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Occurrence of Stored Grain Insect Pests in Traditional Underground Pit Grain Storages of Eastern Ethiopia

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Abstract
Grain samples were collected from 179 on-farm traditional underground pit stores found in agro pastoralist villages. The samples were collected from four district namely Babille, Gurusm, Jigjiga and Awbarre districts of Ethiopian Somali provenance. The study was conducted to assess the occurrence and damage related to storage insect pests in traditional grain pit stores. Data on relative abundance, insect grain damage and germination percentage for each district were summarized and subjected to descriptive statistics analysis and mean and standard deviation were performed. According to the result, all assessed grain stores exhibited with significant infestation with storage insect pests. Over all finding indicted that maize weevil (*S zeamais*), angoumois grain moth (*S cerealella*) with mean relative abundance of 41.25 and 28.52% respectively others including flour beetle (*T castenum*), flat grain beetles (*C ferugineus*) and Saw-toothed grain beetle (*O surinamensis*) were also commonly recorded in all assessed districts. Maximum grain damage in sorghum was recorded from Awbarre district 29.27%. The highest grain damage in maize was recorded in Babile (33.88%), Gursum 32.47% and Jigjiga 30.86%. Sorghum and maize grain stored for at least 8-9 month showed mean germination percentage of 72.81% and 66.96% respectively.
Keywords: Stored grain insect pests underground pit storage system

1. Introduction

Post-harvest losses are one of the major causes of food insecurity in the developing world. In Africa, at the farm level, producers store their grains for three purposes: for consumption until the next harvest, as seed for planting in the next season and for selling when prices become favorable. In many developing countries, including in Ethiopia, grain storage practices involve traditional structures, which are largely ineffective in the prevention of deterioration of stored products (Abraham, 1995). The majority of framers in Ethiopia (93.3%) use traditional storage containers that exposes stored grains to storage insect pest, mold and other lose factors (Dubale *et al*., 2012).

Among the key constraints to improving food security in Africa are losses resulting from poor post-harvest management of grains (Charles *et al*., 2016). The average grain losses due to storage pests about 12% of the total grain produced in some case the losses could be rise to 50% (Gabriel and Hundie, 2006). Deterioration of stored grains results from the interactions of several factors such as physical, chemical and biological variables existing the overall chains from production to consumptions (Dubale *et al*., 2012). Deterioration of grain due to infestations of insects, mites, and fungi is the main post-harvest factor affecting the nutritional quality and marketability of stored grain.

Grain storage pests are major concerns for farmers worldwide but especially in developing countries because large percentage of the crop may be lost to storages pests. Prior to any pest control interventions it is vital to assess the pest status and extent of losses that have occurred or likely to occur during storage (Togola *et al*., 2015).

In Ethiopia studies on grain postharvest storage management practice and associated storage pest are limited to other parts of the country. Information on the occurrence and distribution of stored grain insect pests in common traditional grain store is lacking. The absence of documented information has made difficult to design and implement intervention strategies in the region. Therefore, current study was intended to find out occurrence and distribution of stored grain insect pests in on-farm traditional underground pit grain stores in agro pastoralist villages in Eastern Ethiopia.

2. Material and method

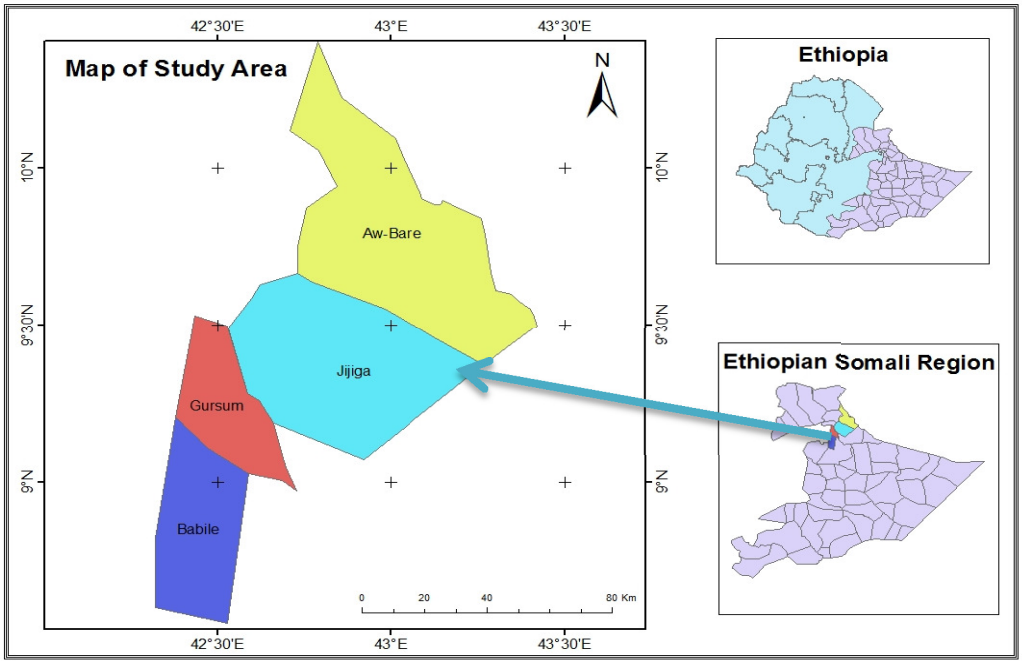
2.1. Description of study area

Data was collected from four randomly selected districts of Eastern Ethiopia namely Babile, Gursum, Awu-barre and Jigjiga. These districts are located 9-11^0 N 42-43^0 E and climate is largely influenced by its proximity to the Gulf of Aden in the north and the Indian Ocean in the East. The area has Bi-modal rainfall pattern with total annual rainfall ranging from 193.1 mm to 756 mm and average annual temperature of 15.3 ^{0}C to 24.9 ^{0}C (Shiferaw *et al*., 2015)

2.2. Methods of data collection

Study was conducted in June-August 2015 on randomly selected 179 traditional underground pit grain stores. Grain samples were collected from storage system found in four districts indicted below in the map. From each

stores 100 g of maize and sorghum grain samples were collected in three different depth of the store (from the surface, midway and near bottom) then samples were bulked and then 300 g sample prepared as sample/each stores. Then samples were tagged and brought to Jigjiga University Dryland Crop Science laboratory for analysis.



2.3. Laboratory analysis

Storage insect pest species identification

Insect pest species were identified after separation of grain debris, suspected grain samples were placed in an incubator adjusted to function + 27 0C for ten days till the adult emerges from the infested seed. Finally insect samples collected from grain and observed under dissecting microscope under 20^X magnification. After observation identification storage insect species were made based on the identification guide presented in (David, 1994).

Relative abundance of insect pests: Relative abundance of each storage insect pest determination was performed after insect pastes were identified and counted from grain samples collected from grain stores of four districts

$$\text{Relative abundance} = \frac{\text{Number of individual insect species in the sample x100}}{\text{Total insect species in the sample}}$$

Physical grain damage due to insects: three hundred seed of sorghum and maize were randomly taken form grain samples collected from four districts then each sample were divided in to three parts finally number of damaged grain was counted manually using hand lens then percent of damaged grain was calculated as (Wambugu *et al*., 2009).

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

***Germination test*:** From each collected grain samples from all districts 400 seed of sorghum and maize seed were taken randomly form each samples then divided in four equal parts and placed in Petridish which was lined with filter paper moistened with distilled water in 100 seed/petridish. Then germinated seed were counted till the 7^{th} day and germination present was calculated.

2.4. Data Analyses

Data on relative abundance, insect grain damage and germination percentage for each district were summarized and subjected to descriptive statistics analysis and mean and standard deviation were performed using SPSS Ver. 23 statistical package and the result was presented in tables.

3. Result and Discussion

3.1. Occurrence of storage insect pests in traditional underground pit grain store

In four assessed districts, two major and three minor species of storage insect pests viz., Maize weevil (*Sitophilus zeamais*), Angoumois grain moth (*Sitotroga cerealella*) and flour beetle (*Tribolium castenum*) , Flat grain beetles

(*Cryptolestes ferugineus*) and Saw-toothed grain beetle (*Oryzaephilus surinamensis*) were recorded (Table-1). Accordingly *S zeamais*, had relatively high relative abundance value in all survey districts, comapred to other all districts the highest relative abundance of *S. zeamais* was recorded in Awu-barre and followed by Jigjiga. Low relative abundance figure of *S. zeamais* was seen in Babile and Gursum districts. Relatively higher *S. cerealella* relative abundance was observed in Jigjiga which was 37% followed by Babble and Gursum (Table-1), the lowest was observed in Awu-barre district. *S. zeamais* and *S. cerealella* were predominantly occurred and highly abundant in all assesd onfarm grain storages. Minor but potential storage insect pests *T. castaneum, C. ferugineus and O. surinamensis* were also recorded in comparably low relative abundance in all assessed grain stores.

Current finding is in agreement with (Dubale et al., 2012) who reported two major insect pests maize weevil (*S. zeamais*) and angoumois grain moth (*S. cerealella*) in large proportion in traditional grain stores in Ethiopia. Similarly (John *et al*., 2011) reported 46.1 % *Sitophilus spp* relative abundance in traditional grain storages. *S cerealella* has been designated as a serious primary pest that mainly attacks maize, wheat and sorghum, both in the field and in stores in central Ethiopia (Emana G, Assefa 1998). Minor but potential storage insect pests also recorded across all districts with relatively low abundance thus *T. castenum, C. ferugineus* and *O. surinamensis* with mean relative abundance of 11.85%, 8.59 % and 10.21% respectively. Similarly (Marryam *et al*., 2013) reported less than five major insects of stored grains particularly stored in traditional storage system. In this study insect grain damage was significant across all districts however the damage was more sever in maize than sorghum. The average insect grain damage was 22.24% and 31.14% for sorghum and maize respectively. Previous studies in other parts of the country reported in the range 20-50% for different stored grain stored in traditional grain stores (Abrham, 1995; Eticha and Tadesse 1999; Dubale *et al*., 2012). Several factors may have contributed to high grain damage, among the factors crop spices, storage duration, storage type and management practice can influence grain damage by insect pests (Mustapha et a*l.,* 2011).

Table-1 Relative abundance of recorded storage insect pests in traditional underground pit grain stores

Districts	**Grain storage insect pests relative abundance across districts**				
	S zeamais (Curculionidae) Coleoptera	*T castaneum* (Tenebrionidae) Coleoptera	*S. cerealella* (Gelechiidae) Lepidoptera	*C. ferugineus* (Laemophloeidae) Coleoptera	*O surinamensis,* (Silvanidae) Coleoptera
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
Babile	34.28 ±5.94	12.66 ±2.38	27.68 ±9.01	14.58 ±6.27	11.88 ±2.06
Gursum	31.50 ±4.35	14.50 ±5.19	26.75 ±6.71	18.08 ±2.61	8.75 ±5.50
Jijiga	44.75 ±2.98	9.35 ±1.46	37.92 ±3.26	2.84 ±0.53	7.25 ±1.25
Awu-barre	54.50 ±5.00	8.25 ±2.50	21.75 ±1.50	5.25 ±1.50	10.25 ±2.5

3.2. Insect grain damage and germination percentage

High percent of grain damage for both stored items observed across all sampled stores across the districts. Maximum grain damage in sorghum was recorded from Awu-barre district 29.27% (Table-2). The highest grain damage in maize was recorded in Babile 33.88%, Gursum 32.47% and Jigjiga 30.86%. In all surveyed districts grain damage due to insect were sever in maize compared to sorghum (Table-2). The mean insect damaged grain of sorghum was 23.4% for all districts were as 28.77% for maize.

Table-2 Germination and insect grain damge persentage of each sampled destrics

Districts	**Insect grain damage %**				**Germination %**			
	Sorghum		Maize		Sorghum		Maize	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
Babile	22.00	±6.82	33.88	±3.51	72.53	±5.85	63.89	±4.35
Gursum	13.33	±1.52	32.47	±6.61	80.49	±9.01	61.67	±3.61
Jijiga	24.33	±7.76	30.86	±3.77	71.42	±10.59	65.35	±17.09
Awu-barre	29.27	±3.05	27.38	±9.50	68.48	±7.37	70.06	±11.71

The result of the laboratory seed germination test showed that both sorghum and maize grain stored for at least 8-9 month showed mean germination percentage of 72.81% and 66.96% respectively (Table-2). Compared to sorghum, maize exhibited relatively low germination percentage across all assessed districts. Highest germination percentage of sorghum was recorded from grain samples collected from Gursum 80.49 followed by Babile 72.53. Lowest sorghum germination percentage was recorded from Awu-barre 68.48%. In this study maize grain samples collected from Awu-barre district showed relatively higher germination percentage 70.06% compared to the other districts and the next higher germination percentage of maize was observed Jigjiga district 65.53%. Other assessed districts showed relatively low germination percentage of maize 63.89% and 61.67% for Babile and Gursum districts respectively (Table-2). Factors like grain storage duration, management practice, grain storage type and insect damage can significantly influence germination capacity of stored grain (Lemessa *et al*., 2000)

According to the result in the (Table-2) sorghum germination percentage was higher than maize the mean

germination percentage was 73.23% and 65.24% for sorghum and maize respectively. Similar reports by indicted that higher grain damage on those grains stored in traditional grain storages due to primary insect pests (Wambugu et al 2009; Chattha *et al*., 2016). In current study in all assed districts, maize germination was significantly lower than that of sorghum this could be due to relatively higher infestation and grain damage exhibited in maize led to reduced germination parentage. There result was in agreement with other study reported by Shakeel *et al*. (2016) indicted that insect grain damage reduces grain germination percentage in seeds stored in traditional storage.

4. Conclusion

Current finding identified that all assessed 179 pit grain stores exhibited with significant infestation with maize weevil (*S. zeamais*), angoumois grain moth (*S. cerealella*) and flour beetle (*T. castenum*), flat grain beetles (*C. ferugineus*) and Saw-toothed grain beetle (*O. surinamensis*). Among five commonly recorded insect pest two of them namely maize weevil (S. zeamais), angoumois grain moth (*S. cerealella*) were highly abundant and damaging in major stored items. There were also maximum grain damage and reduced germination capacity have been observed in grain samples collected from these traditional underground pit storage system. Therefore, efforts should be initiated on activities those leading to improvement traditional storage system and there by reduction in infestation, grain damage and losses.

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