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SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 17 No. 3
July 2017
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2017; **17(3):** 12157-12178 **DOI: 10.18697/ajfand.79.16330**

A SURVEY OF FARMERS' PERCEPTIONS AND MANAGEMENT STRATEGIES OF THE SWEET POTATO WEEVIL IN HOMA BAY COUNTY, KENYA

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ajfand SCHOLARLY, PEER REVIEWED
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Volume 17 No. 3
July 2017
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

Sweet potato (*Ipomoea batatas* L.) is one of the most widely grown root crops worldwide. In Africa, it is grown in small plots by poorer farmers. Production of the crop is extremely low in Kenya as compared to other African countries due to the existence of common insect pests. Sweet potato weevil (*Cylas* spp.) is known as the biggest pit fall for production and productivity of the crop in the country. This study sought to determine the opinion of sweet potato farmers concerning sweet potato resistance to *Cylas* spp. and determine control strategies employed by sweet potato farmers in managing the pest. The study also sought to determine the sweet potato production constraints faced by the farmers in Homa Bay County, Kenya. The study was conducted using a Participatory Rural Appraisal approach in which 269 farmers in the County were interviewed on the sweet potato varieties with field resistance to *Cylas* spp., the crops' production constraints (with emphasis on damage by *Cylas* spp.) and farmers' control strategies in regard to the weevil. Data were also collected from the farmers whose sample size was determined using the table on sample size selection and standardization equation. Data were analysed using descriptive statistical techniques that were frequencies, percentages and standard errors. The study established that majority of the farmers from Rachuonyo (89.7%) and Ndhiwa (91.9%) were not aware of any variety that had field resistance to *Cylas* spp. However, 10.5% of the farmers in Rachuonyo and 8.1% of the farmers in Ndhiwa identified nine varieties which have shown relative field resistance to root damage by *Cylas* spp. The varieties that were identified to be resistant to *Cylas* spp. by farmers in Rachuonyo were Kalamb Nyerere, Tombra, Sinia, Odinga, Kemb 10, Wera and Zapallo. However, the varieties that were identified to be resistant to *Cylas* spp. by farmers in Ndhiwa were Amina, Mugande and Ndege Oyiejo. Further, the findings revealed that *Cylas* spp. was the most problematic pest by 90.3% and 96.8% of households in Rachuonyo and Ndhiwa, respectively. Majority (64.5%) of the farmers in Ndhiwa did not use any methods to manage *Cylas* spp. However, farmers in Rachuonyo (26.2%) and Ndhiwa (15.3%) preferred re-ridging during weeding as a management strategy in regard to *Cylas* spp. These findings reiterate the importance of the sweet potato weevil in rural sweet potato farming systems and thus innovative management strategies are necessary.

Key words: Sweet potato, control strategies, *Cylas* spp., resistance, pest, variety, constraints

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INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is the world's sixth most important food crop, after rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), potato (*Solanum rootosum* L.), maize (*Zea mays* L.) and cassava (*Manihot esculenta* Crantz) [1]. In developing countries, it is the fifth most important food crop [1]. In Kenya, sweet potato production is practiced in the western, central and coastal areas of the country. Out of this, over 80% is grown in the Lake Victoria basin [2] with Kakamega, Bungoma, Busia, Homa Bay and Kisii Counties having high acreages of this crop. The crop can be used for human consumption, livestock feed, and for industrial processes to make alcohol, starch and other products such as desserts and flour [3, 4]. Sweet potato can adapt to a wide range of environmental conditions and can be grown on marginal areas with poor soils of limited fertility and inadequate moisture. The production of sweet potato in Kenya has been low due to several abiotic (drought, low rainfall, poor soils) and biotic (insect pests and diseases) factors [5, 6, 7]. Among the major biotic constraints for sweet potato production insect pests are recoded as the most important [8].

The most serious and commonly reported insect pests for sweet potato in Africa are caterpillars of the sweet potato butterfly (*Acraea acerata* Hew., Nymphalidae), the Sweet potato weevils (*Cylas brunneus* F. and *Cylas puncticollis* Boheman), the clearwing moth (*Synanthedon* spp.), the sweet potato hornworm (*Agrius convolvuli* L.) and vectors of the sweet potato virus diseases, such as the sweet potato whitefly (*Bemisia tabaci*) [9]. The two African *Cylas* spp. (*C. puncticollis* and *C. brunneus*) usually appear together in fields and cause huge yield losses of up to 100% especially during dry periods [9].

The recent climatic change in Kenya has led to a decrease in rainfall and a rise in temperatures by $3^{\circ}C$ [10, 11]. Higher temperatures may lead to increase in insect population growth rates, number of generations per year, risk of invasion by migrant pests and could also increase the severity of insect outbreaks hence altering species geographical distribution [12, 13]. Assessing farmers' observations of crop production constraints has been used as a tool for documenting pest status and designing pest management options suitable for a particular community [14]. Such information could be obtained using various approaches, but the most commonly used method is the participatory rural appraisal (PRA). The PRA approach has been used in a number of studies to collect data from farmers that would help in understanding the pest status and possible management strategies in various crops [15, 16].

Comprehensive studies on the sweet potato weevils (*Cylas* spp.) in Kenya are scanty though preliminary observations suggest that insects probably cause appreciable damage to the crop annually on farmers' fields [8]. The current study was designed to establish the farmers' perception of sweet potato resistance to sweet potato weevil and further determine their control management strategies. The study also determined the sweet potato production constraints faced by the farmers in Homa Bay County, Kenya. The findings are of great importance in the development of management strategies that are appropriate for resource poor farmers.

METHODOLOGY

Study area

The study was conducted between February and April, 2012 in two sub-Counties (Rachuonyo and Ndhiwa) of Homa Bay County of Kenya (Figure 1). Ndhiwa sub-County lies on the geographical co-ordinates of 0° 44′ 0″ South and 34° 22′ 0″ East. Ndhiwa is administratively divided into five Divisions which include Riana, Ndhiwa, Nyarongi, Kobama and Pala. Ndhiwa sub-County receives long rains during the months of February to May (500 – 1000 mm) and short rains during the months of August to November (250 – 400 mm) with an average range of between 500 – 1650 mm p.a. [17]. The agro-ecological zone of the region is within the lower midlands (LM1 – LM3). Altitude ranges between 1200 – 1400m above sea level and average annual temperatures are 20.5-21.7°C. The area has three types of soils: black soils (vertisols–cotton soils), silt loam and clay loam (luvisols) [17].

Rachuonyo sub-County lies on the geographical co-ordinates of 0° 26′ 24″ South and 34° 44′ 20″ East. Rachuonyo is divided into two agro-ecological zones: the medium-high potential “upper midland” (found in Kasipul and Kabondo Divisions), and the drier “lower midland” found close to Lake Victoria (in Karachuonyo East and West Divisions) [18]. The region receives an average annual rainfall of 800 -1800 mm. The site has an elevation ranging between 1180 and 1900m above sea level [18]. Kasipul and Kabondo Divisions have deep, well drained relatively fertile soils. The main food crops grown in this region include maize, cassava, beans, groundnuts and sweet potatoes, while the main cash crops are tea and coffee [18]. Karachuonyo East and West Divisions on the other hand have soils of poor fertility and drainage. The food crops grown in this region include maize, sorghum, millet, sweet potato, cassava, groundnuts, beans and yams while cotton is the main cash crop in the region [18].

DOI: 10.18697/ajfand.79.16330

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ISSN 1684 5374

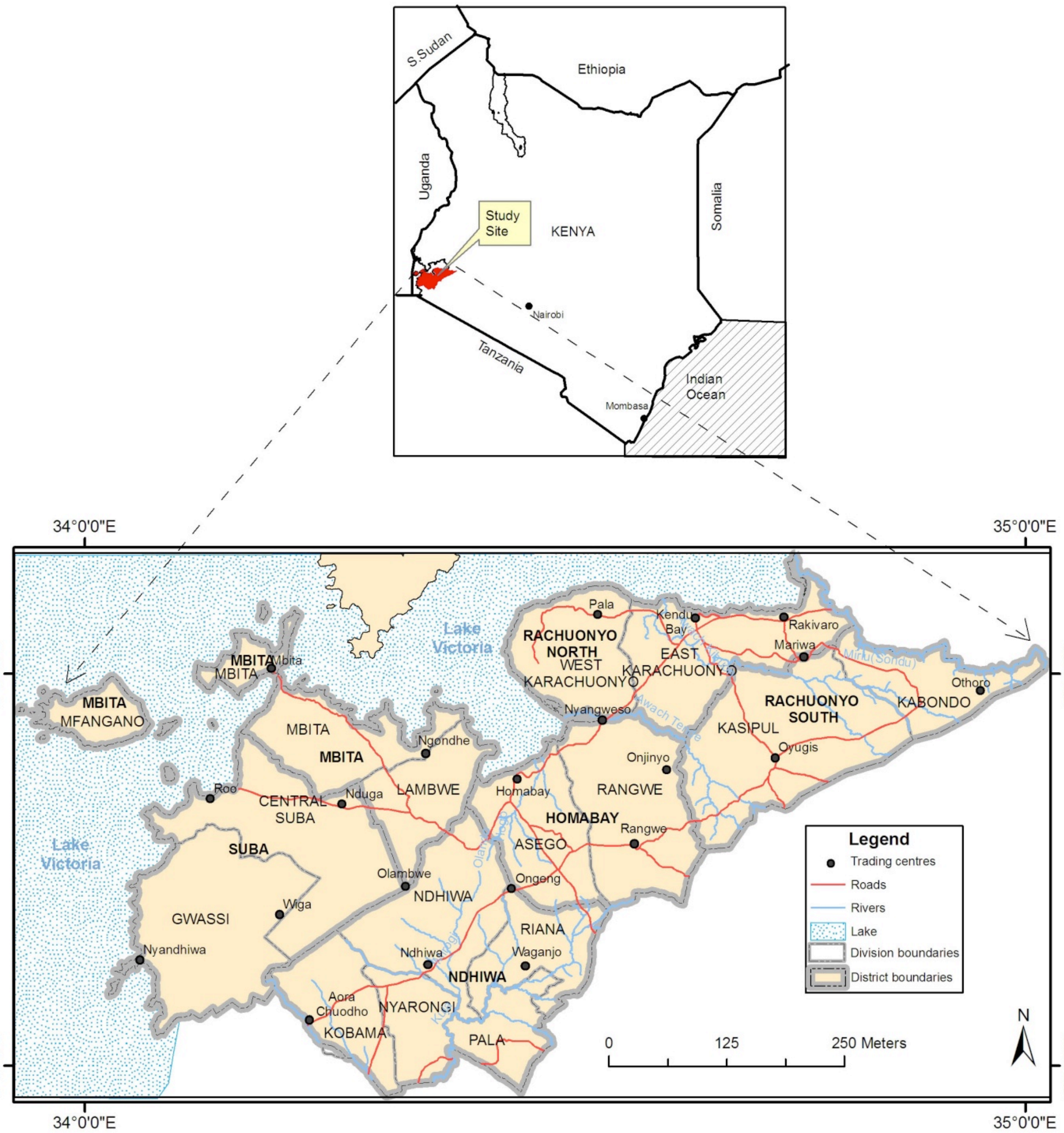

Figure 1: A map showing the location of Ndhiwa and Rachuonyo sub-Counties

Research Design

The study was conducted using a Participatory Rural Appraisal (PRA) approach in which a reconnaissance survey preceded a detailed survey of the area. Participatory Rural Appraisal is a set of participatory and largely visual techniques for assessing group and community resources, identifying and prioritizing problems and appraising strategies for solving them. In this study, the approach aimed at incorporating the knowledge and opinions of rural people in developing an integrated pest management strategy that is appropriate for resource poor farmers.

Target Population, Sample Size and Sampling Techniques
With the assistance of agricultural extension workers, a preliminary survey was done to obtain information on the total number of sweet potato farmers in the area. Based on this information the number of interviewees per sub-County was determined. A sample size of 269 farmers was arrived at using the table on sample size selection and standardization equation [19, 20].

$$n = \left[\frac{n_0}{1 + \left(\frac{n_0 - 1}{N} \right)} \right]$$

Where: *N* is the known population; *n* is sample size; and n_0 is the unknown population.

Out of the 269 farmers who participated in this study, 145 were selected purposively from Rachuonyo sub-County whereas 124 were selected from Ndhiwa sub-County. This comprised 80 male and 189 female participants from the two sub-Counties (Table 1). The qualification of the selected focus discussion group was based on the fact that there were more than 25 members who have been actively growing sweet potatoes for the last five years and above. The respondents were purposively identified through the help of extension officers in the County.

Data Collection Methods
Data were collected using focus group discussion and a questionnaire. A semi-structured questionnaire was designed, administered and used to collect data from the respondents. Farmers were shown colored photographs of insect pests to ensure they correctly identified the pest. Colored photographs showing the effects of weevil infestation on the sweet potato roots were also shown to the farmers to ensure they correctly identified the effect of weevil damage. More information was collected using focus group discussions with farmers, transect walks and pairwise ranking. All these were done within purposively selected groups with the help of extension officers to obtain a wide range of group observations. Two and four groups from Rachuonyo and Ndhiwa respectively were involved in the discussions. Data were collected from the farmers on names of sweet potato varieties that were known to be resistant to the sweet potato weevil, constraints affecting sweet potato production and strategies used for managing the sweet potato weevil.

Data Analysis Techniques
Quantitative data collected were analysed using descriptive statistical techniques that were frequencies, percentages and standard error. This was done using Statistical Package for Social Sciences (SPSS) version 16. For the qualitative data, the farmers were initially given an opportunity to list all the problems they encountered during the production of the crop and thereafter, the standard pair wise ranking was done. Pairwise ranking was used as a means of prioritizing or ranking lists of constraints encountered by farmers during sweet potato production. To make matrix tables, each constraint was compared in turn with each of the other constraints. The constraint with the highest frequency in the matrix was considered to be the most important and hence ranked as number one.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 17 No. 3 July 2017 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

RESULTS AND DISCUSSION

Demographic Profile and Characteristics of the Respondents

Information concerning the occupation, sex, sub-County of residence, level of education and age, of 269 respondents who participated in this study is shown in Table 1. Of all the respondents, 92.2% were self-employed in agriculture, 2.6% were self-employed in non-farm enterprises and 1.5% were salaried workers in non-agriculture areas. It was further established that majority (70.3%) of the respondents were female whereas only 29.7% were male. The data were collected from the respondents in Ndhiwa and Rachuonyo sub-Counties, where 53.9% (145) were from Rachuonyo and 46.1% (124) were from Ndhiwa. Concerning the educational level of the respondents, majority (66.2%) had completed primary school education whereas 15.2% (41) had completed secondary school education. However, 11.9% (32) never attended any formal education and the rest had attained Advanced level (taken two years after high school), middle level or university education. This implies that majority of the respondents were atleast able to read and write. The findings also shows that 26.8% (72) of the respondents were 41-50 years old while 26.0% (70) were aged 31-40 years old. There were 17.1% (46) of the respondents who were aged 20-30 years while the rest of the respondents were over 50 years old.

Most Problematic Pests of Sweet potato Varieties

About 93.3 % (250) of the respondents who participated in this study stated that sweet potato weevil was the most problematic pest that affects sweet potato. Another 3.4% (9) of farmers identified moles as an equally problematic pest (Table 2). In some previous studies, *Cylas* spp. was equally identified as the most problematic pest. For instance, in Southern Ethiopia, 68.3% of the interviewed farmers identified *Cylas* spp. to be the most important pest in sweet potato production [21]. Further, the findings of this study revealed that large animals like cattle were also considered as a threat to the production of sweet potatoes as stated by 1.5% (4) of the respondents (Table 2). Other pests mentioned were potato root moth (0.7%), stainer (0.4%), porcupine (0.4%) and grain borer (0.4%) (Table 2).

Further statistical analysis indicates that 90.3% of the respondents from Rachuonyo sub-County stated that sweet potato weevil was the most problematic pest while 96.8% of the respondents from Ndhiwa stated that sweet potato weevil was the most problematic pest (Table 2). At significance level of 0.05, a p-value of 0.160 was obtained which implied that the respondents' observation on the most problematic pest in the two sub-Counties were not significantly different from each other (Table 3). This is an indication that *Cylas* spp. is an economically important pest in the region of study.

Sweet potato Varieties with Field Resistance to *Cylas* spp.

The study established that majority of the farmers from Rachuonyo (89.6%) and Ndhiwa (91.9%) were not aware of any variety that had field resistance to *Cylas* spp. (Table 4). However, some farmers in Rachuonyo (10.4%) and Ndhiwa (8.1%) identified nine varieties which have shown some form of field resistance to root damage by *Cylas* spp. (Table 4). The varieties identified by farmers in Rachuonyo (Kalamb nyerere, Tombra, Sinia, Odinga, Kemb 10, Wera, Zapallo) were different

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from those identified in Ndhiwa (Amina, Mugande and Ndege oyiejo (Table 4). This is contrary to the findings from other studies where varieties Kemb 10 and Zapallo were considered to be very susceptible to weevils [22]. According to the same researchers, varieties SPK 004 and Bungoma exhibited some degree of weevil resistance but in the current study, no farmer made that observation [21].

This study established that only a small percentage of the farmers from Rachuonyo (1.4%) and Ndhiwa (4.0%) who were aware of varieties that had field resistance to *Cylas* spp. were still growing them (Table 5). However, the rest of the farmers gave different reasons as to why they no longer grew the resistant varieties even though they were aware of them (Table 5). Some of the reasons that were given by farmers to justify why they did not grow the resistant varieties known to them are presented in Table 5. The reasons included unsuitable variety characteristics like high fibre content (0.7%), not tasty/sweet (2.6%), poor storage potential (1.5%), low yielding (0.4%), late maturity (0.4%), susceptibility to water logging (0.4%) and unmarketability (2.2%).

The results of this study show that the varieties identified by farmers for resistance to *Cylas* spp. were region specific. This may be attributed to the fact that planting varieties readily available to farmers are region specific due to different agro-ecological conditions exhibited by the two sub-Counties [18]. The farmers in the two sub-Counties planted different varieties and, therefore, their observation on the resistance of the varieties to *Cylas* spp. could not be the same. Nonetheless, the correlation between Rachuonyo and Ndhiwa sub-Counties on the resistant varieties to *Cylas* spp. was not significant (Table 6). A correlation value of 0.108 and at significance level of 0.05, p-value of 0.077 was obtained (Table 6), which implied that there was no significant relationship between the sub-County and the varieties that had field resistance to *Cylas* spp.

Some studies have reported differences in *Cylas* spp. damage among varieties [23, 24]. However, complete sweet potato variety resistance to *Cylas* spp. has not been reported [24, 25]. Factors such as depth of rooting, quantity of root latex and amount of foliage, have been reported to contribute to reduced *Cylas* spp. sweet potato damage [24, 26].

Sweet Potato Production Constraints

Among the production constraints identified by farmers as shown in Table 7, infestation of crop by *Cylas* spp. was ranked number one by three groups (two from Ndhiwa and one from Rachuonyo) (Table 7). Therefore, identification of factors limiting production and provision of environmentally-friendly options for integrated crop management is inevitable if sweet potato production among the small-scale farmers is to be increased [27]. Erratic rains were observed by two groups each in Ndhiwa and Rachuonyo as the most limiting factor of sweet potato production (Table 7). They explained that erratic rains lead to soil cracking, which enhances the weevils to attack the crop. The least threatening factors to sweet potato production observed by farmers in groups were infestation of crop by disease, difficulty to prepare the land and infestation by mole rats (Table 7). However, the study established that infestation by porcupines, too much rain, difficulty in land preparation and infestation by couch grass (*Elymus repens*) were sweet potato constraints that were unique to Ndhiwa sub-County

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(Table 7). The results that some sweet potato production constraints were reported by farmers in Ndhiwa and not by farmers in Rachuonyo (Table 7) could have been attributed to the differences in the agro-ecological conditions exhibited by the two regions. For instance, Ndhiwa sub-County in particular is noted for its heavy, difficult to manage vertisols, which occasionally are mixed with sandy loams or clay loams. In case of the presence of much rain, they hold excess amounts of water resulting to rotting of the sweet potato roots. Rachuonyo on the other hand is covered by deep well drained soils that are easy to cultivate.

Farmers' Management Practices of *Cylas* spp.

It was evident from the study that different methods of *Cylas* spp. management were engaged in the two sub-Counties. The findings are shown in Table 8. *Cylas* spp. management methods used by farmers in Rachuonyo include earthing-up of ridges (re-ridging) during weeding (26.2%), early harvesting (14.5%), removal of exposed roots from the ground (11%), disposal of infested roots at harvest (11.7%), early planting (12.4%), planting on ridges (19.3%), use of clean planting vines (15.2%), covering of exposed roots with soil (23.4%), minimizing movement in the field once the crop is ready for harvest (20%), intercropping sweet potato with other crops (0.7%), crop rotation (2.8%), use of pesticides (2.1%), practicing field sanitation (2.1%) and growing the crop in a field that is situated far away from an old sweet potato crop (4.1%). In Ndhiwa, sweet potato management practices include re-ridging during weeding (15.3%), disposal of infested roots at harvest (12.1%), early planting (0.8%), early harvesting (6.5%), crop rogueing (7.3%), use of pesticides (0.8%) and use of wood ash (0.8%).

The most popular *Cylas* spp. management method in both Rachuonyo and Ndhiwa sub-Counties was found to be earthing-up of ridges (re-ridging) during weeding (Table 8). This is an important strategy to deter weevil infestation during drought conditions. It can be achieved by hilling (ridging) a small area around the sweet potato plant in order to prevent the entry of weevils into roots and oviposition by female weevils [28]. However, re-ridging works best only when performed at the root formation stage [29]. Therefore, the practice of some farmers (12.6%) covering already exposed roots with soil is not an effective management strategy.

A total of 8.2% respondents interviewed in this study use clean planting vines as a management strategy of *Cylas* spp. (Table 8). More than 95% oviposition occurs in the first 35 cm of vines especially when female weevils cannot access the roots and thus planting of infested vines is one of the ways of distributing weevils [28]. Nevertheless, farmers are cautioned against the use of older portions of vines as these are usually severely infested with weevils as compared to younger vines [30]. Since planting of infested vines will spread weevil infestation, treatment of infested vines with insecticides is currently being recommended to reduce weevil infestation [28].

Intercropping of sweet potato with maize or cowpea, crop rotation and field sanitation as practiced by some farmers reduces the incidence of sweet potato weevils. It has been reported that intercropping sweet potato with cowpea resulted in up to tenfold reduction in the infestation of *Cylas* spp. compared to monocrop of sweet potato [31]. Besides,

DOI: 10.18697/ajfand.79.16330

effective crop rotations also resulted in lower tuber damage compared to monoculture of sweet potato [32]. Further, sanitation practices play a vital role in protecting sweet potatoes from pests with limited flying capacity such as *Cylas* spp. [28].

Other *Cylas* spp. management methods used by farmers such as early planting and harvesting as practiced by 7.1% and 10.8% of the total respondents respectively (Table 8) can also reduce incidences of *Cylas* spp. [28]. This is because early planting ensures that the crop matures during rainy season, which prevents soil cracking [28]. Soil cracking due to drought will facilitate the entry of eggs into the roots. Besides, some studies reported that weevil associated damage increase by over four times if harvesting was delayed by 30 days [33, 34]. This means that it is necessary to harvest mature crops early enough to reduce weevil spread.

CONCLUSION

In conclusion, *Cylas* spp. was found to be an important pest of sweet potato crop in Homa Bay County. Technologies to sustainably manage these weevils would boost sweet potato production greatly and impact positively on the livelihoods of poor farmers in the County. Promoting the use of cultural methods such as use of clean planting vines, crop rotation, early planting and harvesting have potential to reduce damage by *Cylas* spp. In this regard, innovative management strategies that are based on the needs of small-scale farmers and their production systems are vital.

ACKNOWLEDGEMENT

The authors would like to thank National Council of Science and Technology (NACOSTI) for funding the research activities carried out in this study. The authors also extend their appreciation to farmers from Homa Bay County (Kenya) for providing the information and the Ministry of Agriculture offices (Homa Bay County) for helping us to access the region.

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ISSN 1684 5374

Table 1: Demographic profile of the respondents (N=269)

	FREQUENCY	PERCENTAGE
AGE		
20 - 30 yrs	46	17.1
31 - 40 yrs	70	26.0
41-50 yrs	72	26.8
Above 50	108	30.1
SEX		
Female	189	70.3
Male	80	29.7
LEVEL OF EDUCATION		
Primary	179	66.2
Secondary	41	15.2
Never attended	32	11.9
Others	17	6.3
SUB-COUNTY		
Rachuonyo	145	53.9
Ndhiwa	124	46.1
OCCUPATION		
Self-employed in agriculture	248	92.2
Self-employed in non- farm enterprises	7	2.6
Salaried workers in non-agriculture	4	1.5
Others	10	3.8

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Table 2: Most problematic pests/predators of sweet potato

S/N	Name of most problematic Pest/Predator	Counts of respondents			Percentage of respondents: Within the sub-County			Percentage of respondents: Within the the two sub-Counties		
		SB1 (m)	**SB2 (n)**	**∑ SB1 + SB2 (p)**	**SB1 (u)** u =m/144 * 100	**SB2 (v)** v =n/124 * 100	**∑ SB1 + SB2 (w)** w =p/268 * 100	**SB1 (x)** x =m/p * 100	**SB2 (y)** y =n/p * 100	**∑ SB1 + SB2 (z)** z =p/p * 100
1	Sweet potato weevil	130	120	250	90.3	96.8	93.3	52.0	48.0	100
2	Potato root moth	2	0	2	1.4	0.0	0.7	100	0.0	100
3	Livestock	4	0	4	2.8	0.0	1.5	100	0.0	100
4	Moles	6	3	9	4.2	2.4	3.4	66.7	33.3	100
5	Stainer	1	0	1	0.7	0.0	0.4	100	0.0	100
6	Porcupine	1	0	1	0.7	0.0	0.4	100	0.0	100
7	Grain borer	0	1	1	0.0	0.8	0.4	0.0	100	100
	TOTAL	**144**	**124**	**268**	**100**	**100**	**100**	**53.7**	**46.3**	**100**

Key: *SB1 means Rachuonyo sub-County*
SB2 means Ndhiwa sub-County

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Table 3: Correlation of respondents observation on the most problematic pest in Rachuonyo and Ndhiwa sub-Counties

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-0.086	0.061	-1.411	0.160[c]
Ordinal by Ordinal	Spearman Correlation	-0.126	0.054	-2.079	0.039[c]
N of Valid Cases		268			

a. Not assuming the null hypothesis
b. Using the asymptotic standard error assuming the null hypothesis
c. Based on normal approximation

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Table 4: Farmers observations of sweet potato varieties with field resistance to *Cylas* spp.

S/N	Name of weevil resistant variety	Counts of respondents			Percentage of respondents					
					Within the sub-County			Within the the two sub-Counties		
		SB1 (m)	SB2 (n)	∑ SB1 + SB2 (p)	SB1 (u)	SB2 (v)	∑ SB1 + SB2 (w)	SB1 (x)	SB2 (y)	∑ SB1 + SB2 (z)
					u =m/144 * 100	v =n/124 * 100	w =p/268 * 100	x =m/p * 100	y =n/p * 100	z =p/p * 100
1	Not applicable	129	114	243	89.6	91.9	90.7	53.1	46.9	100
2	Kalamb Nyerere	1	0	1	0.7	0.0	0.4	100	0.0	100
3	Tombra	3	0	3	2.1	0.0	1.1	100	0.0	100
4	Sinia	2	0	2	1.4	0.0	0.7	100	0.0	100
5	Odinga	6	0	6	4.2	0.0	2.2	100	0.0	100
6	Odinga and Kemb 10	1	0	1	0.7	0.0	0.4	100	0.0	100
7	Odinga, Kemb 10 and Zapallo	1	0	1	0.7	0.0	0.4	100	0.0	100
8	Tombra and Wera	1	0	1	0.7	0.0	0.4	100	0.0	100
9	Amina and Mugande	0	9	9	0.0	7.3	3.4	0.0	100	100
10	Ndege oyiejo	0	1	1	0.0	0.8	0.4	0.0	100	100
	Total	**144**	**124**	**268**	**100**	**100**	**100**	**53.7**	**46.3**	**100**

Key*: SB1 means Rachuonyo sub-County*
SB2 means Ndhiwa sub-County

DOI: 10.18697/ajfand.79.16330

ajfand SCHOLARLY, PEER REVIEWED
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Volume 17 No. 3 July 2017
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 5: Farmers reasons on why they do not grow sweet potato varieties with field resistance to *Cylas* spp.

S/N	**Reason given by farmer for not growing weevil resistant variety**	**Counts of respondents**			**Percentage of respondents**					
					Within the sub-County			**Within the the two sub-Counties**		
		SB1 (m)	**SB2 (n)**	**∑ SB1 + SB2 (p)**	**SB1 (u)** $u = m/144 * 100$	**SB2 (v)** $v = n/124 * 100$	**∑ SB1 + SB2 (w)** $w = p/268 * 100$	**SB1 (x)** $x = m/p * 100$	**SB2 (y)** $y = n/p * 100$	**∑ SB1 + SB2 (z)** $z = p/p * 100$
1	Not applicable (since farmer was not aware of any sweet potato resistant variety)	129	114	243	89.6	91.9	90.7	53.1	46.9	100
2	Not applicable (since farmer still grows the resistant sweet potato variety)	2	5	7	1.4	4.0	2.6	28.6	71.4	100
3	Lack of planting vines	5	3	8	3.5	2.4	3.0	62.5	37.5	100
4	Variety not marketable	6	0	6	4.2	0.0	2.2	100	0.0	100
5	Variety has high fibre content	2	0	2	1.4	0.0	0.7	100	0.0	100
6	Variety not tasty/sweet	5	2	7	3.5	1.6	2.6	71.4	28.6	100
7	Poor storage potential	4	0	4	2.8	0.0	1.5	100	0.0	100
8	Suceptible to water logging	1	0	1	0.7	0.0	0.4	100	0.0	100
9	Variety is low yielding	1	0	1	0.7	0.0	0.4	100	0.0	100
10	Variety is late maturing	1	0	1	0.7	0.0	0.4	100	0.0	100
	Total	**144**	**124**	**268**	**100**	**100**	**100**	**53.7**	**46.3**	**100**

Key: *SB1 means Rachuonyo sub-County*
SB2 means Ndhiwa sub-County

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Table 6: Correlation of varieties observed to have resistance to *Cylas* spp. in Rachuonyo and Ndhiwa sub-Counties

		Symmetric Measures			
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	0.108	0.054	1.776	0.077[c]
Ordinal by Ordinal	Spearman Correlation	-0.026	0.061	-0.422	0.673[c]
N of Valid Cases		268			

a. Not assuming the null hypothesis
b. Using the asymptotic standard error assuming the null hypothesis
c. Based on normal approximation

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Table 7: Major Constraints to sweet potato production

SUB-COUNTY	Division	RANKS 1	2	3	4	5	6	7
Rachuonyo South	Kasipul	Infestation by SPW and Mole rats	Lack of market	Lack of healthy vines	*	*	*	*
	Kabondo	Erratic rains	Lack of healthy vines	Lack of capital	Lack of market	Infestation by Mole rats	Infestation by SPW	Infestation by disease
Ndhiwa	Kobama	Lack of healthy vines	Erratic rains	Infestation by SPW	Lack of market	Weeds (couch grass)	Late maturity of variety	Difficulty in land preparation
	Nyarongi	Infestation by SPW	Infestation by Mole rats	Infestation by disease	Too much rains	Lack of market	Erratic rains	*
	Ndhiwa Group 1	Infestation by SPW	Lack of healthy vines	Erratic rains	(i) Infestation by disease (ii) Road inaccessibility	(i) Lack of capital (ii) degraded soils	Infestation by porcupines	Infestation by Mole rats
	Ndhiwa Group 2	Erratic rains	Lack of healthy vines	Lack of capital	Lack of market	Infestation by Mole rats	Infestation by SPW	Infestation by disease

*There was no ranking of any constraint SPW means Sweet potato weevil

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Table 8: Control methods for *Cylas* Spp. on sweet potato crop by farmers

S/N	Control Method(s) as practised by respondents	Counts of respondents			Percentage of respondents					
					Within the sub-County			Within the two sub-Counties		
		SB1 (m)	SB2 (n)	∑ SB1 + SB2 (p)	SB1 (u) u =m/145 * 100	SB2 (v) v =n/124 * 100	∑ SB1 + SB2 (w) w =p/269 * 100	SB1 (x) x =m/p * 100	SB2 (y) y =n/p * 100	∑ SB1 + SB2 (z) z =p/p * 100
1	Not applicable (Don't control the weevils)	16	80	96	11.0	64.5	35.7	16.7	83.3	100
2	Early harvesting	21	8	29	14.5	6.5	10.8	72.4	27.6	100
3	Earthing up of the ridges during weeding	38	19	57	26.2	15.3	21.2	66.7	33.3	100
4	Planting during rainy season (Early planting)	18	1	19	12.4	0.8	7.1	94.7	5.3	100
5	Use of Pesticides	3	1	4	2.1	0.8	1.5	75.0	25.0	100
6	Removal of exposed roots from the ground	16	0	16	11.0	0.0	5.9	100	0.0	100
7	Disposal of infested roots during harvesting	17	15	32	11.7	12.1	11.9	53.1	46.9	100
8	Planting on ridges	28	0	28	19.3	0.0	10.4	100	0.0	100
9	Use of clean planting vines	22	0	22	15.2	0.0	8.2	100	0.0	100

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S/N	Control Method(s) as practised by respondents	Counts of respondents			Percentage of respondents					
					Within the sub-County			Within the two sub-Counties		
		SB1 (m)	SB2 (n)	∑ SB1 + SB2 (p)	SB1 (u) u =m/145 * 100	SB2 (v) v =n/124 * 100	∑ SB1 + SB2 (w) w =p/269 * 100	SB1 (x) x =m/p * 100	SB2 (y) y =n/p * 100	∑ SB1 + SB2 (z) z =p/p * 100
10	Planting in fields that are situated far away from old sweet potato fields	6	0	6	4.1	0.0	2.2	100	0.0	
11	Field sanitation	3	0	3	2.1	0.0	1.1	100	0.0	100
12	Practice crop rotation	4	0	4	2.8	0.0	1.5	100	0.0	100
13	Covering exposed roots with soil	34	0	34	23.4	0.0	12.6	100	0.0	100
14	Intercropping sweet potato with other crops (cowpea or maize)	1	0	1	0.7	0.0	0.4	100	0.0	100
15	Farmer minimizes moving in the field once the crop is ready for harvest	29	0	29	20.0	0.0	10.8	100	0.0	100
16	Crop rogueing	0	9	9	0.0	7.3	3.3	0.0	100	100
17	Use of wood ash	0	1	1	0.0	0.8	0.4	0.0	100	100
	Total	**145**	**124**	**269**	**100**	**100**	**100**	**53.9**	**46.1**	**100**

Key: SB1 means Rachuonyo sub-County
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