Journal of Plant Biology and Agronomy

Research Article

Open Access

JPBA @scientificeminencegroup.com

Sweetpotato Varieties Response to Weevils, Cylas Species Infestation in Coastal Tanzania

Gration M. Rwegasira*

Department of Crop Science and Horticulture, Sokoine University of Agriculture, P. O. Box 3005, Morogoro, Tanzania.

*Corresponding Author

* Gration M. Rwegasira, Department of Crop Science and Horticulture, Sokoine University of Agriculture, P. O. Box 3005, Morogoro, Tanzania. Tel: +255 754 595058, E--mail: grwegasira@sua.ac.tz

Citation

Gration M. Rwegasira (2023) Sweetpotato Varieties Response to Weevils, Cylas Species Infestation in Coastal Tanzania. 2: 1-9

Publication Dates

Received date: March 10, 2023
Accepted date: May 10, 2023
Published date: May 15, 2023

Abstract

A field experiment was conducted at Tanzania Agricultural Research Institute (TARI-Kibaha) from October, 2014 to July 2015 to assess the impact of sweetpotato weevil, Cylas puncticollis and C. brunneus infestation and damage on tubers of selected varieties; Ukerewe, Simama, Mataya and Kiegea. Experiments were laid out in the randomised complete block design (RCBD) with sweetpotato varieties as treatments. Results revealed that all varieties were susceptible to weevils' infestation albeit at varied degrees. Orange fleshed varieties; Mataya and Kiegea yielded higher (2.02 ton/Ha and 1.76 ton/Ha) than white fleshed varieties; Simama and Ukerewe (1.66 ton/Ha and 1.53 to/Ha) respectively and were less susceptible to sweetpotato weevils infestation. Highly significant ($p<0.001$) variation among tested varieties in terms of yield (number of harvested tubers) was recorded. There was a positive correlation between yield and percentage infestation by Cylas spp suggesting that weevils exerts significant impacts on sweetpotato yield in costal Tanzania. Management of the pest should be prioritized whenever the crop is grown. Orange fleshed varieties are likely to increase sweetpotato production through increased yield per unit area thus, should be complemented with other management practices that have been shown to reduce weevil damage.

Keywords: Cylas Spp; Ipomea Batatas; Infestation; Sweetpotato Varieties; Yield Loss

Introduction

Sweetpotato (Ipomea batatas (L.) Lam) is the 7th most important root crop worldwide and the 5th most produced in east Africa [1,2]. It is a source of dietary of most carbohydrates, vitamins, minerals and proteins and used for subsistence by poor-resource farmers in developing countries. The crop is increasingly becoming popular among smallholder farmers in Tanzania because of its ability to grow on wide and various soil types and high production potential in marginal lands. According to FAOSTAT (2012), Tanzania hit the 3rd producer of sweetpotato in Africa next to Nigeria after Uganda. The country's production of sweetpotato in 2010 was 1 400 000 tons whereas those of Uganda and Nigeria were 2 883 408 tons and 2 883 408 tons, respectively. However, by comparing its production for the period of 4 years from 2006 when the production in Tanzania was 1 396 400 tons, it is beyond doubt that the change in the rate of sweetpotato production in the country has not picked significant acceleration.

The unexpected very low change in sweetpotato yield in producing countries has been associated with many factors some if not all of which have been comprehensively addressed but under different biotic and abiotic conditions [3]. Mostly, low yield is attributed to the low soil fertility, lack or inadequate of improved varieties, diseases, agronomic and storage practices, unpredictable climatic conditions and the elements of weather, and important insect pests, or interaction of these. In sub-Saharan Africa, sweetpotato is produced annually on over 53 thousand hectares of land with total production over 4 240 t and the average productivity is 8 t ha-1 [4]. However, a study conducted by revealed that smallholder farmers get low yields varying between 5 and 12 t ha-1, which is very far below the potential yield of 40 to 60 t ha-1.

Insect pests such as weevils particularly Cylas sp. have been reported to be the most important constraint to yield and economic losses in sweetpotato producing farmers [5]. reported that sweetpotato weevils (Cylas brunneus and C. puncticollis) and millipedes (Diplopoda) of the species Omopyge sudanica (Omopygidae) can access sweetpotato plants throughout the growing season. According to the population densities of the insect pests can build-up in the course of the plant's growing season. In addition, weevils are repotedly more abundant and injurious during the dry season than the rainy season [3]. Soil cracking induced by dry and hot conditions promote new infestation and fast development of the weevil through exposure of the storage roots to the weevils. Nevertheless, [5] reported that vines are often susceptible to sweetpotato weevils from planting onwards provided that conditions are favorable. Sweetpotato weevils can live 3–4 months and produce up to an average of 100 eggs per female in 3 generations per year during its lifetime [1].

Sweetpotato weevils (Cylas sp.) are the cosmopolitan insects and most serious insect pests of sweetpotato reported worldwide [3]. In response to weevil feeding, sweetpotato storage roots produce bitter tasting and toxic sesqui-terpenes that render them unfit for human consumption. According to [6], weevils are the most important pests of sweetpotato in most sub-Saharan Africa countries, which destroy large parts of the roots thereby causing unsightly damage; the 'undamaged' part of the root also becomes bitter and unmarketable. The weevil larvae also feed in the stems, causing large lumps to appear and damaging the connection to the roots but the sweetpotato weevil larva is the only insect that tunnels throughout the root.

A study conducted by [8] indicated that the effects of infestation by the sweetpotato weevil, Cylas formicarius (Elegantulus summers), on yield in 12 sweetpotato cultivars showed significant reductions in yield which was demonstrated by comparing weevil-free fields with infested fields. According to [8-10] the average yield reduction of 69% was attributed to many factors but mortality of infested plants was the major contributing factor. Most studies have been conducted regarding the sweetpotato weevils on their biology, ecology, mode of feeding, and adaptation, using different approaches for its control. These studies have been exacerbated by the high levels of production losses of 60-100% associated with this insect pest [11].

Although moderate levels of resistance of sweetpotato varieties to infestation of the sweetpotato weevils particularly the Cylas sp. have been demonstrated in most studies [1,9,3] there has never existed a complete immunity. Many sweetpotato varieties have been released in Tanzania for farmers' adoption but their levels of resistance to the sweepotato weevil as well as a wide range of other insect pests and diseases has not been comprehensively studied. Little has been done to examine the effect of sweetpotato weevil infestation on yield losses. [13] observed that the effects of weevil infestation on yield were minimal for C. formicarius (Fabricius) in Taiwan. However, [14] reported yield losses of 10 to 100% due to weevils. [15] reported losses of 35 - 70% depending on the season. [10] found that severe crown damage, especially in varieties like Centennial, resulted in significant reductions in yield. [10] reported high yield losses due to mortality of infested plants. Therefore, by considering the present knowledge gaps, the objectives of this study were; i) to determine the incidences of sweetpotato weevils in selected improved sweetpotato varieties, and ii) to determine the on yield losses associated with sweetpotato weevil infestation on orange and white fleshed sweetpotato varieties grown in Tanzania.

Materials and Methods

Description of the Study Area

The field experiments were conducted at TARI Kibaha located at 06° 46′ S, 38° 55′ E and 370 meters above sea levels during short rains from October, 2014 to February, 2015 during the intermittent drought then repeated from March to July, 2015 during the long rains with harvesting done at the helm of dry season. The soils were predominantly sandy clayey loam. The area received an average annual rainfall of 728.5 mm characterized by erratic distribution a weak bi-modal pattern (Figure 1).

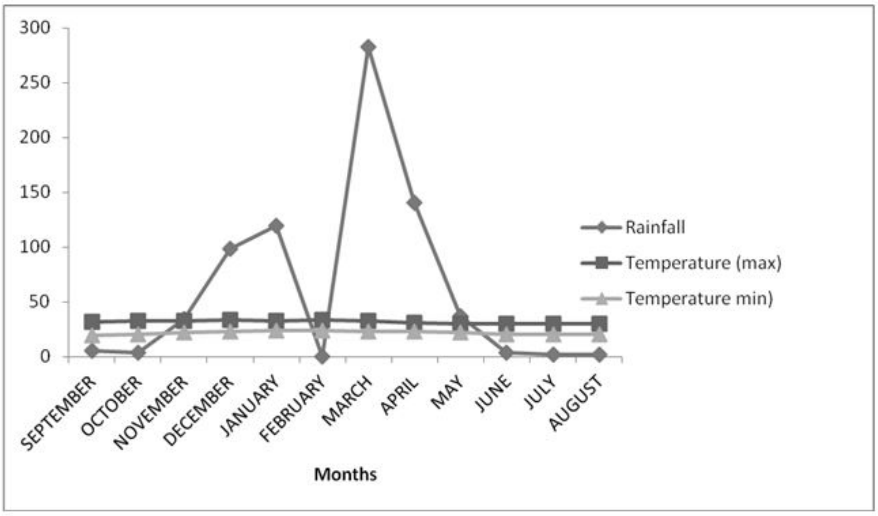

Figure 1: Average annual rainfall (mm) and temperature (0C) distributions in the study area. Source: Sugarcane Research Institute- Kibaha, Coast Region (TMA)

Experimental Layout, Design and Experimentation

The experiment was laid down in a randomized complete block design (RCBD) in the field with a history of weevil infestation to determine the infestation and damage levels as well as yield losses caused by the insect pest on the selected sweetpotato varieties. The test varieties were orange fleshed sweetpotato; Kiegea, Mataya and white fleshed sweetpotato; Simama (SPNO) and Ukerewe. All treatments were replicated three times. The experimental set up was that, planting would be done during the rainy season but maturation be attained with increased drought to promote suitable environment for weevil infestation. Thus, the roots were harvested at the helm of dry seasons after short and long rains respectively. Each experimental plot measured 6.0 m × 6.0 m in size and it was consisted of six ridges each of 1.0 m × 6.0 m in size. The vine cuttings each of 30 cm long with 4 - 6 nodes were planted singly along each ridge at a spacing of 0.6 m × 0.3 m which gave a population of 20 plants per ridge.

Routine Management of Plants in the Experimental Plots

Normal agronomic practices such as weeding, earthing-up and routine guarding were done throughout the growing period as recommended (CIP, 2003).

Data Collection

The collected data includes, the percentage plant establishment which was done two weeks after planting, plant vigour, total number and weight (g) of storage roots harvested per plot, number and weight of large (marketable) and small (non- marketable) (>3mm, <3mm diameter roots size)(CIP, 2003). Others were the vine weight, number of crown (vines) damaged using 1- 4 severity index where 1= no damage; 2= very little damage; 3= moderate damage; 4= severe damage, severity of root damage using a (CIP, 2003) rating scale where 1= 0% no damage; 2= 1- 25%; 3= 26- 50%; 4= 51-75%; 5= ≥ 75% (Stathers et al., 2003). Percentage infestation (number of infested roots per plot divided by the total number of roots harvested multiplied by 100), and percentage yield loss. The measurement of the weights was done by using Mettle Toledo to an accuracy of 0.001 g.

$$Severity\ Index = \frac{(a \times score\ 0) + (a \times score\ 1) + (a \times score\ 2)............+(a \times score\ 5)}{Total\ number\ of\ roots}$$

Where, ‘a’ is the number of roots with a particular score

$$Percentage\ \text{infestation} = \frac{Total\ number\ of\ \text{infested}\ roots}{Total\ number\ of\ harvested\ roots} \times 100$$

Statistical Data Analyses

All data were subjected to Analysis of Variance using GenStat release 10.3DE statistical software. The significant means were separated using both Least Significance Difference (LS-D) and Duncan’s New Multiple Range Test (DNMRT) at 5% error limit. Correlation analysis of yield and Cylas sp. attributes was also determined.

Results

Plant Establishment, Mean Severity Score and Vigour

Generally, all varieties had good rate of establishment with an average of 99.5% and also had an average intermediate vigour of class 3 (Table 1).

Table 1: Plant establishment and vigour of the tested sweetpotato varieties

Variety	Plant establishment	Vigour (average)
Ukerewe (WFSP)	99.4	3.4
Simama (WFSP)	99.6	3.6
Mataya (OFSP)	99.4	3.1
Kiegea (OFSP)	99.7	3.5
Mean	99.5	3.4

*OFSP (Orange Fleshed sweetpotato) & WFSP (White fleshed sweetpotato)

Number and Weight of Harvested Roots and Vine

Obtained results (Table 2) suggested highly significant (p<0.001) differences in the number of harvested roots among the four varieties, whereas the root numbers were 196.4, 174.9, 111.8 for 101.5 varieties Kiegea, Mataya, Ukerewe and Simama, respectively. However, higher root weights were recorded on Mataya and Kiegea varieties with 2.02 ton/Ha and 1.76 ton/Ha respectively. Vines weight among the studied sweetpotato varieties were statistically significant (p<0.05). The highest weight was recorded in variety Simama (1.29 ton/Ha) and Ukerewe (1.16 ton/Ha) than Kiegea (0.67 ton/Ha) and Mataya (0.58 ton/Ha) suggesting an inverse relationship between root weight and vine weight. The highest mean number of marketable roots was recorded on Mataya variety (73.8), whereas the lowest was on Ukerewe (48) and Simama (49). In addition, the highest weight of marketable roots was recorded on Mataya variety (1.39 ton/Ha) while the lowest was from Kiegea variety (1.06 ton/Ha), although the weights for all varieties studied did not differ statistically.

Table 2: Mean number and weights of roots and vines of sweetpotato

Variety	Harvested roots			Marketable roots			Vines	
	Number	Weight (Kg/ plot)	Weight (ton/Ha)	Number	Weight (Kg/plot)	Weight (ton/Ha)	Weight (Kg/plot)	Weight (ton/Ha)
Ukerewe	111.8	5.5113	1.53	48	4.2387	1.18	4.19	1.16
Simama	101.5	5.9776	1.66	49.1	4.6777	1.3	4.646	1.29
Mataya	174.9	7.2833	2.02	73.8	4.9947	1.39	2.1	0.58
Kiegea	196.4	6.328	1.76	63.2	3.8003	1.06	2.412	0.67
LSD(0.05)	33.26***	2.2925n.s		20.54*	1.9618n.s		1.9421*	

Key: F stat: *** = p <0.001 very highly significant; **= p ≤0.01 very significant; *= p ≤0.05 significant; n.s= p >0.05 Not Significant

Infestation with Cylas Sp., and Damaged Sweetpotato Roots and Vines

Results indicated insignificant differences (p> 0.05) in damaged vines among the test varieties but percentage infestation and damaged roots differed significantly (p<0.05) (Table 3). The damages by C. puncticollis was significant (p<0.05) compared to that of C. brunneus. The highest C. puncticollis infestation was recorded in Simama variety (43.53%) while Kiegea variety recorded the lowest (11.46%). However, the percentage infestations with C. puncticollis on varieties Mataya (22.69%) and Ukerewe (25.74%) were statistically indifferent. Despite the generally low infestation of roots with C. bruneus, the variety Simama had the highest infestation (6.24%) while Kiegea had the lowest (2.485%). The weights of the damaged roots in each variety followed the same trend of the number of damaged roots.

Table 3: The mean percentage weevils infestation, damaged roots and vines

Variety	Percentage infestation (incidences)		Damaged roots		Number of damaged vines
	C. puncticollis	C. brunneus	Number	Wt (g)	
Ukerewe	25.74abc	4.698a	33.67ab	1117ab	10.8a
Simama	43.53c	6.247ab	44.67ab	1311abc	24.63a
Mataya	22.69abc	5.279a	43.67ab	1692abc	14.34a
Kiegea	11.46a	2.485a	30.33a	1628abc	24.45a
LSD(0.05)	11.8**	3.5ns	18.80ns	609.2ns	1942.1n.s

Key: F stat: *** = p <0.001 very highly significant; **= p ≤0.01 very significant; *= p ≤0.05 significant; n.s= p >0.05 Not Significant. *The means along the same column bearing similar letter(s) do not differ significantly at 5% level of probability based on Duncan's Multiple Range Test (DMRT)

Yield Losses of Sweetptatoes Associated with Cylas Sp

The percentage of storage roots damaged by C. puncticollis was higher on variety Simama (59.8%) and Mataya (51%) followed by Ukerewe (37.4%) and Kiegea (30.4%) (Table 4). Variety Kiegea (orange fleshed) showed higher levels of resistance than the other three varieties.

Table 4: Percentage yield losses associated with Cylas sp.

Variety	Yield (undamaged roots)		Optimum yield (Damaged +undamaged)		Yield reduction (yield lost to weevils damages)		Percentage yield loss
	Weight (Kg/plot)	Weight (ton/ha)	Weight (Kg/plot)	Weight (ton/Ha)	Weight (Kg/plot)	Weight (ton/Ha)	(%)
Ukerewe	4.017	1.12	6.417	1.78	2.400	0.67	37.4
Simama	3.333	0.93	8.300	2.31	4.967	1.40	59.8
Mataya	6.750	1.88	10.133	2.81	3.383	0.94	51
Kiegea	5.467	1.52	7.850	2.18	2.383	0.66	30.4

Correlation Between Weevils and Root Yield Parameters

The Pearson correlation coefficients for the relationship between root yield and Cylas sp. were as presented (Table 5). The total root weight and C. puncticollis was positively correlated and significant ($p<0.05$).

Table 5: Correlation analysis of root yield, Cylas puncticollis and C. brunneus

Variables	C. brunneus	C. puncticolis	Root weight
C. bruneus	1		
C. puncticollis	0.73**	1	
Yield (weight)	0.06	0.083	1

Key: *** = Correlation is significant at the p< 0.001 level (2-tailed).

Discussion

The sweetpotato weevil species C. puncticollis and C. brunneus occurred in all fields wherever sweetpotatoes were grown as similarly observed by [4]. The mean severity and vine (crown) infestation were not considered as an important factor in yield reduction. This is because some severely weevil damaged vines (crown) were thicker indicating that adventitious growth roots had replaced the damaged tissues allowing the plant to recover and develop properly. Weevil infestation caused significant reduction in yield of all the studied sweetpotato varieties as similarly reported by Talekar (1982). The findings of this study indicated that yield losses were as high as 59.8% re-affirming the significance of sweetpotato weevils in reducing sweetpotato root yield. Nevertheless, OFSP were less infested with weevils compared to WFSP varieties suggesting that sweetpotato flesh colour could have a role to play on weevil's preferences. Similar observation was reported by [12] that orange fleshed cultivars displayed higher levels of resistance to weevils compared to white fleshed varieties.

The impact of the weevil, C. puncticollis was significantly high across the varieties as opposed to C. brunneus since the latter did not exert destructive effects on the sweetpotato roots. Suggestively C. puncticollis caused more damage to the harvested sweetpotato roots than C. brunneus. [16] reported similar findings that C. puncticollis is the most serious pest in drier agro-ecological zones. As reported by the present study established significant differences among sweetpotato varieties in terms of damages sustained from weevils [16] likewise reported that most of the sweetpotato varieties grown in Tanzania are susceptible to weevil infestation but the infestation level differs significantly. The consistency in responses of tested varieties to the two weevil's species during the two consecutive seasons of experimentation ascertained the reality that C. puncticollis is more aggressive and responsible for sweetpotato root damages than C. brunneus. Similar observation was reported by [17] and [13] that root tuber characteristics influenced the severity of the damage caused by C. puncticollis.

There was no obvious relationship established between weights of root yield and Cylas sp. despite the positive correlation recorded. [18] similarly reported positive correlations between sweetpotato tuber yields and multi-environmental factors but not weevils. A significantly positive correlation was obtained between the two weevil species suggesting that environmental conditions that favours C. puncticollis establishment also supports C. brunneus.

Conclusion

The orange fleshed varieties Mataya and Kiegea yielded better but were less susceptible to C. puncticollis than the varieties Ukerewe and Simama. However, the level of yield losses varied with the variety and with the percentage of infestation by the weevils. Furthermore, losses in yields among sweetpotato varieties also depends on the species of the weevil infested the tubers.

Acknowledgements

The Ministry of Agriculture is highly acknowledged for funding this study. We are also gratefully to Kibaha Sugarcane Research Institute authority for allocation us the land to conduct the experiments. Their technical support and provision of planting materials used in this study was resourceful.

References

1. Ebregt EP, C Struik, PE Abidin, B Odongo (2005) Pests damage in Sweetpotato, Groundnut and Maize in North-Eastern Uganda with special reference to damage by millipedes (Diplopoda), NJAS-Wageningen. Journal of Life Sciences 53: 49-69.

2. Temu A, Nyange D, Kolijn S, Mtunda K, Mukasa SB et al. (2003) Sequence variability within the 3„-proximal part of the sweet potato mild mottle virus genome. Archives of Virology 148: 487-96.

3. Mwanga ROM, Ocitti p'Obwoya C, Odongo B, Turyamureeba GM (2001) Sweet potatoes (Ipomoea batatas (L.) Lam.). In: Mukiibi, J.K. (Ed.), Agriculture in Uganda. Vol. II Crops. National Agricultural Research Organisation (NARO) and Technical Centre for Agricultural and Rural Cooperation (CTA). Fountain, Kampala 233-51.

4. Shonga E, Gemu M, Tadesse T, Urage E (2013) Review of entomological research on sweetpotato in Ethiopia. Discourse Journal of Agriculture and Food Sciences 1: 83-92.

5. Nderitu J, Silai M, Nyamasyo G, Kasina M (2009) Insect species associated with sweet potatoes (Ipomoea batatas (L.) Lam), in Eastern Kenya. International Journal of Sustainable Crop Production 4: 14-8.

6. Stathers T, Namanda S, Mwanga ROM, Khisa G, Kapinga R (2005) Manual for sweetpotato Integrated Production and Pest Management Farmer Field Schools in sub-Saharan Africa.

7. Stathers TE, Rees D, Kabi S, Mbilinyi L, Smit N et al. (2003) Sweetpotato infestation by Cylas spp. in East Africa: I. Cultivar differences in field infestation and the role of plant factors. International Journal of Pest Management 49: 131-40.

8. Mullen MA (1984) Influence of sweetpotato weevil infestation on the yields of twelve sweetpotato lines. Journal of Agriculture and Entomology 1: 227-30.

9. Mullen MA, Jones A, Arbogast RT, Paterson DR, Boswell TE (1981) Resistance of sweet potato lines to infestations of sweetpotato weevil, Cylas formicarius Efegantulus. (Summers). Horticultural Science 16: 539-40.

10. Mullen MA, Jones A, Paterson DR, Boswell TE (1985) Resistance in sweet potatoes to the sweetpotato weevil, Cylas formicarius Elegantulus (Summers). Journal of Entomological Science 20: 345-50.

11. Chalfant RB, Jansson RK, Seal DR, Schalk JM (1990) Ecology and management of sweet potato insects. Annual Review of Entomology 35: 157-80.

12. Pinese B (2001) 'Final Report VG98002: Developing strategies to control sweetpotato weevil.' Queensland Department of Primary Industries and Fisheries, HAL Project number. VG98002.

13. Talekar NS (1982) Effects of sweet-potato weevil (Coleoptera: Curculionidae) infestation on sweet potato root yields. Journal of Economic Entomology 75: 1042-44.

14. Pillai KS, Nair SG (1981) Field performances of borne pre-released sweetpotato hybrids to weevil incidence. Journal of Root Crops 7: 37-39.

15. Pillai KS, Lal SS, Palaniswami MS (1981) Evaluation of newer insecticides and soil amendments for the control of sweet potato weevil, Cylas formicarius Fabricius. Entomology 6: 69-72.

16. Rees D, Farrell G, Orchard J (2012) Crop Post-Harvest: Science and Technology, First Ed. Blackwell Publishing Ltd 406-7.

17. Mansaray A, Sundufu AJ, Yilla K, Fomba SN (2013) Evaluation of cultural control practices in the management of sweetpotato weevil (Cylas puncticollis) Boheman (Colepotera: Curculionidae), QScience Connect 44.

18. Hartemink AE (2003) Sweet potato yield and nutrient dynamics after short term fallows in the humid lowlands of Papua new Guinea. NJAS 50: 297-319.

19. Ebregt E, Struik PC, Abidin PE, Odongo B (2004) Farmers information on sweetpotato production and millipede infestation in north-eastern Uganda. II. Pest incidence and indigenous control strategies. NJAS-Wageningen. Journal of Life Science 52: 69-84.

20. Ebregt E, Struik PC, Abidin PE, Odongo B (2007) Feeding activity of the East-African millipede Omopyge sudanica

Kraus on different crop products in laboratory experiments. NJAS – Wageningen Journal of Life Sciences 54: 313-23.

21. FAOSTAT (2012) Statistical Database (online).