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Distribution and Incidence of *Cylas puncticollis* in Sweet potato and their Economic Losses in Small Holder Farming Systems of Gairo District, Tanzania

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Abstract

This study assessed the incidences, distributions and yield losses in sweet potatoes (*Ipomoea batatas* (L.) Lam) associated with *Cylas puncticollis* in small holder farming systems of Gairo District, Tanzania. This was accelerated by the fact that small holder farmers produce sweet potatoes in areas with high risks of sweet potato weevils. At the farmer's fields, plots measured 5m × 5m in each replicate, sweet potatoes were harvested and assessments were done on the variables such as number of weevils, species, roots infested by *Cylas* and areas infested (above-below ground). Two sweet potato varieties namely Morogoro and Shangazi in Mtumbatu village were involved. Results indicated that the number of weevils and their species were more in vines than in roots but serious damage was observed in roots. These were also more prevalent in variety Morogoro compared to variety Shangazi. The mean number of undamaged sweet potato was significantly (P<0.001) higher in Shangazi variety (54.7) compared to Morogoro variety (43.3). In addition, economic losses of marketable roots were highly caused by *Cylas* infestations (USD 306) in variety Morogoro and breaking (USD 425), cutting (282.5) and rotting (USD 67.5) in variety Shangazi. It was concluded that variety Morogoro is more susceptible to economic losses caused by *Cylas* infestations compared to variety Shangazi. Therefore, variety Morogoro should be harvested as early as it reaches maximum maturity and where possible farmers in Gairo District and similar areas should invest more on variety Shangazi.

Keywords: *Economic losses; Sweet potatoes; Weevils*

Introduction

Sweet potato is an important food and vegetable crop grown for edible roots and leaves [1,2]. The crop is a source of energy supplying sugars as well as other carbohydrates, calcium, iron and some minerals [3]. According to Njoku [4], the high nutritive value and performance of this crop under resource-poor climatic conditions make it the best choice to the subsistence farmers and for their households.

The extent of world's production of sweet potato is still questionable because of its slow pace in most regions, Africa inclusive. According to FAOSTAT [5], 115 countries in the world produced 108,274,685 tons of sweet potato in 2010 and China was the largest producer (82,474,410 tons) followed by Indonesia (2,083,623 tons). Also Uwah., *et al*. [6] reported that worldwide far behind, but ranked second after Asia, was Africa which contributed to 14% of global production and yield stood at 14,441,099 tons in the same year 2010. Tanzania ranked third (1,400,000 tons) after Uganda (2,838,800 tons) and Nigeria (2,883,408 tons); and Tanzania was almost half below the first two countries in Africa. This indicates a trend that the rate at which sweet potato is produced in Tanzania is very insignificantly increasing which is only 0.26% since 2006 in which the production was 1,396,400 tons [5].

The potential land yield of sweet potato can be 40 to 50 t ha^{-1} or sometime a bit less for high dry matter indigenous landraces. Despite the importance of sweet potato for multi-applications, its production potential has not been realized in most developing countries, in which Tanzania is also inclusive. Oswald., *et al*. [7] reported that the average yields of root crops are low, ranging from 3 to 6 t ha^{-1} if water supply is a limiting factor or 10 to 12 t ha^{-1} where natural soil fertility and rainfall are adequate. The most reported constraints alarming to sweet potato production include poor soil fertility, lack of improved varieties, insect pests, diseases, erratic climatic conditions, and agronomic practices [8]. Huang and Sun [9] reported that sweet potato yields in east African countries are very low ranging between 1.6 and 9.7 t ha^{-1}. The performance of the crop is also determined soil reaction in which it is reported to thrive at a soil pH of 4.5 to 7.5, but 5.8 to 6.2 is optimal [10]. Other factors reported include fluctuating seasonal rains and their unreliability, erratic soil temperature regimes, and limited diversified processing and utilizations options of the crop [11,12].

Sweet potato weevil (*Cylas formicarius* (Fabricius) (Coleoptera: Brentidae)) is the major pest constraining sweet potato production in tropics and subtropics. It is reported to cause losses ranging from five to 97% in areas where it infests [13]. Ebregt., *et al*. [14] reported that smallholder farmers consider that the sweet potato weevils (*Cylas brunneus and C. puncticollis*) and the caterpillars of the sweet potato butterfly (*Acraea acerata*) are the main culprits. Studies have also revealed a positive relationship between vine damage or weevil density, and the root damage by the weevil [15]. However, the plants exhibited some compensatory ability, with the relationship between vine damage and yield non-linear, and sometimes not significant. Powell., *et al.* [16] reported that the incidence of sweet potato weevils is related to the type of cultivar, soil characteristics and rainfall patterns.

Studies have shown that the intensity of infestation and severity of damage of sweet potato caused by weevils varied significantly with application levels of NPK fertilizer [17]. However, a study conducted by Powell., *et al*. [16] indicated that an application of N and K at rates from 0 to 150 kg ha^{-1} and 0 to 50 kg ha^{-1}, respectively, did not significantly obstruct incidence of sweet potato weevils and the severity of damage they caused. Similar authors found that use of fallow vegetation using *Imperata cylindrica, Piper aduncum or Gliricidia sepium* on sweet potato fields had no significant effect on sweet potato weevil incidence and damage to tubers. Significant effect of fertilizer application on the infestation of weevils and severity of damage to sweet potato is often realized during the first cropping. There has been a controversy on the soil properties suitable for sweet potato production, and the possible fertilizer combinations and rates appropriate for the optimum yield of this crop when grown on impoverished soils [6,18]. For instance, Onunka., *et al*. [19] confirmed that yields of sweet potato are restricted by many factors among which are low soil fertility, varietal selection, planting date, weather condition, soil type, weed, insect and disease pressure, and crop management practices.

In East Africa, sweet potato plays an important role in the diet and food security of the population indicated by the high per capita consumption [8]. However, sweet potato yields in the region are very low (1.6-9.7 t/ha) compared to yields of 24, 26, and 32 t/ha for Japan, the Cook Islands, and Israel, respectively [9]. Major constraints to increased sweet potato productivity in East Africa include sweet potato weevils (*Cylas puncticollis* and *C. brunneus*), viruses (mainly sweet potato virus disease), *Alternaria* stem blight, poor yielding varieties of low nutritive value (low or no ß-carotene), shortage of high quality planting materials, marketing problems [8], and limited range of processing and utilization options, leading to high postharvest losses, estimated between 30-35% [12].

Gairo district produces many varieties of sweet potatoes such as *Kasimama*, NASPOT1, Morogoro, Shangazi, Ejumula and Kakamega [20]. Damage of these varieties by weevils is more severe under dry conditions and production losses of 60 to 97% have been recorded during both the growth season and in storage [11]. Weevil damage results mainly from their larvae which feed within tuberous roots. Furthermore, in response to the weevil feeding, plants produce unpalatable terpenoids that render tubers unfit for consumption [21]. Although a few varieties including Morogoro and Shangazi have been reported to be endemic, several other new varieties have been recently introduced through a Sweet potato Project based at the Sokoine University of Agriculture. However, the response of all these varieties to the infestation of sweet potato weevils in Gairo District is not yet known. Research findings on sweet potato weevils in Gairo District are scarce, inconsistent and very little is known about this pest. Despite the potential of sweet potato for food and income in Gairo District, there exists no reliable information in Tanzania on the effect of agronomic practices on the infestation and severity of sweet potato weevils. Therefore, this study was designed to respond to such arguments and beyond those, which might have received different debated responses. This study also explored the status of sweet potato weevils in Gairo District and recommended the appropriate measures to be taken against the potential spread and damage caused by the pest. Therefore, the specific guidelines of this study were to: (i) assess the distribution and incidence of sweet potato weevils in the district, (ii) identify the species of sweet potato weevils that prevail in the district. Others were to: (iii) assess the damage levels associated with sweet potato weevils in the grown varieties under natural infestation, and (iv) compare foliar and root damage levels at harvest with respect to sweet potato varieties.

Materials and Methods

Description of the Study Area

The study was conducted in Mtumbatu, Magubike, Kiegea, and Kidete villages in Gairo District, Morogoro region located at $06^0$08`34`` S and $36^0$52`10`` E. The area is predominated by a prolonged typical dry spell with short rains and an average annual rainfall ranges from 500 to 800mm. The district is a hill (class T-Hypsographic) in located at an elevation ranging between 1230 and 1370m above sea level (masl) and the maximum temperature is about 22^0C [20]. The soils have been classified as *Haplic Lixisols* with an organic carbon content of 0.24-0.84% and a sandy loam to sandy clayey soil to the 120cm depth and the pH ranges between 5.47 and 5.88 [22]. The district's semi-arid climate is dominated by a unimodal distribution of rainfall, which starts in November and heavy rains continue in January. In February, there is usually a dry spell of three to four weeks which is followed by heavy rains in May and less intense rains in April. The long-term average of annual precipitation is 499 mm with erratic and poorly distributed rainfall [23]. The mean annual temperature ranges between 18 and 28°C [24]. Because of its semi-arid climatic conditions, Gairo District is disadvantaged in terms of food production, relying largely on sweet potatoes, cassava and sorghum and short season maize variety Tanzania Maize Variety-1 (TMV-1).

Research Design and Experiment

A cross-sectional research design was used in this study and the target groups were all smallholder farmers growing sweet potato in Gairo District. The focus village was Mtumbatu, which was obtained from the initially identified 4 villages namely Mtumbatu, Magubike, Kiegea, and Kidete. The choice of this village was purposive because of its high production potential of sweet potato although farmers have continuously experienced low yields. The study was based on the modification of technique described by Sefasi., *et al*. [21] with one factor variety: (1) Morogoro, (2) Shangazi. Three (3) hamlets were randomly selected from the village and in each hamlet 3 fields were considered for each variety hence 6 fields for two varieties hence making total of 18 farmers' fields.

Data Collection

In each farmer's field a plot measured 5m × 5m was demarcated and sweet potatoes vines were assessed and then harvested and assessed for number of weevils, species, roots infested by *Cylas* and areas infested (above or below ground).

Data on sweet potato weevil distribution and incidence

In each farmer's field and variety, the populations of adult sweet potato weevils were counted within-foliage at harvest. In addition, vines were randomly selected in the field, slashed to within 15 cm of the root crown and removed from the field. A few plants were randomly selected and dug manually, removed from the field and the remaining vine sections were cut and placed in paper bags. The number of vines damaged and undamaged, and vine weights were recorded. Vines were dissected to assess the damage as it was indicated by the presence of feeding marks and weevil life-stages.

Marketable tubers were subdivided by external appearance of the outer periderm as either damaged (presence of feeding and/or ovipositor marks) or undamaged (no marks). The damaged marketable tubers were sliced at the zone of maximum surface damage and categorized using the visual damage rating scale of Ndunguru., *et al*. [25]. The scoring of the level of damage was such that: 1 = 0%, 2 = 1–25%, 3 = 26–50%, 4 = 51–75% and 5 = 76–100% but after each assessment the roots with 4 and 5 scores were discarded. The underground incidence of weevils was then determined in damaged roots whereby the damaged roots were sliced into 3 mm sections to count the weevil's life stages. In addition, the species of weevils above-and-below ground in each variety, and farmer's fields were identified by the use of Dichotomous Keys as described by Marvaldi and Lanteri [26].

Data on quantity and economic loss of roots as damage of sweet potato weevil

Sweet potato roots were harvested and data recorded prior to any form of sorting by farmers and/or buyers. The roots were sorted into two different categories namely: The 1st category – this was classified into: (i) undamaged roots (absence of feeding marks); (ii) roots with superficial damage (scuffing) only; (iii) roots with serious damage (presence of feeding and/or ovipositon marks). The 2nd category - this was classified as: (i) broken roots; (ii) cut roots; (iii) weevils infected or rotten roots. In addition, the roots which were found to suffer from more than one form of damage were classified based on the most obvious form of damage. In case of any root rotting, the rotting was scored on the extent observed on the external surface: 1 = 0%; 2 = 1–25%; 3 = 26–50%; 4 = 51–75%; 5 = 76–100% as described by Rees., *et al*. [20]. The severity index (SI) was calculated using the formula:

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

Where, 'a' is the number of roots with a particular score

In addition, the data related to percentage infestation was computed using the formula:

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

Figure 1a: *Cylas punchocollis destroyed sweetpotato.*

Figure 1b: *A striped weevil (Alcidodes dentipes).*

Figure 2: *Harvesting (a), grade 1 sweetpotato (b), grade 2 sweetpotato (c), and transporting of sweetpotato (d). These photos were taken during data collection in May 2015.*

Data Analysis

The data were subjected to one sample test analysis design. Furthermore, Likelihood was used to determine association effects of varieties on weevil's incidence and abundance and their contribution to the loss of sweet potato roots in terms of quantities and quality. All statistics were performed using GenStat Computer Software [27].

Results

Distribution and incidence of the sweet potato weevils

Results indicated that there where various heterogeneity on differences of the distribution and the incidence of sweet potato weevils in the studied varieties studied in Gairo district (Table 1).

Variety	Fields	Distribution above ground (Vine)		Distribution below ground (roots)	
		Number of weevils	Species of weevils	Number of weevils	Species of weevils
Morogoro	1	6	2	3	1
Morogoro	2	9	1	6	1
Morogoro	3	21	1	12	1
Mean		12	1.33	7.0	1
Shangazi	1	6	2	2	1
Shangazi	2	3	2	2	1
Shangazi	3	3	1	2	1
Mean		4.0	1.67	3.0	1

Table 1: *Distribution and incidence of sweet potato weevil in Morogoro and Shangazi varieties.*

Variables	Size	Mean difference	Var. (σ^2)	Std. dev. (σ)	Std error.	95% CI for mean	Test "t" stat. (5 d.f)	*P-value*
Weevils per vine	6.00	8.0*	45.6	6.753	2.757	(0.91, 15.09)	2.90	0.034
Weevil species per vine	6.00	1.5**	0.3	0.548	0.224	(0.93, 2.08)	6.71	0.001
Weevils per root	6.00	4.5*	15.9	3.987	1.628	(0.32, 8.69)	2.76	0.040
Weevil species per root	6.00	1	0	0	0	(1.00, 1.00)	*	*

Test of null hypothesis that mean of a variable is equal to 0

Table 2: *Statistical comparison on the distribution of the sweet potato weevil.*

Number of sweet potato weevils in vine

Results indicated that the number of weevils differed significantly (P= 0.034) between the two sweet potato varieties and their mean difference ranged from 0.91 to 15.09 weevils (Table 2). In addition, results showed that the mean number of weevils (12) found in variety Morogoro was greater than those weevils recorded from variety Shangazi (4).

Species of sweet potato weevils in vine

Results indicated that there was significant (P = 0.001) mean difference in the mean number of species of sweet potato weevils in vines obtained in variety Morogoro and those obtained in variety Shangazi. The mean difference in species of weevils in vines between the two sweet potato varieties ranged from 0.93 to 2.08 (Table 2). Results also indicated that variety Shangazi had mean of 2 species while variety Morogoro had mean of 1 species of weevils in their vines (Table 1).

Number of weevils in sweet potato roots

Results indicated that there was significant (P =0.04) variation between the mean number of weevils in roots obtained from sweet potato varieties Morogroro and Shangazi ranging from 0.32 to 8.69 (Table 2). In addition, results revealed that the mean number of weevils in roots of variety Morogoro was greater (7) than the mean number of weevils in roots of variety Shangazi (3).

Species of weevils in sweet potato roots

Results indicated that the mean number of species of weevils in roots was numerically similar (1) between sweet potato varieties Morogroro and Shangazi (Table 1). Because of this numerical similarity, there was no feasible statistical comparison of this variable between the two varieties of sweet potato (Table 2).

Damage caused by sweet potato weevils

Results of the various damages caused by weevils on sweet potato are presented in Table 3 and the statistical comparisons of the levels of damages on different parts of the sweet potato are presented in Table 4.

Variety	Size	Serious damage				Superficial damage	Undamaged
		Rotten	*Cylasinfested*	Broken	Cut		
Morogoro	1	1	20	11	5	19	32
Morogoro	2	0	10	3	8	12	47
Morogoro	3	0	16	9	9	9	51
Mean		0.3	15.3	7.7	7.3	13.3	43.3
Shangazi	1	0	1	22	10	4	49
Shangazi	2	0	3	16	19	11	55
Shangazi	3	0	4	13	5	10	60
Mean		0	2.7	17	11.3	8.3	54.7

Table 3: *Damage caused by sweetpotato weevils for sweetpotato varieties Morogoro and Shangazi in Mtumbatu village.*

Variable	Size	Mean difference	Variance (σ^2)	Std. dev. (σ)	Std error	95% CI for mean	Test "t" stat. (5 d.f.)	*P-value*
Rotten	6	0.17	0.17	0.41	0.17	(-0.26, 0.60)	1	0.363
Cylas infested	6	9.00*	59.2	7.69	3.14	(0.95, 17.07)	2.87	0.035
Broken	6	12.33**	41.47	6.44	2.63	(5.57, 19.09)	4.69	0.005
Cut	6	9.33**	26.67	5.16	2.12	(3.91, 14.75)	4.43	0.007
Superficial damage	6	10.83**	23.77	4.88	1.99	(5.72, 15.95)	5.44	0.003
Undamaged	6	49.00***	90.8	9.53	3.89	(39.00, 59.00)	12.6	<0.001

Test of null hypothesis that mean of a variable is equal to 0

Table 4: *Statistical comparison of the damage caused by the Cylas specie.*

Rotting of sweet potato caused by weevils

There was no significant (P =0.36) difference in the mean number of rotten sweet potatoes obtained in variety Morogoro and those obtained from variety Shangazi (Table 4). Results indicated that the mean number of the rotten sweet potatoes ranged from absent to at most 1 (Table 4). On the other hand, the number of the rotten sweet potatoes recorded in variety Morogoro was 0.3 and in average there was no rotten roots (0.0) recorded for the variety Shangazi (Table 3).

Cylas infestations on sweet potatoes

The mean difference of infested sweet potatoes was significant (P =0.035) between varieties Morogoro and Shangazi and the mean *Cylas* infested sweet potato ranged from 0.93 to the highest 17.07 (Table 4). In addition, the mean *Cylas* infested sweet potato was larger in variety Morogoro (15.3) than in variety Shangazi (2.7) (Table 3). Furthermore, from these results it was realized that the mean Percentage Infestation (PI) of *Cylas* on variety Morogoro (34.9%) was higher than that of variety Shangazi (5.45%).

Broken sweet potatoes

Results showed that there was significant (P =0.005) variation between the mean number of broken sweet potatoes obtained in varieties Morogoro and Shangazi ranging from 5.58 to 19.09 (Table 4). Results also indicated that the mean number of the broken sweet potatoes in variety Shangazi (17.0) was larger than those obtained in variety Morogoro (7.7) (Table 3).

Superficial damage of sweet potatoes

Results indicated that there was significant (P =0.003) difference between the mean number of superficial damage of sweet potato varieties Morogoro and Shangazi and the means ranged from 5.72 to 15.95 (Table 4). In addition, results also showed that the mean superficial damage of varieties Morogoro and Shangazi were 13.3 and 8.3, respectively (Table 3).

Undamaged sweet potato

Results showed that there was significant (P <0.001) variation in the mean number of undamaged sweet potatoes for varieties Morogoro and Shangazi ranging from 39.00 to 59.00 (Table 4). Results also indicated that the mean number of undamaged sweet potatoes was higher for variety Morogoro (54.7) than in variety Shangazi (43.3) (Table 3).

Effect of sweet potato damages on economic returns

Results of the economic losses caused by serious damage of sweet potato are presented in Table 5. The computation was based on the on-farm price of these sweet potatoes of Tshs. 500/= and Tshs. 400 for varieties Shangazi and Morogoro, respectively, during harvest.

Sweet potato variety	Causal of damage	Weight losses (kg/ha)	Price (Tshs kg^{-1} ha^{-1})	Price (USD kg^{-1} ha^{-1})
Morogoro	Rotten	30	12,000.00	6.00
	Cylas infested	1530	612,000.00	306.00
	Broken	770	308,000.00	154.00
	Cut	730	292,000.00	146.00
	Sum	3060	1,224,000.00	612.00
Shangazi				
	Rotten	0	-	-
	Cylas infested	270	135,000.00	67.50
	Broken	1700	850,000.00	425.00
	Cut	1130	565,000.00	282.50
	Sum	3100	1,550,000.00	775.00

The exchange rate was based on 1 USD ≈ Tshs. 2,000/= in May 2015.

Table 5: *Economic losses caused by different damages of sweet potato roots.*

Results indicated that high economic losses caused by combinations of rotting, *Cylas* infestations, breaking, and cutting were recorded in variety Shangazi (USD 775) compared to variety Morogoro (USD 612). However, *Cylas* infestation outperformed all other causes of this lose in these varieties followed by breaking (USD 282) in variety Shangazi and closely by breaking (USD 154) and cutting (USD 146) in variety Morogoro (Table 5). In addition, results indicated that *Cylas* infestation significantly caused high economic losses of variety Morogoro (USD 306) compared to its effect on economic losses in variety Shangazi (USD 67.5), which differed by USD 238.5.

Discussion

Distribution and incidence of the sweet potato weevils

Results of the above-ground assessment in vine indicated that the mean number of weevils for variety Morogoro was higher than that of variety Shangazi. The species of weevils in sweet potato vines differed significantly between the two varieties but they did not differ in roots apart from differences in varieties of sweet potato. The differences observed between varieties in parts of sweet potato could be attributed to the variety and within-plant site specific. This is similar to the findings of a study done by Okonya., *et al*. [28] which found that the external and internal vine damage by *Cylas* did not differ significantly between seasons and were generally low ranging between 1.1 and 1.2. Stathers., *et al*. [11] reported that the high foliage weight was associated with reduced level of infestation and attributed this to the needs of investing on selection of the variety with increased foliage and/or persists for longer period on the dry season.

The below-ground distribution of the weevils was greater in the variety Morogoro than in the variety Shangazi and this was the same as the distribution observed above-ground. One species of weevils was obtained below-ground on both varieties of the sweet potato. Most farmers in Mtumbatu village (personal communication, 2015) indicated that the infestation of the sweet potato by weevils is greater when harvesting is delayed and the infestation increases when it rains and stops instantly. Similar findings were also reported by Okonya., *et al*. [28] who found that the mean external and internal vine damage by *Cylas* sp. was significantly higher at the lowest altitude (1.3) than at mid and high altitudes (1.4).

Damage caused by sweet potato weevils

On serious damage, rotten sweet potatoes were observed in the variety Morogoro while variety Shangazi had no rotten signs. *Cylas* infestation was high in variety Morogoro compared with the variety Shangazi and their difference was significant. The broken variety Shangazi was higher than the broken variety Morogoro and this was probably due to the structure and morphology of the variety Shangazi. The latter is morphologically very coiled and this characteristic might have protected them from being damaged as they are removed from the soil below. Similar observation was also observed on the cuts of the sweet potatoes and where the superficial damage caused by weevils was high in the variety Morogoro. This indicates that the variety Shangazi was not much affected by weevils and this might be due to the low vulnerability. In addition, early harvesting of variety Shangazi gives strong evidence that farmers have to do timely harvesting of the crop to avoid the damage by weevils. This is also important because high soil moisture during maximum maturity has great influence on the infestations of the weevils [16].

Powell., *et al*. [16] reported that as approaching final harvest, corresponding with a period of high rainfall, weevil levels generally declined on both varieties. According to Ndunguru., *et al*. [25], rotting, *Cylas* infestation, and breakage of roots caused economic loss of sweet potatoes of 100%, 55%, and 25%, respectively, in Gairo district. This means that the number of weevils is inversely proportional to the amount of rainfall. Furthermore, in the dry condition or season the probability of the weevil to infest the field is greater. Okonya and Kroschel [29] reported that the mean root yield loss by *Cylas* sp. was significantly higher at low altitude (28.5%) than at mid (6.5%) and high (3.9%) altitudes, indicating that altitude has influence on the incidence and abundance of sweet potato weevils.

Economic losses of *Cylas* infestations on sweet potatoes

The studied sweet potato varieties differed in their selling on-farm prices at the same location and time of harvesting. The reasons given for variation in selling prices were that variety Morogoro is yellow inside, egg-cream outside and not much grown because of early damage caused by root weevils. On the other hand, variety Shangazi is deep-purple outside, white colour inside and much grown because of early maturity, high yield, and not much damaged by root weevils, and stays long under storage without being no damaged. The economic losses caused by destruction of marketable sweet potato roots was in the decreasing order of *Cylas* infestations, breaking, and cutting in variety Morogoro and rotting in variety Shangazi. These findings suggest that variety Morogoro is more susceptible to economic losses compared to variety Shangazi and high losses are caused by *Cylas* infestations.

Conclusion

This study assessed the incidences, distributions and economic losses of the two sweet potato varieties namely Morogoro and Shangazi in Gairo district. This was prompted by the fact that most smallholder farmers produce sweet potatoes in areas with high risks of sweet potato weevils. The number of weevils and their species are more in vines than in roots but serious damage was observed in roots. These were also more prevalent in variety Morogoro compared to variety Shangazi. In addition, economic losses of marketable roots were in the decreasing order of *Cylas* infestations (USD 306) in variety Morogoro and breaking (USD 425), cutting (USD 282.5) and rotting (USD 67.5) in variety Shangazi. It was concluded that variety Morogoro is more susceptible to economic losses caused by *Cylas* infestations compared to variety Shangazi. Therefore, variety Morogoro should always be harvested early and where possible farmers in Gairo District and similar areas should invest more on variety Shangazi.

Conflict of Interest

Authors of this research article declare that there is no any financial interest or any conflict of interest existing pertaining to entire process of executing this study.

Sweetpotato-Morogoro var.

Cylas infested Sweetpotato.

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