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Review of Entomological Research on Sweet Potato in Ethiopia

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Abstract: **Sweet potato is one of the most widely grown root crops in SSA, it is particularly important in countries surrounding the Great Lakes in Eastern and Central Africa, in Angola, Madagascar, Malawi and Mozambique in Southern Africa, Nigeria in West Africa and China being the largest producer worldwide. In Africa, it is grown predominantly in small plots by poorer farmers, and hence known as the “poor man’s food.” However it is among well known and established crops in Southern, Eastern and South western parts of Ethiopia. It is produced annually on over 53 thousand hectares of land with total production over 4,240 tons and average productivity of 8.0 tons per hectare. The production and productivity of the crop is extremely low as compared to other African and Asian countries where it gives more than 18t/ha. The lower productivity of sweet potato is mainly due to the existence of common, major, minor and sporadic insect pests. Sweet potato weevil is known as the most pit fall for production and productivity of the crop followed by viral diseases in the country. In addition, sweet potato butter fly is the most devastating pest in major sweet potato growing zones in the country but its occurrence is sporadic based on agro-ecological condition. Thus this paper aimed to review the prevalence, incidence, population dynamics, distribution of economically important sweet potato insect pests and their management options, particularly on broader aspects of research and production challenges of sweet potato in relation to economically important insect pests in the country.**

Key Words: Sweet potato, Southern Ethiopia, Sporadic, economically important

INTRODUCTION

The sweet potato, *Ipomoea batatas* (Lam.) is a dicotyledonous plant that belongs to the family Convolvulaceae, and a tuberous root crop important for food security. It is cultivated in over 100 developing countries and ranks among the five most important food crops in over 50 of those countries (FAOSTAT, 2012). It is one of the most widely grown root crops in SSA, it is particularly important in countries surrounding the Great Lakes in Eastern and Central Africa, in Angola, Madagascar, Malawi and Mozambique in Southern Africa, and in Nigeria in West Africa. China being the largest producer worldwide. In Africa, it is grown predominantly in small plots by poorer farmers, and hence known as the “poor man’s food.” Sweet potato is among well known and established crops in Southern, Eastern and South western parts of Ethiopia. It is produced annually on over 53 thousand hectares of land with total production over 4,240 tons and average productivity of 8.0 tons per hectare (Table 1; CSA, 2011). Ethiopia is one of the largest sweet potatoes producing country in east Africa and the Southern Nations Nationalities and Peoples’ Region (SNNPR) is the major sweet potato producing region in the country. According to the CSA agricultural sample survey data (2011), it is the 2nd to potato in area of production and productivity (Table 1). The production and productivity of the crop is affected by a number of constraints.

Among the major biotic constraints for sweet potato production insect pests are recoded as the major one (Adhanom *et al.,* 1985; Ferdu *et al.,* 2009). A complex of insect pests recorded in sweet potato producing areas of the country. The stem and root feeders like sweet potato weevils, *Cylas puncticollis,* (Coleoptera: Curculionidae); sweet potato butterfly, *Acraea acerata* (Lepidoptera: Nymphalidae), sweet potato hornworm, *Agrius convolvuli* (Lepidoptera: Sphingidae), tortoise beetles, *Aspidomorpha spp*., *Laccoptera spp*. (Coleoptera: Chrysomelidae); and virus transmitters *Aphis gossypii* (Homoptera: Aphididae) and *Bemisia tabaci* (Homoptera: Aleyrodidae) are the major ones. For the last

Table 1. Area, production and yield of root and tuber crops for private peasant holdings for Meher season 2009/2010

Crop	Number of holders	Area in hectare	Production in quintal	Yield (qt / ha)
All Root Crops	5,038, 428	212,208.33	208.33	18,063,778
Beet root	257,382	1, 096.31	100, 785	91.93
Carrot	157,032	2,712.70	182, 293	67.2
Onion	556,342	17, 588.41	1, 693,168	96.27
Potatoes	1,371,759	69, 783.60	5,723,325	82.02
Garlic	2,079,195	15, 361.25	1,796,578	116.96
Taro/ 'Godere'	956,894	52, 200.84	4, 060,001	77.78
Sweet potatoes	1,296,460	53, 465.22	4, 507,628	84.31
Enset	4,377, 124	301, 978.68	6, 948, 102.45	23.01

Source: CSA 2011/12

20-30 years a number of researchers were involved in Sweet potato Entomology in Ethiopia. They have made different applied and basic studies and a number of recommendations were made. Crop improvement research on this crop in Ethiopia started in early 1970’s and resulted in release of about 23 varieties with their appropriate production packages. Therefore, this paper is focusing on entomological researches and reviewing those findings and availing the information for users in suitable form.

Insect pests recorded on sweet potato in Ethiopia

Since the inception of agricultural research in the country, a number of survey works were made by different researchers and investigated the dynamics of insect pests associated with sweet potato in the Ethiopia. The 1st and 2nd comprehensive review of entomological researches on root and tuber crops in general were made by Tsedeke, *et al.,* 1986 and Ferdu, *et. al.,* 2009, respectively. The pests recorded on sweet potato in Ethiopia are presented in Table 1. Among these, only sweet potato weevil (*Cylas puncticollis*) and the sweet potato butterfly (*Acraea acerata*) are the major ones (Crow *et al.,* 1977; Emana and Adhanom, 1989; Azerefegne, 1999) and they have also received better research attention.

Sweet potato weevil

Sweet potato weevil (*Cylas* sp.) are the cosmopolitan insect and most serious insect pests of sweet potato in Central America, Africa and Asia; production losses often reach 60-100% (Chalfant *et al*., 1990; Lenné 1991; Jansson and Raman 1991; Mullen, 1984; Smit, 1997). Even small weevil populations can reduce sweetpotato root quality. In response to weevil feeding, sweet potato storage roots produce bitter tasting and toxic sesqui-terpenes that render them unfit for human consumption.

Ashebir (2006) was made a comprehensive survey and reported that, the sweet potato weevil was to be found in all woredas surveyed in southern Ethiopia. Although there were difference in extent of stem and tuber damage and weevil population density per plant parts (Ashebir, 2006). High level of stem and tuber damage and high number of larvae per tuber was recorded in Demba Goffa and Arbaminch Zuria woreds (Ashebir, 2006); at Nazret and Melka were (Emana 1987), Awassa, at Areka and Humbo (Emana and Amanuel, 1992; Adhanom and Tesfaye, 1994).

BASIC STUDIES ON SWEET POTATO WEEVIL

Biology study

The biology of sweet potato weevil was studied in Awassa and Nazreth Research Centers. The weevil required 30 and 31.5 days to complete its life cycle in Awassa and Nazreth, respectively. It was also reported that the weevil could complete nine generations at Awassa and eight at Nazreth (Emana, 1987; Emana and Amanuel, 1992).

Extent of infestation and loss by sweet potato weevil

Yield loss assessment studies were carried out between 1984 and 1987 at Nazreth and Werer using various insecticides showed that the weevil can cause losses of 10 – 48 % (Emana, 1987). The bitterness resulting from sweet potato weevil damage makes even the partially damaged tubers are unsuitable for human consumption. As lack of storage technologies and for preservation of planting material; farmers practice piecemeal harvesting techniques which keeps the crop in the field for up to six months. According to Emana (1990), the infestation could increase from 29 to 68 % when harvesting was delayed from five to six months. Moreover, growing sweet potato on the same plot of land for four consecutive years at Awassa resulted in over 70 % infestation; whereas less than 20 % infestation was recorded in plots where rotation of crops was practiced (Emana, 1990). The extent of yield loss was high towards the dry season due to low soil moisture, low biomass yield and possibly high soil crack (Ashebir, 2006). The pest is particularly serious under dry conditions because the insect can reach the root more easily through the cracks that appear as the soil dries out; therefore sweet potato cannot be stored safely in-the ground for long period during the dry season.

Farmers' perception on sweet potato weevil

Ashebir (2006) conducted survey on farmer's perception in major sweet potato growing areas of SNNPR including Arbaminch-Zuria, Demba-Goffa, Boloso-Sore, Humbo, Damote-Gale, Sodo Zuria and Kachbira. It was found that insect pests were the major constraints of sweet potato production followed by porcupines, mole rat, and shortage of land, drought and storage problems in descending order. Among the insect pests, 63.8% of the farmers perceived sweet potato weevil to be the most important, while 27.6% of the farmers indicated the sweet potato butterfly is important. The rest of the farmers (8.6%) reported leaf miner and vine borers are important. It was observed that the weevil was important in Humbo, Boloso sore, Goffa and Arbaminch zuria woredas, while the sweet potato butterfly was important in Damot Galle and Sodo Zuria woreds. Leaf miner and vine borer were important in Kacha Bira woredas. The response of the farmers indicated that the weevil is more important in the low-land and mid-highland areas, while the sweet potato butterfly, leaf miner and vine borer are important in the mid highlands and highland areas.

CONTROL MEASURE STUDIES

Cultural control

Effect of sowing dates on sweet potato weevils infestation was evaluated at Awassa and Areka research centers in the 1994 cropping season (Adahanom and Tesfaye, 1994). Among the six planting dates extending from June to September, higher tuber infestation was obtained from the late plantings. The highest tuber attack (over 64%) and the lowest yield was obtained from September planted sweet potato followed by the early and late August plantings at Areka (Table 3. The second planting date July 10 gave the highest yield with low weevil infestation. Similarly, higher levels of tuber infestation were recorded from September planting followed by the early and last week of August at Awassa (Table 3). In general, late planted sweet potato attracted high level of sweet potato weevil damage at both locations. A similar study conducted in Wolayita indicated that sweet potato planted in August sustained lesser damage than September planted ones (Tesfaye, 2002). Earthing up of soil around the plant three times at monthly intervals starting from the second month after planting significantly reduced infestation of tuberous roots and this practice could enable to delay harvesting for more than six months (Emana, 1990).

Varietal Resistance for sweet potato weevil

Several researches have verified the presence of variability in sweet potato genotypes for resistance to sweet potato weevil. However, some of the materials reported to be resistant succumb under high weevil population pressure. Emana (1990) evaluated sweet potato varieties for resistance to the weevil from 1987- 1989 and found that 38 % of the varieties to be resistant and remaining were moderately resistant at Areka. At Awassa however, 55 % of the varieties were reported to be moderately resistant and the rest were susceptible. The reason for the variation in the level of resistance at the two locations was attributed to the difference in population density of the pest. Fields at Areka had been cultivated for only three years with sweet potato when the trial was conducted and the pest has not yet established itself. However, the varieties differed in the degree of damages and infestation levels they sustained. Varieties like Koka-26 and Cemsa had the lowest level of infestation and adult weevil density in the field. On the other hand, varieties

Table 2. Major insect pest species recorded on sweet potato, their order, family generic and common names (Ferdu *et. al.,* 2009)

Scientific name	Common name	Status	Reference
Homoptera			
Aleurodidae			
Bemisia tabaci	Cotton white fly	Vector of Virus	E
Aphis gossypii	Cotton aphid	Vector of Virus	E
Cicadelidae			
Emoasca fasciatis (Jacoby)	Cotton leaf hopper	Minor	65
Coleoptera			
Curculiondae			
Cylas puncticollis (Boheman)	Sweet potato weevil	Major	
Chrsysomelidae			
Aspidomorpha quadrimaculata (Oliver)	Tortoise beetle	Minor	65
Aspidomorpha tecta Boh	Tortoise beetle	Minor	
Lepidoptera			
Lyonetiidae			
Beddelia somnulentella Zeller	Sweet potato leaf miner	Sporadic	
Noctudae			
Spodoptera littorallis	Cotton leaf worm	Sporadic	
Nymphalidae			
Acrea acerata Hew.	Sweet potato butterfly	Major	
Spingidae			
Hippotion celerio (Linnaeus)	Vine hawk moth	Sporadic	E*
Hyles lineata (Fabricus)	Silver stripped hawk moth	Sporadic	E
Acarina			
Tetranichus cinnabrinus	Red spider mite	Sporadic	E

Source: Ferdu *et al*., 2009;
*E= the authors personal observations.

Table 3. Effect of sowing date on sweet potato tuber infestation due to sweet potato weevil at Areka and Awassa (After Adahanom and Tesfaye, 1994)

Areka			Awassa		
Planting date	**Yield ton/ha**	**Infestation (%)**	**Planting date**	**Yield ton/ha**	**Infestation (%)**
June 25	6.7	0.57	June 19	17.3	18.96
July 10	14.8	0.54	July 1	17.1	45.51
July 24	4.3	8.40	July 16	16.7	62.87
August 8	12.2	28.46	August 2	20.1	81.12
August 22	10.2	23.32	August 16	9.9	70.76
September 6	4.8	64.02	September 3	8.1	87.03
CV%	22.6	21.10	CV%	11.7	23.3
LSD0.05	3.93	8.29	LSD0.05	3.41	25.85
LSD0.01	1.59	11.79	LSD0.01	4.85	36.76

TIB-1102 and TIB-1-1102 had higher levels of tuber infestations. It is known that varieties with deeper roots suffer less from the attack of sweet potato weevils. The study alsro showed that Koka-26 and Cemsa had deeper roots than the other varieties considered (Temesgen and Tesfaye, 1995b).

Chemical control

Emana and Adhanom (1990) evaluated seven insecticides as dipping, foliar sprays and combination of both at Awassa and Areka during the 1987 and 1989 cropping seasons. Spraying begins two months after planting and continued up to the fourth month at fortnightly interval. Out of the seven insecticides cypermethrin and pirimiphos-methyl gave best control of the sweet potato weevil which resulted in higher marketable yield (Table 4). In another study dipping sweetpotato cuttings in diazinon 60 % EC before planting improved the yield and reduced the level of infestation (Tesfaye , 2002).

Integrated management of sweet potato weevil

The integration of insecticides, early planting and earthing up three times starting from one month after planting highly reduced the percentage of infestation by the sweet potato weevil and increased root yield of sweet potato (Mesele *et al.,* 2005). As indicated in Table 5, percent infestation by sweet potato weevil significantly ($p<0.05$) affected by planting date and earthing up (Table 6). The lowest percent infestation was recorded from early planting time (July 12), while the highest was recorded from late planting time (August 12). By hilling up the soil three times around the root of sweet potato crop the infestation percent was reduced from 21.4 to 17.3 %. The interaction of planting date by earthing up and chemical affected the percent infestation by target pest. Generally, lower percent infestation was recorded from the interaction of early planting by chemical treatment and earthing up as compared to other treatments (Table 6).

SWEET POTATO BUTTERFLY (*Acraea acerata*)

Sweet potato butterfly has become the most important insect pest of sweet potato in the southern parts of the country (Adhanom and Emana, 1987; Emana and Adhanom, 1989; Emana and Amanuel 1992; Ejigu, 1995; Tesfaye, 1995; Azerefegne, 1999). It was first noted and reported in 1986 as an outbreak in Gamogofa Awuraja. Since then it has spread over wide areas of southern Ethiopia (Table 7) It poses a very serious threat to farmers whose daily diet depends on sweet potato. Complete failure is now very common in many areas of the region where sweet potato is intensively cultivated.

Basic studies on sweet potato butterfly

Basic studies on sweet potato butterfly such as biology, host plant interactions, natural enemies, generation and population fluctuation, extent of infestation and yield loss were studied by different researchers (Ferdu, 1990).

Biology of the sweet potato butterfly

Ferdu (1990) studied the biology of potato butterfly in southern Ethiopia and found that the insect breeds throughout the year with about six discrete generations a year. Females lay their eggs in single layered batches of approximately 160 eggs on the underside of young as well as old sweet potato plants. Most eggs were found on the middle leaves along the vine. Larval development was shorter in males than in females. Pupation took place on the foliage or on the ground. Pupation under clods of soil and in cracks was more frequent during the dry periods. The pupal stage lasted about seven days and adults emerged during the day time, while mating occurred during in the afternoon. The adults lived for a short time with a maximum life span of nine days. In the laboratory, total development from egg to adult took 34 days. However, in the field both egg and larval developments were of longer durations resulting in a total development time of 40-50 days from egg to adult. Moreover, larval development was extended by 10 days during the rainy period compared with the dry periods. Adult butterflies are aposomatically coloured with orange and black. There is a less bright colour form which was frequent at all times of the year.

Host plants of sweet potato butterfly

Both male and female butterflies were found to feed on flower of many plants such as *Bidens pilosa, Croton macrostachys, Tagetes minuta, Guizota scabra* and *Solanum tuberodum.* Larvae of sweet potato butterfly develop not

Table 4. Efficacy of insecticides in the control of sweet potato weevil (after Emana and Adhanom, 1990).

Insecticide	Areka		Awassa	
	Infestation %	Marketable yield (t/ha)	Infestation %	Marketable yield (t/ha)
Carbaryl	29.94ab	7.9d	46.3b	4.4a
Cypermethrin	23.94a	16.5a	36.6a	5.3a
Endosulfan	28.01ab	8.2d	44.48b	5.67a
Pirimiphos methyl	25.01a	13.4abc	32.46a	5.7a
Karate	33.01ab	8.4cd	50.67b	4.5ab
Deletamethrin	23.54ab	11.1bc	48.63b	4.4ab
Diazinon-dipping	28.56ab	6.8d	53.73b	4.7ab
Diazinon-dipping + spray	31.28ab	9.0cd	48.06b	3.8ab
Diazinon spray	31.61ab	6.6d	48.13b	3.6ab
Untreated check	41.13b	5.1d	53.14b	1.3ab

NB: Means followed by the same letter (s) within a column are not significantly different from each other at 5% level of probability (DMRT).

Table 5. Effect of planting dates and earthing up on sweet potato weevil infestation and root yield at Awassa, 2004 (after Mesele *et al.,* 2005).

Planting date	Earthing up					
	% infestation			Yield ton /ha		
	Without earthing up	Three times earthing up	Mean	Without earthing up	Three times earthing up	Mean
July 12	15.7cd	6.9c	11.3c	34.3	33.6	33.9
July 27	21.8bc	12.9de	17.3b	28.4	24.8	26.6b
August 12	26.7ab	32.2a	29.4a	16.4	17.9	17.2c
Mean	21.4a	17.3b		26.4	25.4	
CV%	35.2			26		
SE	2.27			2.29		

Table 6. Effect of insecticides and earthing up on sweet potato weevil infestation and root yield at Awassa, 2004 (after Mesele *et al.,* 2005).

Planting date	Earthing up					
	% infestation			Yield ton /ha		
	Without earthing up	Three times earthing up	Mean	Without earthing up	Three times earthing up	Mean
Diazinon 60% EC	19.7ac	15.9bc	17.8c	22.8	26.7	24.7
Fenitrothion 40%EC	20.2ac	14.2c	17.2	27.6	24.5	26.0
Without insecticides	24.2a	22.0ab	23.1	28.7	25.2	26.9
Mean	21.4a	17.3b		26.4	25.4	
CV%	25.2			26.54		
SE	2.27			2.29		

only on sweet potato, but also on various wild *Ipomoea* species in Ethiopia. Larva feed and developed successfully on two indigenous species *I. cairica* and *I. tenuirostris*. (Ferdu, 1999).

Table 7. Status of sweet potato butterfly in some localities of southern Ethiopia (after Emana and Amanuel , 1992)

Survey location	Status of the pest in different seasons		
	1987	1990	1991
Damot Galle	unknown	Major	Major
Sodo zuria	unknown	Major	Major
Bedessa	unknown	Minor	Major
Areka	unknown	Minor	Major
Gassuba	unknown	unknown	Minor
Selamber	unknown	Major	Major
Sawula	Minor	Major	Major
Chanodorga	Major	Minor	absent
Zefine	Major	Minor	absent
Wajifo	Minor	absent	absent

Table 8. Yield loss of sweet potato in farmers' field caused by *A. acerata* (after Ferdu , 1999)

Season	Location	Treatment	5 months			6 months		
			Tuberous root yield (t/ha)	Loss (%)	Profit (birr)	Tuberous root yield (t/ha)	Loss (%)	Profit (birr)
1995-96	Abotaulto	Unsprayed	16.86a	41.4	2669	21.97a	38.6	3126
		Sprayed	28.78b			35.7b		
1996-97	Abotaulto	Unsprayed	7.61a	-	-	9.03a	-	-
		Sprayed	7.35a			8.85a		
1997-98	Abotaulto-I	Unsprayed	5.21a	53.2	1161	8.28a	51.5	1885
		Sprayed	11.12b			17.09b		
	Bugie	Unsprayed	12.44a	31.6	1119	17.60a	27.5	1684
		Sprayed	18.18b			24.26b		

Studies on Control measures of sweet potato butterfly

According to Ashebir (2006) more than 75% of the interviewed farmers in Wolaita zone did not use any control measures against the sweet potato butterfly, and less than 28% of the farmers applied control methods such as manure, wood ash, irrigation, mulching and synthetic insecticides like malathion.

In comparison between sprayed and unsprayed treatments at each site means followed by the same letter are not significantly different from each other.

Host plant resistance

Tesfaye (1995) tested six different sweet potato cultivars for resistance in terms of preference of adults for oviposition, landing and visiting as well as the level of larval infestation. However, on variation was observed among the varieties evaluated.

Use of botanicals

Mesele *et al*., (2004) evaluated leaf and seed extracts of *Tephrosia vogelli, Datura stramonium, Mellia azadirachta, Chenopodium album* and *Milletia ferrugenia*, and leaf of *Calusia abyssinica* and seed of *Azadrichata indica* for their insecticidal activity against the sweet potato butterfly larvae, and found that the botanicals showed differential insecticidal activity with respect to larval mortality and damage to sweet potato. *M. ferrugenia, T. vogelli* and *A. indica*

Table 9. Effect of botanicals on percentage mortality of sweet potato butterfly larvae and percentage leaf damage of sweet potato (after Mesele *et. al*., 2004).

Treatments	Part used	Days after treatment application (DAT)				Damaged leaves (%)
		1	5	10	15	
Tephrosia vogalli	Seed	60bc(7.54)	26.7ab(4.48)	6.67b(1.98)	0a(0.71)	4.6c(1.58)
T. vogalli	Leaf	33.3cd(4.95)	46.7a(6.84)	13.3b(2.59)	6.67a(1.98)	1.5c(1.32)
Datura stramonium	Seed	6.7de(1.98)	6.7bc(1.98)	0b(0.71)	0a(0.71)	17.2b(4.21)
D. stramonium	Leaf	13.3e(3.72)	0c(0.71)	0b(0.71)	6.67a(1.98)	13.2b(3.82)
Calusia abysinica	Leaf	13.3e(3.72)	6.7bc(1.98)	0b(0.71)	0a(0.71)	13.4b(3.71)
Azadrichta indica	Seed	6.7de(1.98)	26.7ab(5.21)	40a(6.22)	0a(0.71)	4.2c(2.16)
Mellia azadirach	Leaf	0e(0.71)	20bc(4.53)	6.67b(1.98)	0a(0.71)	12.4b(3.51)
Chenopodium album	Leaf	6.7de(1.98)	6.7bc(1.98)	6.67b(1.98)	0a(0.71)	16.8b(4.16)
Milletia ferrugenia	Seed	80ab()8.97	20bc(4.53)	0b(0.71)	0a(0.71)	2.2c(1.52)
M. ferrugenia	Leaf	66.7b(8.12)	6.7bc(1.98)	0b(0.71)	0a(0.71)	1.9c(1.45)
Endosulfan 35%EC	-	100a(10.02)	0c(0.71)	0b(0.71)	0a(0.71)	1.2c(1.16)
Untreated	-	0e(0.71)	0c(0.71)	0b(0.71)	0a(0.71)	26.6a(5.20)

Means followed by the same letter(s) with in a column are not significantly different at (P<0.05). Figures within brackets are square root transformed values.

out performed in killing sweet potato butterfly larvae and influenced larval leaf feeding compared to the other botanicals considered (Table 9).

In another study, the efficacy of *Milletia ferrugenia* seed powder aqueous suspensions was evaluated against the sweetpotato butterfly larvae under the laboratory and field conditions (Ferdu, 2006). Dipping test conducted in the laboratory showed that *M. ferrugenia* can cause high level of mortality on the fourth and fifth instar larvae. Spray of 5 and 10 % of *M. ferrugenia* on the larvae under field conditions caused more than 90% mortality and there were very few survivors. On the field spray made at Sodo Zuria, survival of the larvae was higher as most of the larvae were entered the fifth instar. The result indicated that spray should be timed at earlier instars of the insect (Ferdu, 2006).

Chemical control

Tesfaye (1995) reported that cypermethrin, carbaryl, deltamethrin, diazinon, endosulfan, lamdacyhalothrin and malathion gave satisfactory control when applied at the manufacturers' rates. Addis and Tesfaye (1995) also reported that pirimiphos-methyl, diazinon, carvaryl, deltamehrin and endosulfan were effective against the sweet potato butterfly.

GAPS AND CHALLENGES

Ferdu *et al.* (2009) have reviewed and well summarized the entomological researches on root and tuber crops in Ethiopia. Accordingly, the gaps and challenges were indicted as follows. The studies on root and tuber crop pests in Ethiopia were focused on very few economically important pests. Most of the studies were not continued for a longer durations and similar type of none-detailed studies prevailed in most of the case. The status of pests of the crop is not known except for those which cause significant crop damage.

The sweet potato weevil and butterfly are relatively better studied among the root and tuber crop pests and efforts has been made to develop management practices including use of appropriate varieties, insecticides, botanicals and cultural practices. However, the study on planting dates and insecticides were very repetitive. The planting date study were only focused from July to October and does not cover all the farmers practiced period or dates of sweet potato planting. If the soil moisture is not limiting, the farmers were planting sweet potato throughout the year. Moreover, the temporal distribution of sweet potato butter fly is one of the study areas which need investigation. The botanicals recommended for the insect were based on laboratory and small-scale field studies.

CONCLUSION AND RECOMMENDATIONS

In southern Ethiopia, sweet potato is grown in year round and plots of different age are always found in farm. Sweet potato plots belonging to the same farmers or neighbors' are located immediately next to the older plots or within 10 m distance, which create conducive conditions for the continues infestation by the sweet potato weevil. Therefore neighboring infested sweet potato fields and left over infested sweet potato tubers are the most important source of infestation for newly planted sweet potato plots in the region. Good field sanitation and planting away from weevil-infested fields are the two practices expected to have noticeable effect on weevil management. Farmers of the region are not familiar with the life cycle and dispersal of the sweet potato weevil. They don't usually establish a link between the mobile adult weevil and the larvae. Therefore, acquainting farmers to the sweet potato weevil life cycle will help in the extension of cultural control methods. The carryover effect of the weevil from an infested to a new field can be reduced by careful selection of planting materials by taking the tip of the vine. Vine tip yield planting is recommended because it produces high yield, and it is likely to be free from prior infestation by the pest. Sweet potato planting at different times of the year encountered varying level of infestations by the weevil. Therefore, planting at the appropriate time minimizes infestation. Generally, for sweet potato plantings of June to September, the main rainy season, early planting is advised. Those planted late needs to be protected with insecticides. There are no resistant varieties for the sweet potato weevil. However, varieties differed in the degree of damage and infestation by the pest. For example, varieties Koka 26 and Cemsa which are characterized by deeper roots had the lowest level of infestations and adult weevil density in the field. Among the insecticides, cypermethrin, pirimiphosd-methyl, and diazinon were found to be effective against weevil. To get better result farmers should integrate planting less susceptible varieties, use of vine free from infestation by dipping vines in insecticides or using the tip only, early planting, earthing up three times starting from one month after planting, and insecticide spraying if the area experiences high level of infestations.

For the management of sweet potato butter fly, among the botanicals tested, *M. ferrugenia, T. vogeli* and *A. indica* were found to be effective and can be used. On the other hand the insecticides cypermethrin, carbaryl, deltamethrin, diazinon, endosulfan, lamdacyhalotrin, malathion and pirimiphos-methyl gave satisfactory control when applied at the manufacturers rate. Therefore, these insecticides can be used in the period of outbreaks.

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