Journal of Pure and Applied Agriculture (2023) 8(1): 8-15
ISSN (Print) 2617-8672, ISSN (Online) 2617-8680
http://jpaa.aiou.edu.pk/

Response of improved Sweetpotato varieties to weevils, *Cylas* species infestation in Coastal Tanzania

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Abstract

Field experiments were 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 yield of selected improved varieties; Ukerewe, Simama, Mataya and Kiegea. Experiments were laid out in randomised complete block design (RCBD) with sweetpotato varieties as treatments. About 30cm long sweetpotato vines were collected from a three-month aged crop maintained as nursery in screen-house. 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 ton/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, suggesting that weevils exert significant impacts on sweetpotato yield in costal Tanzaniathus, the need to prioritize the management of the pest whenever the crop is grown. Orange fleshed varieties are likely to increase sweetpotato production through increased yield per unit area. Therefore, they should be complemented with other management practices that have been shown to reduce weevil damage.

Keywords: *Cylas* spp, Infestation, Orange-fleshed, Sweetpotato, Tanzania, Varieties, Weevils

To cite this article: Rwegasira, G. M. (2023). Response of improved Sweetpotato varieties to weevils, *Cylas* species infestation in Coastal Tanzania. *Journal of Pure and Applied Agriculture, 8*(1), 8-15.

Introduction

Sweetpotato (*Ipomoea batatas* (L.) Lam) is the 7th most important root crop worldwide and the 5th most produced in east Africa (Temu et al., 2003; Ebregt et al., 2004). It is a source of dietary of most carbohydrates, vitamins, minerals, and proteins and used for subsistence by poor-resource farmers in developing countries. According to sources, sweet potatoes provide carbohydrates, vitamins, fibre, and minerals (USDA, 2015). It provides palatable nutritional and physiological advantages, including anti-inflammatory, anti-microbial, hypoglycaemic, hypocholesterolemic, and immunomodulatory effects (Chandrasekara & Kumar, 2016). Sweetpotato is one of the crops that farmers can grow to gain monetary income as agriculture becomes increasingly market oriented (Best et al., 2006). 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 (Masumba et al., 2007; Ndunguru & Kapinga, 2007). 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 1400000 tons whereas those of Uganda and Nigeria were 2883408 tons and 2883408 tons, respectively. However, by comparing its production for the period of 4 years from 2006 when the production in Tanzania was 1396400 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 (Mwanga, 2001). 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 (Huang & Sun, 2000). In sub-Saharan Africa, sweetpotato is produced annually on over 53 thousand hectares of land with total production over 4240 t and the average productivity is 8 t ha^{-1} (Shonga et al., 2013). However, a study conducted by Tewe et al. (2003) 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 (Mukasa et al., 2003; Ebregt et al., 2005; Nderitu et al., 2009). Ebregt et al. (2007) and Mwanga *et al.* (2001) 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 Ebregt et al. (2007), the population densities of the insect pests can build-up during the plant's growing season. In addition, weevils are reportedly more abundant and injurious during the dry season than the rainy season (Mwanga et al., 2001). Soil cracking induced by dry and hot conditions promotes new infestation and fast development of the weevil through exposure of the storage roots to the weevils. Nevertheless, Nderitu et al. (2009) reported that vines are often susceptible to sweetpotato weevils from planting onwards if 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 (Ebregt et al., 2007).

Sweetpotato weevils (*Cylas* sp.) are the cosmopolitan insects and most serious insect pests of sweetpotato reported worldwide (Mwanga et al., 2001). In response to weevil feeding, sweetpotato storage roots produce bitter tasting and toxic sesqui-terpenes that render them unfit for human consumption. According to Stathers et al. (2005), 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 Mullen (1984) on the effects of the sweetpotato infestation with 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 Mullen (1984), 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 (Chalfant et al., 1990; Mullen et al., 1985; Shonga et al., 2013).

Host plant resistance has been adopted for appreciably long as one of the strategies in the management of this *C. puncticollis*. However, progress in breeding of sweetpotato varieties with resistance to *C. puncticollis* and *C. brunneus* that is of dynamic rather than escape has been slow (Stather et al., 2003). The often-regarded resistance to the pests in some varieties is largely due to escape and other parameters but not pure resistance. Although moderate levels of resistance of sweetpotato varieties to infestation of the sweetpotato weevils particularly the *Cylas* sp. have been demonstrated in most studies (Ebregt, et al., 2007; Mwanga et al., 2001; Mullen, 1984), there has never existed a complete immunity. Lack of heritable resistance in the sweetpotato germplasm in particularly East Africa has compounded the limited breakthrough in breeding for resistance against sweetpotato weevils. The scarcity of varieties with significant level of resistance in Africa has almost been a mainstay (Stather et al., 2003 a&b; Mansaray et al., 2015).

Recent reports in Tanzania indicated progress in collective breeding for sweet potato with improved agronomic qualities which were subsequently released for farmers' adoption. Many of these sweetpotato varieties released and made available to farmers have their levels of resistance to the sweepotato weevil as well as a wide range of other insect pests not been comprehensively studied. Little has been done to examine the effect of sweetpotato weevil infestation on yield losses. Talekar (1982) observed that the effects of weevil infestation on yield were minimal for C. *formicarius* (Fabricius) in Taiwan. However, Pillai & Nair (1981) reported yield losses of 10 to 100% due to weevils. Pillai et al. (1981) reported losses of 35 - 70% depending on the season. Mullen et al. (1981) found that severe crown damage, especially in varieties like Centennial, resulted in significant reductions in yield. Mullen et al. (1985) 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 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 (Masumba et al., 2007). The area received an average annual rainfall of 728.5 mm characterized by erratic distribution a weak bi-modal pattern.

Experimental design and layout

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 selected from among improved and farmers' preferred varieties which 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 was 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 the top of each ridge at a spacing of 0.6 m × 0.3 m which gave a population of 20 plants per ridge.

Routine management of the experimental plots

Normal agronomic practices such as gap filling, weeding during the first six weeks, earthing-up when root formation started (two months after planting) that triggered cracking of soils and routine guarding were done throughout the growing period as recommended (CIP, 2003). To avoid disturbance to root formation weeding was done using hand hoe. Neither fertilizer nor manure was added given the fact that prior soil analysis had indicated no acute deficiency of nutritive elements. Moreover, sweetpotato is known to tolerate low soil fertility and yield fairly well even on marginal lands (Ndunguru & Kapinga, 2007).

Data collection

The data on crop establishment and pest infestation were collected with reference to the specific objectives of the experiment. Collected data included, the percentage plant establishment (Number of available vines/Total number of planted vines) multiplied to 100, 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.

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

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

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

$$Yield\ loss\ (\%) = \frac{Total\ (optimum)\ Yield - Obtained\ yield}{Total\ (optimum)\ yield}\ x\ 100$$

Statistical analysis

All data were subjected to Analysis of Variance using GenStat release 10.3DE statistical software. The mean separation test was done by using both Least Significance Difference (LSD) and Duncan’s New Multiple Range Test (DNMRT) at 5% error limit (P < 0.005). Correlation analysis of yield and *Cylas* sp. attributes was also determined to establish influence of test parameters on each other.

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 which is regarded very good at 3-4 weeks after planting (Table 1). The recorded mean plant establishment of more than 99.5 suggest that almost all planted vines managed to sprout well. Thus, the planted vines were of good health quality and the soil moisture content was appropriate for planting the crop.

Table 1 Plant establishment and vigour of the tested sweetpotato varieties

Variety	Plant establishment (%)	Vigour score (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 tons/Ha respectively which are both orange fleshed. Suggestively, orange fleshed variety performed better in the respective environment compared to the white fleshed varieties. 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) compared to 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 of all studied varieties did not differ significantly (p < 0.05).

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

Variety	Harvested roots			Marketable roots			Vines	
	Mean number per plot	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	4.190	1.16
Simama	101.5	5.9776	1.66	49.1	4.6777	1.30	4.646	1.29
Mataya	174.9	7.2833	2.02	73.8	4.9947	1.39	2.100	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*	

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 damages to sweetpotato roots and vines

The results indicated that most of infested sweetpotato roots and vines endured significant damages. There was insignificant differences (p > 0.05) in the number of damaged vines among the test varieties but percentage infestation with weevils as well as number and weight of damaged roots differed significantly (p<0.05) (Table 3). The percentage infestation with *C. puncticollis* was significantly different (p<0.05) while insignificant (p > 0.05) for *C. brunneus*. The highest infestation with *C. puncticollis* was recorded in Simama variety (43.53%) while Kiegea variety recorded the lowest (11.46%). Nevertheless, the percentage infestations with *C. puncticollis* on varieties Mataya (22.69%) and Ukerewe (25.74%) were statistically indifferent (p > 0.05). Despite the generally low infestation of roots with *C. brunneus*, 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. Generally the roots of all test varieties were equally damaged and the differences in recorded numbers and weight of roots were statistically insignificant. The number of damaged vines was likewise insignificantly different suggesting that the tested varieties equally succumbed to the weevils.

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	25.74[abc]	4.698[a]	33.67[ab]	1117[ab]	10.8[a]
Simama	43.53[c]	6.247[ab]	44.67[ab]	1311[abc]	24.63[a]
Mataya	22.69[abc]	5.279[a]	43.67[ab]	1692[abc]	14.34[a]
Kiegea	11.46[a]	2.485[a]	30.33[a]	1628[abc]	24.45[a]
LSD(0.05)	11.8**	3.5ns	18.80ns	609.2ns	1942.1n.s

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)

Sweetpotato yield losses associated with *Cylas sp.*

The obtained root yield was segregated into weight of damaged and undamaged roots from which the percentage yield loss was estimated (Table 4). The varieties Simama and Mataya sustained greatest yield losses compared to the rest of varieties. Kiegea had the lowest yield loss with statistical similarity to Ukerewe. The highest yield loss (59.8%) was recorded in Simama variety while the lowest was in Kiegea (30.4%). Likewise, Simama produced the lowest number of undamaged roots (0.93 ton/ha). The losses were mainly attributed to weevils' infestation as related to the root-setting trend of the test varieties. Despite being highly infested with *C. puncticollis* and subsequently damaged, the variety Mataya had the highest yield considering both the undamaged roots (1.88 ton/ha) and the combined total yield of damaged and undamaged root (2.81 ton/ha). The variety Simama is known to set roots on shallower soils while Kiegea tend to set roots deeper in the soil. The general assessment suggests that Mataya was the best performing variety in terms of the yield despite the greatest loss sustained. As such, in areas not infested with *C. puncticollis*, the variety would make the best choice for growers. On the other hand, the variety Kiegea could also make the best choice to nutritionally sensitive farmers growing the crop in the weevils' endemic areas due to its being an orange fleshed variety with the lowest percentage yield loss (30.4%). Considering the nature of the test varieties the obtained results indicate that they were equally infested and damaged regardless of whether were orange fleshed or white fleshed as evidenced by Mataya and Simama that equally endured statistically similar yield reduction levels.

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[b]	1.12[a]	6.417[a]	1.78[a]	2.400[a]	0.67[a]	37.4[a]
Simama	3.333[a]	0.93[a]	8.300[c]	2.31[ab]	4.967[c]	1.40[b]	59.8[b]
Mataya	6.750[d]	1.88[b]	10.133[d]	2.81[b]	3.383[b]	0.94[ab]	51.0[b]
Kiegea	5.467[c]	1.52[ab]	7.850[b]	2.18[ab]	2.383[a]	0.66[a]	30.4[a]

Means along the same column bearing similar letter(s) do not differ significantly at (P< 0.05) as per Duncan's Multiple Range Test (DMRT)

Correlation between weevils and root yield parameters

The Pearson correlation coefficients for the relationship between root yield and *Cylas sp.* are presented (Table 5). The total root weight and *C. puncticollis* was insignificant (p > 0.05) and positively correlated. The weevil species, *C. brunneus* and *C. puncticollis* significantly (p <0.01) influenced each other suggesting that the ecological parameters influencing the occurrence and perpetuation of both species are similar.

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

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

*Key: *** = Correlation is significant at the p< 0.001 level* (*2-tailed*) & *** = Correlation is significant at the p< 0.01 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 Shonga et al. (2013). Mansaray et al. (2015) reported of the almost similar infestation levels of the tested varieties with *C. puncticollis* and *C. brunneus.* Suggestively, almost all sweetpotato varieties succumb to weevils' infestation regardless of the varieties. As previously reported (Ebregt et al., 2007; Mwanga et al., 2001; Mullen, 1984) the resistance often observed in some sweetpotato varieties could mainly be an escape phenomenon rather than the inherent resistance against the pests (Stathers et al., 2005). 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 of roots had replaced the damaged tissues allowing the plant to recover and develop properly. This could be an important character to observe in breeding for resistance that varieties with strong development of adventitious roots strives to recover and overcome the effect of crown damage thereby minimizing the weevils' impacts on plants by crown damage.

Weevil infestation caused significant reduction in yield of all the studied sweetpotato varieties as similarly reported by Talekar (1982); Mansaray et al. (2015). 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. However, some varieties like Kiegea proved that not all sweetpotato succumbs highly to sweetpotato weevils' infestations and subsequent damages. Interestingly, the Kiegea is an orange fleshed (OFSP) variety suggesting the possibility of offering multiple benefits to growers including the high yield, low susceptibility to weevils and precursor for vitamin A an important nutritional element for repair and reinforcement of sights in human. The fact that another OFSP variety, Mataya succumbed to weevils at equal rate to Simama, the white fleshed variety (WFSP) enduring similar yield losses suggests that sweetpotato varieties succumbs equally to the weevils and flesh colour has limited influence on the resistance to the pests. Similar observation has been reported (Ehisianya et al., 2012). The present observations are in contrast to Pinese (2001) who reported that orange fleshed cultivars displayed higher levels of resistance to weevils compared to white fleshed varieties. Thus, sweetpotato flesh colour neither plays a role on weevil's preferences of the variety nor the variety's resistance to weevils.

Although the observed low infestation of Kiegea and Ukerewe varieties with *C. puncticollis* and *C. brunneus* is largely assumed and attributed to deeper root system, the possible composition of the hydroxycinnamic acid esters in the root latex by the variety cannot be totally ignored. Stevenson et al. (2009) found hydroxycinnamic acid esters in the root latex of sweet potatoes that are resistant to sweetpotato weevils, which may indicate that the chemicals have a deterrent effect on weevil infestation. Additional research demonstrated that these chemicals prevented SPW larvae from growing, and it was hypothesised that variations in the concentration of these compounds could account for variations in resistance. According to definitions, hydroxycinnamic acids are a significant class of phenolic acids that are frequently found in the plant kingdom and have bioactive capabilities (Levin et al., 2010). They are created to provide protection from biotic and abiotic stressors (Heleno et al., 2015). The metabolic process that produces lignin, a polymeric substance that supports the mechanical integrity of the plant cell wall, also produces hydroxycinnamic acids (Xu et al., 2009). Similar effects of the compounds were observed by other researchers in the United States of America (Snook et al., 1994; Data et al., 1996). They claimed that hydroxycinnamic acid esters were likewise connected to sweet potato genotypes' resistance to C. formicarius, and they concluded that these elements might offer globally applicable qualities to impart resistance to all significant Cylas species. As such, different varieties would respond differently to weevils' infestation depending on the concentration of the phenolic compounds. Similar observation was reported by Talekar (1982); Mansaray et al. (2013) that root tuber characteristics influenced the severity of the damage caused by *C. puncticollis*.

The impact of the *C. puncticollis* was significantly high across the varieties as opposed to *C. brunneus* since the latter did not exert much destructive effects on the sweetpotato roots. Suggestively *C. puncticollis* caused more damage to the harvested sweetpotato roots than *C. brunneus.* Rees et al. (2012) reported similar findings that *C. puncticollis* is the most serious pest in drier agro-ecological zones. As reported by Masumba et al. (2007) the present study established significant differences among sweetpotato varieties in terms of damages sustained from weevils. Likewise, Rees et al. (2012) 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*.

There was no obvious relationship established between weights of root yield and *Cylas sp*. despite the positive correlation recorded. Hartemink (2003) 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

Root flesh colour had no influence on the susceptibility of the tested varieties to the sweetpotato weevils. The response to the pest attack was more associated with rooting characteristics and possible compositions of the Hydroxycinnamic acids which has been indicated to confer resistance to sweetpotato weevils, the suspicion that remain to be proven in future studies. Orange fleshed varieties (Mataya and Kiegea) yielded relatively better than the white fleshed varieties (Ukerewe and Simama). The level of yield losses varied with respect to the varieties and the percentage of infestation by the weevils. The magnitude of sustained yields losses among sweetpotato varieties depends on the weevil species that infest the tubers as *C. puncticollis* was observed to cause more damages compared to *C. brunneus*.

Acknowledgement: This research was funded through author's own funding. I am gratefully to TARI-Kibaha authority for allowing the conduct the experiments on their land as well as the provision of planting materials which was used in this study.

Conflict of interest: The author has no conflict of interest of any form and do declare no compromise between and among any other parties.

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