Insect Pests of Farm-stored Sorghum in the Bako Area

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Abstract

A survey was conducted in 1996 and 1997 to assess the species of insects and the associated damage levels in farm-stored sorghum. Fifty and 75 farm-stores in 1996 and in 1997 respectively were visited in some parts of western Shewa, east and western Wellega zones. Seven species of beetles, three species of moths, several hymenopteran parasitioids, bugs and pseudoscropions were recorded from the samples. Weevils of *Sitophilus* species followed by the Angomois grain moth were found to be the major insect pests of stored sorghum causing substantial losses. *Sitophilus* weevils were collected from all sites in large numbers. *S. cerealella* was also observed in most of the samples. The average grain damage and weight losses for the two years were 38.7% and 14.5%, respectively. Fifty eight percent and 55% of the farmers used gotera (gombissa and gota) type of storage structures in 1996 and 1997, respectively. Other storage facilities such as sacks, gumbi, clay pots and wooden boxes are also used in smaller proportions. Fifty percent of the respondents in 1996 and 28% in 1997 reported that they applied different types of chemicals to protect their sorghum in storage. Ten percent of the respondents in 1996 and 6.6% of them in 1997 used the non-recommended chemical DDT while 6% and 4% used pirimiphos-methyl in respective years. Some of the farmers responded that the treated grain is not used for consumption, but is sold in the market. They also practised periodical exposure and drying of grains in the sun, mixing sorghum with tef and finger millet and admixing of sorghum with partially ground hot pepper to protect their sorghum. Sorghum is also stored by putting in the middle of tef or finger millet either of the two being put at the top and bottom layers.

Introduction

In Ethiopia, sorghum is the third most important cereal crop following tef and maize in area of production. It is produced on an area of over 1.2 million hectares of land. It is also the third important crop in total production following maize and tef (CSA 1996). Most of the production comes from small-scale subsistence farmers. Most of the grain produced is retained and stored on the farm where post-harvest pest management practices are inadequate. Consequently, considerable amount of food is lost to pests of stored products. Losses ranging from about 2-30% have been reported to occur in different grains stored in Ethiopia (Abraham, unpublished). However, research on stored products has been neglected until recently. Abraham (1991, 1997) listed 37 species of arthropods associated with stored maize in western Ethiopia. However, information on arthropods involved, losses caused and management practices followed on stored sorghum is scanty in this country. Knowledge on the presence and distribution of stored grain insect species is essential for application of effective management.

The objectives of this study were to determine the species of insect pests associated with stored sorghum and to estimate the extent of damage and losses inflicted to the crop in the Bako area, western Ethiopia.

Methodology

A survey was conducted in August 1996 and June 1997 to assess the species of insects in farm-stored sorghum and the associated damage and loss levels. Fifty farm-stores in the 1996 and 75 in 1997 at altitudes ranging from 1150 to 1900 meters above sea level (masl) were visited from the western Shewa and eastern and western Wellega zones. Sites were selected at a distance of about 15 km far from each other. One or more farm-stores were taken from each site, depending on the availability of stored sorghum and the extent of its production in the area. Sorghum grain samples were withdrawn using a 100 g capacity can. Three samples were withdrawn from the different parts (upper, middle, bottom) of each store and were mixed and put in a paper bag for inspection in the laboratory.
Information on the location, altitude, sorghum variety, storage time, grain deterioration, post-harvest pesticide use, type of storage facilities, and farmers pest management practices were recorded using a semi-structured questionnaire.

In the laboratory, insects were separated, and their numbers and identities at each site were recorded. Insects were identified by examining under a dissecting microscope and comparing with previously identified specimens. Each sample of grain was reduced to sub-samples in order to have samples of equal size for grain damage analysis. These were separated into undamaged and insect damaged categories. Each category was weighed, the number of grains was counted and percentage weight loss was determined using the formula of Adams and Schulter (1978). Thus:

*% wt loss = (UNd - DNu/U(Nd+Nu))*100*
where U = weight of undamaged grain, D = weight of damaged
grain, Nu = number of undamaged grains, Nd = number of damaged grains.

Results and Discussion

Insect Pests Recorded

List of insects collected and their status of occurrence in the sample are given in Tables 1 and 2. Beetles such as *Sitophilus spp. (S. zeamais and S. oryzae), Tribolium spp., Carpophilus spp., Orzaephilus spp., Cryptolestes spp., Lasioderma serricorne, Rhizoperta dominica;* Moths such as *Sitotroga cereallela, Plodia interpunctella* and *Ephestia spp.*; several Hymenpteran parasitoids; bugs and pseudoscropions were recorded from the samples collected during the two years. *S. zeamais,* followed by *Tribolium spp. from* Coleoptera, and *S. cereallela* from Lepidoptera were found to cause substantial loss in stored sorghum.

Sitophilus weevils were collected from all sites at different altitudes in large numbers. *Sitotrga cerealella* was also observed in large numbers in various farm-stores from most of the sites surveyed (Table 2). Abraham (1997), recorded 24 species of Coleoptera, six Hymenoptera, three Lepidoptera, two Pseudoscorpions, one Diptera and one Thysanura on stored maize in western Ethiopia. The order of importance was *Sitophilus* spp., *Sitotroga cerealella, Tribolium* spp., *Carpophilus* spp. and *Cryptolestes* spp. However, *Sitotroga* infestation and damage was more in maize samples obtained on cob (Abraham 1991). Emana (1993) also reported more *Sitotroga cereallela* than *Siptophilus* spp. in southern Ethiopia where maize is stored on the cob.

Parasitic wasps of different species were recorded from almost all samples collected. However, it was hardly possible to obtain all individuals in the sample because of their fast flying behavior and small size. Some arthropods indicated in Table 1 were collected from only a few sites at relatively lower densities. The number of species recorded during the present work is lower than those recorded on maize in the area (Abraham 1997). The observed variability in the density and species of insects between the two crops and sites could be due to differences in crop varieties, storage management, variation in temperature and humidity.

All the arthropods recorded in this work have also been recorded on stored maize and sorghum in Ethiopia by different authors (Abraham 1991, 1997, McFarlane 1969, Walker & Boxall 1974).

Grain Damage and Weight Losses

Percentage grain damage and weight losses in respective years in each of the sites are indicated in Tables 3 and 4. *Sitophilus* weevils caused the highest proportion of grain damage in threshed sorghum the unthreshed grain was most damaged by *Sitotrga cerealella*. Mean percentage grain damage and weight losses caused by *Sitophilus* weevils as calculated by the count and weigh method were 48.1% and 21.9%, respectively, for sorghum stored in 1996 while the damage and weight loss figures for the 1997 were 29.9% and 7%, respectively. The range of grain damage was between zero and 100% in both years. The two years' average grain damage and weight loss were 38.7% and 14.5% respectively.

Insect populations corresponded with the grain damage levels in most sites. McFarlane (1969) reported that at lower altitudes (1500-1800 masl) grain damage levels were higher. Yemane and Yilma (1989) reported 7-34.6% damage in pit-stored sorghum after 8 months at lower altitudes (1780 masl) while 1.7 - 19.2 % damage in sorghum stored in gotera at highlands (2050 masl) after 13 months of storage. The associated losses were however similar, 15.4% and 14.1% at low and high altitudes, respectively (Yemane & Yilma 1989). Temperature, grain moisture content and relative humidity are the most important factors that determine the incidence and severity of storage arthropods.

Storage losses of 2.5 - 7.6 % were recorded in sorghum in Sudan (Seifelnasr 1992). The percentage weight loss for sorghum 4 months after harvest was 6.1 - 14.3 on average in traditional granaries in Kenya (Nyambo 1993). Loss figures obtained in this work is in line with the earlier reports.

Storage Facilities

Farmers store their sorghum in two ways i.e. threshed or unthreshed (on heads). Different traditional containers are used for storing the threshed produce (Table 5). These containers are situated either inside or outside of the house. The types of storage structures recorded in the survey area include gotera (gombissa and gota), gumbii (dibignit), clay pots, wooden boxes, kuna and sacks. Gombissa and gota types were the most common storage facilities used to store sorghum in the survey area. In 1996 and 1997, 58% and 55% of the farmers responded to use both types of storage structures respectively. In 1996, 20% of the respondents used sacks, 14% used gumbi, 2% stored in clay pots and the rest stored their sorghum in unthreshed form in and outside of their houses. During the 1997 survey, 24% of the respondents stored it in sacks, 6.7% stored in gumbi and the rest 14.7% in clay pots, wooden boxes and unthreshed. The unthreshed sorghum is stored on horizontally placed and raised structures.

It was also observed that farmers use different names for the same storage facility. For instance, gotera is used to mean either gombissa or gota. Gombissa is a storage structure which is top-roofed for protection against rainfall as it is placed outside of the house. On the other hand, gota is similar to gotera and it is a storage structure which is placed inside of the house. Both are made of locally available materials such as bamboo or *soyoma*. In most cases they are plastered with mud and/or cow dung. Gumbi is made of mud and straw of crop residues like tef straw. It has a layered structure of rings staked one over the other.

Post-harvest Pesticide Use

During 1996 survey 50% of the respondents informed that they have applied different types of chemicals of which 10% of them used DDT, 6% used pirimiphos-methyl, 2% used malathion, 2% used aluminum phosphide, 6% used both pirimiphos-methyl and aluminum phosphide, and 24% of them did not clearly know the type of chemicals they have applied (Table 5). In 1997, 28% of the respondents used different types of chemicals in order to protect their sorghum in store. Out of this, 6.6% of the respondents used DDT, 9.3% aluminum phosphide, 4% used pirimiphos-methyl, 2.6% used both DDT and aluminum phosphide, 1.3% malathion and aluminum phosphide, 1.3% DDT and pirimiphos-methyl simultaneously. But 2.7% of the farmers did not know the name of the chemicals applied. Most farmers purchased chemicals from the open market.

Some of the farmers indicated that they are

aware of the danger associated with the use of chemicals. They also pointed out the absence of other control methods that are as effective as chemical pesticides. Observations during the survey time indicated that some farmers applied chemicals that are meant for use against malaria vector control or ticks on cattle or field pests. Interviewed farmers responded that they do not use treated grain for consumption as food until several months. However, they disclosed that the treated grain is sold before long storage.

Some of the farmers also revealed that they practiced periodical exposure to drive off insects and dry the grain in the sun, mixing sorghum with *tef* or finger millet and admixing of sorghum with partially ground hot pepper to control sorghum storage pests. Sorghum is also stored by putting it in the middle of tef or finger millet either of the two being put at the top and bottom layers.

Table 1. List and status of insect pests recorded in stored sorghum in the Bako area (1996, 1997).

Order/Species/	common name	status
Coleoptera		
Carpophilus spp.	Sap beetles	common
Cryptolestes spp.	Flat grain beetles-	common
Lasioderma serricorine (F.)	Saw toothed grain beetles	rare
Oryzaephilus spp.	Lesser grain borer	rare
Rhizopertha dominica (F.)	Red/confused flower beetles	rare
Tribolium spp	Maize/rice weevils	common
Sitophilus spp		very common
Lepidoptera	Ware house moth	rare
Ephestia spp.	Indian meal moth	rare
Plodia interpunctella (Hubn.)	Angoumois grain moth	very common
Sitotroge cerealella (Oliver)		
Hymenoptera	-	common
Parasitic wasps		
Pseudoscorpionida	false scorpions	rare
Pseudoscorpions		
Archnida	flour mite	rare
Acarus siro (L)		
Hemiptera		
Bugs	-	rare

Note: rare = very few insect counts (zero to less than 5 in number/sample) recorded from few samples, Common = insects collected from most of the samples but in low numbers (1 to 20 insects/sample), Very common = large no. of the insect was recorded from all the samples (20 to over handreds of insects/sample).

Table 2. Percentage population of the arthropods recorded in the Bako area (1996,1997).

Insect spp.	Status by percent (%) 1996	1997
Sitophilus spp.	89.5	80.3
Sitotroge cerealella (Oliver)	2.5	10.9
Tribolium spp.	5.4	1.9
Rhizoperta dominica	1.4	4.1
Carpophilus spp.	0.3	0.7
Orzaephilus spp.	0.2	0.0
Cryptolestes spp.	0.1	0.6
Others	0.5	1.5

Note : percentage occurrence of hymenopteran parasitoids is not included in this table.

Table 3. Percentage grain damage and weight losses of stored sorghum in the Bako area (n =50)(1996).

Zone	Site name	Altitude (m)	No. of stores	Percentage	
				grain damage	weight loss
W. Shewa	Gibe dambi	1600	1	8.1	12.1
	Oda Gibe	1640	2	38.9	21.0
	Sadan Qite	1590	1	45.5	9.5
	Qarsa Biche	1725	6	49.3	12.1
	Wande	1690	2	43.4	26.7
E. Wellega	Chari	1660	1	82.8	52.6
	Wara Abay	1680	4	71.0	12.0
	Bake Goro	1670	2	51.3	35.6
	Machara	1660	1	78.4	46.7
	Minya Guliso	1770	1	32.1	7.9
	Tato	1835	2	73.8	46.9
	Markafa	1250	1	69.0	18.2
	Markafa	1156	5	57.7	27.1
	Arjo Gudatu	1250	3	67.3	12.2
	Jirma	1300	1	75.7	50.0
	Dimtu	1300	1	29.9	3.8
	Loko S. Farm	1350	2	35.6	8.2
	Loko	1334	5	29.7	18.0
	Uke S. Farm	1340	2	0.0	0.0
	Mender 10	1320	4	42.9	8.7
	Tsige	1600	1	41.3	33.8
	Adamo	1700	1	21.6	8.8
	Cheri	1600	1	60.3	42.7

Table 4. Percentage grain damage and weight losses of stored sorghum in the Bako area (n =75)(1997).

Zone	Site name	Altitude (m)	No. of stores	Percentage	
				grain damage	weight loss
W. Shewa	Gudina W.	1700	1	3.9	0.5
	Ale W. Ilu	1700	2	12.0	2.3
	Sadan Qixe	1700	3	42.2	1.7
E. Wellega	Sire	1790	5	22.0	3.1
	Warago	1817	3	48.3	7.2
	G. Wayu	1840	2	57.9	5.8
	W. Tuka	1800	1	3.4	0.2
	Ambalta	1550	3	55.3	12.9
	Kenaf	1325	2	2.3	0.9
	Mender 10	1300	2	13.1	2.9
	Mender 11	1300	3	51.3	19.8
	A. Lalistu	1300	7	24.6	2.9
	Angar	1300	3	21.2	7.9
	Andode	1350	6	26.6	11.3
	Loko S. Farm	1350	1	2.4	0.3
	Jima Arjo	1725	4	21.3	6.0
	Arjo Gudatu	1590	6	43.6	11.4
	Qarsa A.	1350	1	8.5	0.6
	Markafa	1200	2	46.2	13.7
W. Wellega	E. Dambi	1793	2	41.2	10.0
	Kata Gebo	1905	2	57.2	12.3
	Boji Hidabu	1900	1	100.0	28.7
	Jogir	1300	5	10.6	1.6
	Tole	1200	1	14.2	10.3
	Dabina	1200	1	8.0	2.0
	Dagaga	1200	1	7.7	1.3
	Amuma	1900	3	9.5	2.7
	Sombo	1350	1	5.1	2.3
	Inango	1880	1	55.5	18.8
	Bikltu	1800	1	66.2	8.4

Table 5. Types of storage structures and insecticides used by farmers in the Bako area.

Storage facility	Survey year	
	1996 (%)	1997 (%)
Storage facility		
Gombissa and gota	58.0	55.0
Gumbi	14.0	6.6
	2.0	0.0
Clay pots	20.0	24.0
Sacks	6.0	14.4
Other facilities		
Insecticides used		
DDT	10.0	6.6
DDT + Quickphos	0.0	2.6
DDT + Pirimiphos-methyl	0.0	1.3
Malathion	2.0	0.0
Malathion + Quickphos	0.0	1.3
Quickphos	2.0	9.3
Pirimiphos-methyl	6.0	4.0
Pirimiphos-methyl+ Quickpos	6.0	0.0
Unknown type of chemicals	24.0	2.7
Untreated (without)	50.0	72.0

n=50 in 1996 and 75 in 1997.

Conclusion

From the study made in the Bako area, seven species of beetles, three species of moths, several hymenopteran parasitoids, bugs and pseudoscorpions were recorded. Among these, the two most economically important insect pests were *Sitophilus* weevils followed by *Sitotroga cereallela*. Considerable grain damage and storage losses were also recorded for this area. The average grain damage and weight loss figures were 38.7% and 14.5%, respectively. Farmers of the area were found to use various insect control mechanisms. Periodical exposure and drying of grains to sun; mixing sorghum with tef and finger millet and admixing of sorghum with partially ground hot pepper to protect stored sorhgum were some of the major practices. They also used to store sorghum by putting in the middle of tef or finger millet either of the two being put at the top and bottom layers. Chemical control was also largely practiced. During 1996 survey, 50% of the farmers informed that they have applied different types of chemicals while in 1997, 28% of the them used chemicals in order to protect their sorghum in store. Hence, there is a need to introduce improved storage pest management techniques which rely less on chemicals.

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