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Full Length Research Paper

Storage pests of maize and their status in Jimma Zone, Ethiopia

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An experiment was conducted in 2004 to assess the major pests associated with stored maize, the damage and losses they cause in Jimma Zone, Oromia Regional State. Fifty farm stores were assessed. Seventeen arthropods, thirteen Coleopterans, three Lepidopterans and one Acarina were documented from the samples collected. Maize weevil (*Sitophilus zeamais)* followed by grain moth (*Sitotroga cereallela*), rice weevil (*Sitophilus oryzae)* and flour beetle (*Tribolium confusum)* were the major pests of stored maize in the study area. A major finding of the experiment was that a storage pests particularly, *S. zeamais* is the dominant and most important pest of maize in Jimma Zone. This pest was found in abundance in all areas assessed damaging maize grain. Farmers want to store maize grain for food security, seed, and to sell when the prices are high enough. However, this pest is a major challenge. Quantitative average grain damage of 64.50% and losses of 41 to 80% are common in the store within three to six months after storage. It is recommended that an integrated weevil management method should be implemented to prevent the high quantitative and qualitative grain losses incurred so as to contribute towards family food security in Jimma Zone.

Key words: Storage pests, pest status, *Sitophilus zeamais*, grain damage, grain loss.

INTRODUCTION

In Ethiopia, maize (*Zea mays* L.) is one of the major cereal crops grown for its food and feed values. It is one of the most important staple food and cash crops providing calories for the consumers and income for the traders. The production and productivity of maize has increased since the development of high yielding hybrid varieties by the Ethiopian Institute of Agricultural Research (Bako Agricultural Research Center). Thus, in the Jimma area, maize ranks first in production and productivity since the release of these hybrid varieties (CSA, 2007). Large areas of the zone are covered by maize crop and the area under production is still increasing if not because of seed constraint. Yet, these hybrid varieties are reported to be highly susceptible to insect pest attacks both in the field and storage (Girma et al., 2008). Hence, farmers are not as such the beneficiaries of this increased production and productivity potential of new varieties. Traditionally, maize grain is stored by Ethiopian farmers, both in and outdoors for consumption and sell in the later months of the year depending on the quantity produced per household. The stored maize is attacked and damaged by several pests that lead to quality deterioration forcing farmers to sell at reduced prices and below the production cost.

Insects are most often considered as the principal cause of maize grain losses (Adams and Schulter, 1978; Abraham, 1991, 1995, 1997; Ali et al., 2007). The most important insect pests that cause damage to maize in the field and storage are lepidopterous stalk borers and coleopterous weevils, respectively (Emana and Tsedeke, 1999). More than 37 species of arthropod pests are associated with maize grain in storage (Abraham, 1997). Most of the maize grain harvested was stored on the farm

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where postharvest pest management practices are inadequate (Dubale, 2011) leading to huge amounts of maize grain losses to pests of stored grain.

The global picture of losses of grain and pulse crops after harvest is estimated to be 10% mostly due to insect pests and this is very serious in developing countries (Boxall et al., 2002). The FAO (1985) estimated that storage pests and lack of proper storage methods cause losses of about 200 million tons of grains each year. The annual grain losses in Ethiopia range between 2 and 30% (Firidissa, 1999).

Information on storage pests of maize that cause damage and weight losses in Jimma Zone of Oromia regional state is not available. This experiment was carried out to assess the major insect pests associated with stored maize, the damage and loss caused by these insect pests in this area.

MATERIALS AND METHODS

Description of the study area and year

The study was carried out in Jimma Zone of Oromia Regional State located at about 300 to 400 km south west of Addis Ababa. This zone lies between latitudes 7°15´ N and 8°45´ S, and longitudes 36° 00´ E and 37°40´ E. The elevation of the zone ranges from 880 to 3360 m. a. s. l. The area experienced an annual average rainfall of 1000 mm for 8 to 10 months (Haile and Tolemariam, 2008). The main rainy season extends from May to September and the small rainy season takes place from February to April. The temperature of the zone varies between 8 to 28°C with an annual average of 20°C. It has a sub-humid, warm to hot climate. The study was conducted in Yebu, Asendabo, Seka, Dedo and Kersa, the major maize growing areas of Jimma zone.

Sample collection procedures

The survey areas were generally favorable for storage pest infestations owing to its environmental conditions. The survey was conducted when maize grain was in storage for three to six months and infestation and grain damage levels were most likely to be serious. Survey sites (woredas) were selected based on their maize production status (major maize producing areas) of the zone. A total of 50 farm stores from all woredas were visited and samples collected. Selection of sites, storage containers and samples were made in such a way that they are the representative of the woreda at random. When a selected site or storage did not have maize the next site or storage was taken as a substitute. From each container, three samples, each consisting of 100 g of maize grain seeds were taken. The samples were obtained from as many different parts of the various storage facilities as possible (top, sides, centre, and bottom). Each sample was put in a paper bag and labeled with the necessary information. The samples obtained from the same storage were mixed together and placed in a cloth bag for further inspection in laboratory as per the methods used by Firidissa (1999). Inspection of the samples was made within two weeks of collection in the JUCAVM laboratory.

Laboratory study

In the laboratory, at Jimma College of Agriculture, each sample of maize grain was sieved over a 2 mm mesh sieve (Abraham, 1995) and all fractions were examined. Insects were removed, counted and grouped according to order, family, and were preserved dry as pinned collections or in 75% ethanol for identification. Identification was made using combination of insect identification keys, pictures, comparison with already identified specimens' in laboratory, and descriptions. Sampled grains were separated into damaged and undamaged, weighed, numbers counted and percentage weight losses determined using the formula of Adams and Schulter (1978) as follows:

$$\% \text{ weight loss} = ((Und - DNu) / U (Nd + Nu) \times 100$$

Where "U" is weight of undamaged grain, "Nd" is number of damaged grain, "D" is weight of damaged grain, and "Nu" is number of undamaged grain.

Insect damage was assessed by the count method. One hundred seeds were randomly taken from each maize sample and the number of insect damaged and un-damaged grains was observed using a hand lens for the presence of hole or burrow. The percentage of insect damaged seed was then calculated (Fekadu et al., 2000; Wambugu et al., 2009) as follows:

$$\text{Insect damaged grain (\%)} = \frac{\text{Number of insect damaged grain}}{\text{Total number of grain}} \times 100$$

RESULTS AND DISCUSSION

Insect pests recorded, their status and abundance

All stores tested in this study were infested with insect pests. List of the major pests, their status and abundance are given in Tables 1 and 2. Seventeen arthropod species were recorded on maize grain in Jimma zone. Twelve species of Coleoptera (two species in Curculionidae, Cucujidae, Bostrichidae each, four species in Tenebrionidae, one species in Buruchidae and Silvanidae each), four species of Lepidoptera (three species in Pyralidae and one in Gelechiidae) and one species of Acaridae in the Acarina were identified. Among the different arthropods, the dominant species in all area surveyed was maize weevil (*Sitophilus zeamais)* followed by Angoumois grain moth (*Sitotroga cereallela),* rice weevil (*S. oryzae)* and flour beetle (*Tribolium confusum)* (Table 2). These pests were widespread, abundant and caused damage and loss to maize grain (Table 3). Abraham (1997) collected 37 species of arthropods associated with stored maize grain seeds in western part of Ethiopia, Bako area. He further stated that the most important arthropods were maize weevil, grain moth and flour beetle. However, Emana (1993) reported *S. cereallela* followed by *S. zeamais*, as the two most important pests of stored maize in Southern Ethiopia. This may be because of the similarity of the environmental conditions, which are warm and humid, in the Jimma and Bako areas and differences in the southern part where the environment is cooler. There was no new record of arthropods associated with maize from previous studies (McFarlane, 1969; Walker and Boxall, 1974; Abraham, 1991, 1997; Firdissa, 1999) in this area probably because the record was made on most

Table 1. Identity list of insect pests associated with stored maize and their status in Jimma zone of Oromia regional state, Ethiopia.

Order	Family	Common name	Specific name	Status
Coleoptera	Curculionidae	Rice weevil	*Sitophilus oryzae* (L.)	Major
	Curculionidae	Maize weevil	*S. zeamais* Motschulsky	Major
	Cucujidae	Flat grain beetle	*Cryptolestes pusillus* (Schonherr)	Intermediate
	Cucujidae	Red rust grain beetle	*Cryptolestes ferrugineus* (Stephens)	Minor
	Bostrichidae	Lesser grain borer	*Rhyzopertha dominica* (Fabricius)	Intermediate
	Bostrichidae	Larger grain borer	*Prostephanus truncates* (Horn)	Minor
	Tenebrionidae	Flour beetle	*Tribolium* sp.	Intermediate
	Tenebrionidae	Red rust flour beetle	*T. castaneum* (Herbst)	Intermediate
	Tenebrionidae	Confused flour beetle	*T. confusum* Jacquelin du Val	Major
	Tenebrionidae	Yellow mealworm beetle	*Tenebrio molitor* L.	Minor
	Buruchidae	Mexican bean weevil	*Zabrotes subfaciatus* (Boheman)	intermediate
	Silvanidae	Saw toothed grain beetle	*Oryzaephilus surinamensis* (L.)	Minor
Lepidoptera	Pyralidae	Tropical warehouse moth	*Ephestia cautella* (Walker)	Intermediate
	Pyralidae	Rice moth	*Corcra cephalonica* (Stainton)	Intermediate
	Pyralidae	Indian meal moth	*Plodia interpunctella* (Hubner)	Intermediate
	Gelechiidae	Angoumois grain moth	*Sitotroga cerealella* (Olivier)	Major
Acarina	Acaridae	Flour mite	*Acarus siro*	Minor

Table 2. Mean number of the most important insect pests of maize recorded from maize grain samples in Jimma Zone of Oromia Regional State.

Insect pests		Number of stores with the pest	Mean number per 100 g of seed (mean ± SD)
Common name	Specific name		
Maize weevil	*S. zeamais*	50	69.98 ± 4.73
Grain moth	*S. cerealella*	45	11.26 ± 1.13
Rice weevil	*S. oryzae*	30	9.09 ± 2.00
Confused flour beetle	*T. confusum*	20	5.25 ± 0.51

dominant species alone suggesting the need for further study. There were other pests and also beneficial hymenopterans of concern yet not preserved and identified in the current study. These insects and non-insect pests appeared to be less important, less abundant and difficult to collect and thus, were not recorded because they appear to be of no importance as direct pests. They were only collected from few sites and as such, further investigations need to be conducted. Most of the insect pests species recorded and identified were those which happen to be of great challenge to maize storage attacking the seed and forcing farmers to sell their produce at very low price immediately after harvest. In this study *S. zeamais* was the most common and destructive of all the insect pests recorded (Table 2). Most of the insects mentioned earlier were found attacking maize. *S. zeamais* was recorded in abundance from all the samples at all sites.

Grain damage and weight loss

There was a significant grain damage and weight loss caused by the pests (Table 3). Mean percentage grain damage and weight losses caused by the pests under traditional farmers storage practices were 64.50 and 58.85%, respectively. The maximum damage and weight loss was caused by *S. zeamais*. Grain damage ranged from 54 to 75% between three to six months of storage whereas the weight loss varied from 41 to 80%. More of the number of weevils associated with stored grains at each site was associated with more number of grain

Table 3. Percentage grain damage and weight losses of stored maize grain at different site (Jimma Zone) three to six months after storage (n = 50).

Sites	No. of stores	Grain damage	Weight loss
1	4	73.25 ± 1.48	69.33
2	2	64.50 ± 0.50	50.67
3	3	54.67 ± 0.47	45.33
4	4	63.75 ± 0.83	57.33
5	4	72.75 ± 1.48	70.67
6	2	55.50 ± 0.50	45.67
7	2	61.50 ± 0.50	56.67
8	2	57.50 ±0.50	48.33
9	4	72.00 ±1.58	65.33
10	3	68.33 ± 1.24	56.67
11	3	56.00 ± 0.82	51.67
12	2	75.00 ± 1.00	79.33
13	4	56.50 ± 1.12	41.67
14	2	67.50 ± 0.50	55.33
15	1	72.00 ± 0.00	77.67
16	1	54.00 ± 0.00	45.33
17	2	72.50 ± 0.50	76.00
18	3	63.00 ± 0.82	49.67
19	1	70.00 ± 0.00	58.67
20	1	60.00 ± 0.00	75.67
Mean ± SEM	-	64.50 ± 7.04	58.85 ±11.86
Range	-	54 to 75	41 to 80

damage and weight losses. As the length of storage period increased, the damage and losses also increased. The highest grain damage and weight losses at all location may be due to the conduciveness of the environmental condition for the pests. Schmutterer (1971) reported the severity of *S. zeamais* on both maize and sorghum in storage and showed a loss estimate of up to 80% in maize stored in unprotected silos in Bako area. The storage loss was found to be 80% in Cameroon after six to eight months of storage (Nukenine et al., 2002).

Kerstin et al. (2010) reported 10 to 12% loss of maize stored in traditional storage containers due to insect pests. Loss of about 18% was also reported in other African countries by the same author for maize grain stored in polypropylene sacks for a period of six months storage. Per household, average actual loss was reported to be about 12% of the average total grain produce (Abebe and Bekele, 2006). Farmers are managing insect pests of importance such as weevils by using chemicals, botanicals, sanitation, and mechanical tools.

Most of the species recorded in the present study are cosmopolitan pests in stored grains globally and deserve appropriate management tool development and use. Farmers in the study area were using different pest management methods such as application of insecticides, botanicals, ashes, salt, smoke, sanitation, and mixing of maize seeds with other grains.

CONCLUSION AND RECOMMENDATIONS

Maize is a major staple food and feed source for millions of people of Ethiopia and Jimma zone alike. Seventeen insect pests were associated with stored maize in the area. Maize weevil followed by grain moth, rice weevil and flour beetle was the most important. Significant grain damage (average of 64.50%) associated with losses of up to 80% was caused by the pests within three to six months of storage.

Further study that covers all growing area to evaluate the economic importance of their infestation for devising bio-intensive integrated pest management strategies were needed. Nationwide surveys should also be carried out to determine the species of pests associated with stored produce in Ethiopia in general and with stored maize in particular. Further identification using molecular techniques needed. In addition, losses caused by the major pest species in the different types of stored produce under different management practices should be determined. Novel management practices should be conducted and recommended for the area.

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