorded message on radio, however in order this to be effective needs specific crops and groups.

In sugarcane growing areas of Kilombero, Mvomero, Kilosa and Misenyi there more than 9,000 cane growers who supply sugarcane to millers. Effort to make them improve production and productivity of their fields has been done using different approach like an extension method of training and visiting (T&V) backstopping of VAEO, and use them to train farmers, establishment of FFS to farmers growing areas and establishment of demonstration plot. All these effort aims at increase production and productivity of sugarcane growers. Because of the situation above emphasis on district councils and research is on the growing of this crops especially to the place accessible to mill area, The TARI Kibaha in collaboration with other stakeholders has put emphasis in establishments of Nursery Demonstration B plots and FFS for easy access of clean materials

It is not a secret that most farmers obtain seed from their own field or neighbor which are not clean, therefore diseases especially smut have been passed over generation to another fields and leading to low yields to sugarcane growers.

It is therefore awareness creation through radio farmers will increase knowledge on the importance of agronomical practices of sugarcane as well as importance of using the seedcane from nursery B

Main objective
Promotion of sugarcane production technologies to sugarcane growers through radio program

Specific objective
- Dissemination of sugarcane production technologies in Kilombero, Kilosa and Mvomero mill area

Outputs achieved
- A total of 26 episodes developed was aired to farmers in Morogoro regions sugarcane mill areas
- A total of 3171 messages was received through radio
- A total of 96 telephone calls was received from the starting of radio episodes

6.5.2 Methodology
The Execution of the Project Involved Three Stages
Stage 1 Information gap
In identifying information Participatory Rapid Appraisal (PRA) and Focus groups discussion (FGD) were conducted at Madizini village in Mvomero district, Kitete village in Kilosa district and Nyange village in Kilombero district. Tools used were crop calendar, matrix ranking, and Venn diagram and transect driving around community of sugarcane growing areas. The selection of farmers was

done purposively with assistance of extension officer's and Local Area Officer (LAO) of respective areas and criteria used was good record on production of sugarcane and participation on farmer's field school. The results from pair wise ranking show that most preferred radio along Mtibwa milling area were, Abood FM followed by Planet and uhuru. (Table 6.3)

Table 6. 3 Pairwise and ranking of radio preferred by farmers in Mtibwa mill area

	TBC	**Abood**	**Planet**	**Uhuru**	**Cloud**	**Total**	**Rank**
TBC		Abood	Planet	Uhuru	Cloud	**0**	**4**
Abood			Abood	Abood	Abood	**4**	**1**
Planet				Planet	Planet	**3**	**2**
Uhuru					Uhuru	**2**	**3**
Cloud							

The focus group discussion from kitete and Nyange which represented kilombero mill area were conducted and results is as shown below

Table 6. 4 Pairwise ranking and scoring of radio at Kilombero mill area

	Ulanga	Aboud	TBC 1	Pambazuko	Planet	Score	Rank
Ulanga		ulanga	Ulanga	Ulanga	Ulanga	4	1
Abood			Abood	Abood	Abood	3	2
TBC 1				Pambazuko	TBC 1	1	4
Pambazuko					Pambazuko	2	3
Planet						0	5

The results showed that the most frequency and popular radio were ULANGA FM followed by Abood FM radio and others were TBC, Pambazuko and Radio planet FM.It was north to note that Abood radio covered in both sites, therefore were selected to air radio program (table 6:4).

Stage 2 workshops

Two workshops conducted at Kibaha and Morogoro involving participation of sugarcane stakeholders and media specialist. The aim of workshops was to develop the radio program that will be aired by consideration of important topic and also development of the script which valuing a farmers and listeners, giving them an opportunity to express themselves, and also providing a relevance information, convenience and entertaining messages. The workshops ended by selection of 26 episodes which aired twice per by consideration of crop calendar.

Stage 3 Radio broadcasting

Time selected was 6:30 pm every Friday and repeated at Wednesday day at 6:30. Three methods were used in broadcasting the first was interview of a successful sugarcane farmer from sugarcane growing areas who tell the success stories and challenges and ask some listeners to call and text questions and comments. Second method was interview sugarcane expert from extension services or researchers or any organization then after airing invite the listeners to call or text with questions and comments. Third method was host an expert for live airing at Abood radio studio. After transmissions to radio was concluded by experts giving a

6.5.3 Results and Discussion

Results show all total of 26 episodes was aired from 2017 to 2018/2019 covering the following topics from varieties of sugarcane, agronomic practices, plant protection, harvesting and environment and safety precaution.

A total of 96 calls was received from the respondents over directed calling from respondents and almost questions and comments was covered in all aspects.

A total of 3171 messages have been received from listeners on the questions and issues related to sugarcane.

in summary from the evaluation radio discussions with episodes in Morogoro sugarcane growing areas, show that the most common interactions during radio program were demanding from new seedcane variety (39%), pests and diseases (19%), planting pattern (14%), fertilizers type and application (13%), herbicides (8%) and other question (9%), some was not coverage to directly topics concerned (fig 6;10)

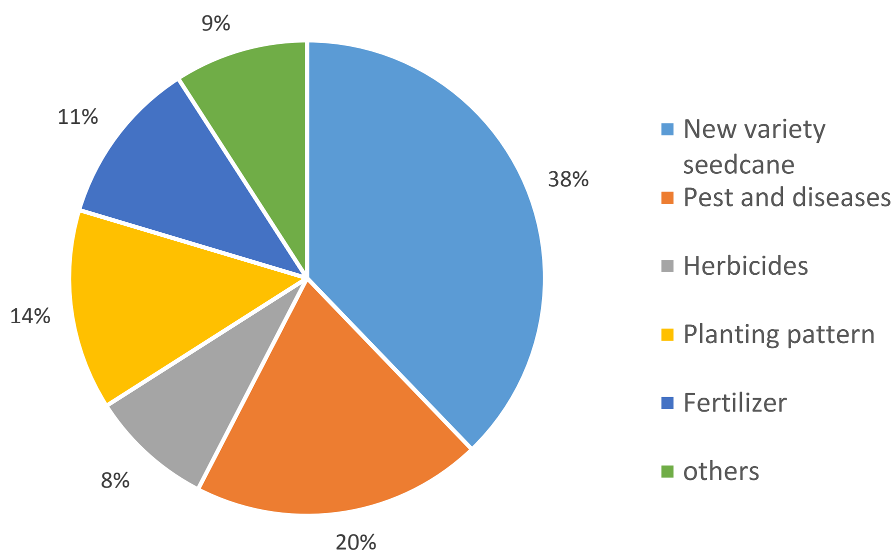

Figure 6. 7 Distribution of questions asked by listeners on radio programs aired

Results also indicate that, radio was covered to larger areas apart from area intended these was Dodoma, Simiyu, Kongwa, Kilosa, Ruvuma,Tanga,Pemba and most of people were demanding to have sugar factory. It was worth to note that the most area covered was Morogoro region especially Kilosa (27%), Mvomero (28%) and Kilombero (33%).

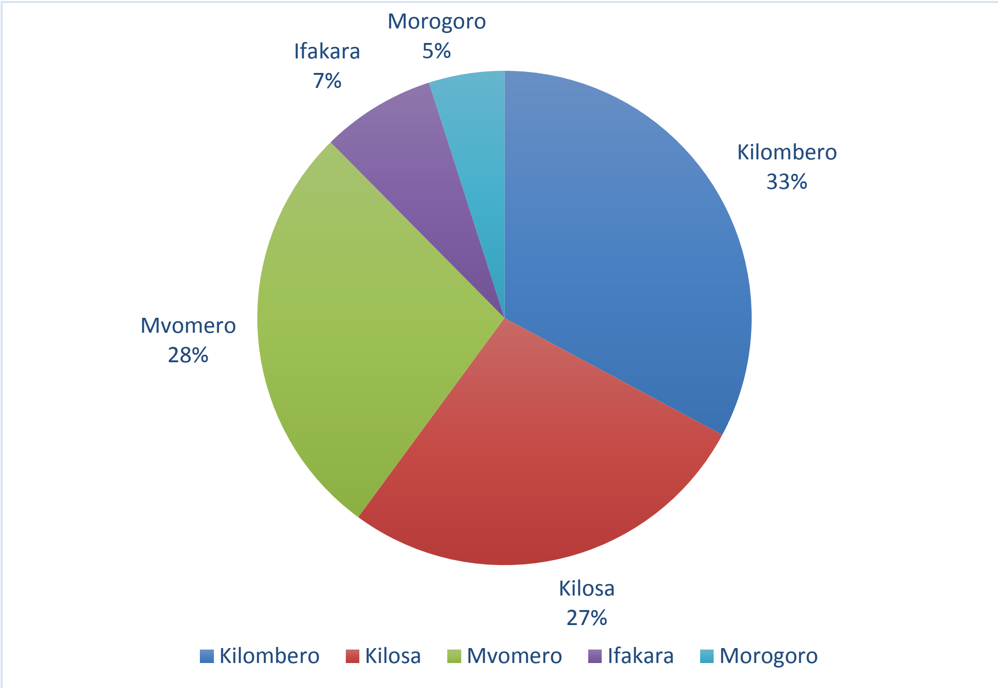

Figure 6. 8.Radio coverage area in Morogoro region

From the listeners of radio and telephone calls the preliminary results show that. The main challenge farmer's face was low yielding of sugarcane and this was due to the use low yielding varieties from neighbors, diseases and pest such as smut, poor weed management and/no little use of fertilizers. The listeners were found to pay attention to the use of clean seed from Nursery B and demanding of new highly yielding seed cane, and the proper use of fertilizer in the productions of sugarcane. The number of farmers reported in different episodes was found to concentrate in the use clean seed and new variety to replace NCO 376 to grower's fields.

Conclusion

The studies show that radio can be used to improve the sharing of agricultural information to remote rural farming areas through participatory communication techniques therefore support extension effort in disseminations of technologies. Also the radio can be effective in narrowing the gap between agriculture extension officers if used properly. It can be concluded that radio programme was well received by target audience, and format in which they were presented was easily understood, that is using the experience from farmers to explain how they know certain topic and summarized by knowledgeable people by showing how it is was supposed to be, however, sustainability and continuity of these programed must be taken into consideration.

Recommendations

- To conduct impact assessment of radio to area which was intended to be aired
- To review the topic intended to be aired based on questions we received

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APPENDIX 9:Projects for 2018/19

1	SCB 2018/01	Closed and open quarantine
2	SCB 2018/03, SCB 2017/02	Smut screening trials
3	SCB 2017/03, SCB 2016/, SCB 2015, SCB 2015/03, SCB 2013/04	Preliminary screening trials
4	SCB 2018/05	Advanced variety trials
5	SCB 2016/05, SCB 2017/05	National Performance trials
6	SCB 2018/06	COSTECH Clonal selection
7	SCB 2018/07	Rapid seedcane multiplication
8	SCB 2018/08	Germplasm conservation
9	AP/2018/03/	12 large bloc experiment at KSC (PC)
10	AP/2017/03/02	12 large block experiment at KSC (R1)
11	AP/2016/03/02	OG variety trial (R11)
12	AP/2015/03/03	OG variety trials (R 111)
13	AP/2014/03/04	OG variety trials (R IV)
14	AP/2016/03/02	Fertilizer trial at Kagera (R1)
15	AP/2017/03/03	Fertilizer trial at Kagera (Pc)
16	AP/2018/03/	Fertilizer trial Kagera (New)
17	AP/2017/03/04	Baseline survey on the status of *Striga* spp in Tanzania
18	AP/2018/03/0	Herbicide trial at Kagera
19	AP/2018/03/0	9 Large block trials at Mtibwa
20	CPE 2018/01	Study on seasonal insect population fluctuation in all estates and OF fields
21	CPE 2018/02	Establishment of WS evaluation trial at KSC
22	CPE 2018/03	Production of white scale predators
23	CPE 2018/04	Insecticides trial for control of YSA at TPC, KSC and KSL
24	CPE 2018/05	Evaluation of sugarcane varieties to YSA damage in cages (New project)
25	CPE 2018/06	Impact of predators in controlling YSA (New project)
26	CPP 2017/01/01	Monitoring and management of plant diseases (RSD)
27	CPP 2018/01/02	Disease assessment (SCWL, Smut, SYLV)

28	CPP 2018/01/03	Diagnosis of sugarcane white leaf scale
29	CPP 2018/01/04	Investigation on potential insect vectors of sugarcane white leaf disease in Tanzania
40	CPP 2018/01/05	Assessment of disease management practices by sugarcane small-scale farmers in Tanzania: Case study of KSL, KSC and MSE Mill areas
41	CPP 2018/02/01	Monitoring and management of plant parasitic nematodes (PPN)
42	CPP 2018/02/02	A study on crop loss on plant parasitic nematodes associated with sugarcane in Tanzania
43	CPP 2018/02/03	An investigation of IPM practices for nematode control in sugarcane
44	TT.2018/01	Establishment of demonstration plots
45	TT.2018/02	Establishment of B-nursery
46	TT.2018/03	Backstopping mission (training of trainers)
47	TT.2018/04	Monitoring and evaluation
48	TT.2018/05	Radio broadcasting
49	TT.2018/06	Factors affecting efficiency of sugarcane productivity along sugarcane value chain