Original Research Article

The Status of Insect Pests Stored Wheat Grain under Traditional Storages of Cheha District of Gurage zone of south central Ethiopia

ABSTRACT

Aims: For assessing the status of stored wheat insect pests in Cheha destrict of Gurage Zone of Southern Ethiopia
Study design: Peasant associations were selected purposefully based on abundance of wheat production, such that those peasant association growing wheat chiefly were selected for the survey, while villages, representative farmers and their storages were selected randomly using a nested design.
Place and Duration of Study: Survey was conducted between 1, July 2019 and 30, January 2020 with the interval of one month in major wheat growing peasant associations of Cheha destrict of south central Ethiopia.
Methodology: The assessment on abundance was made from of half kilogram of wheat grain sample taken from 135 randomly selected farmer's storages of three peasant associations using key of books related to stored product insects.
Results: Eight major species of insect pests consisting of four primary pests and four secondary pests belonging to five families with in two insect orders were documented. Of these pests recorded, *Sitophilus oryzae*, *Sitophilus zeamais*, Sitotroga cereallella, *Tribolium castaneum* and *Tribolium confusum*, respectively were the most abundant and the most frequently occurring as they appeared between 12.74 and 33.78 individuals per 100g of grain and as they occurred in the range between 77.78 and 92.26% per 100g of sample wheat grain collected from the survey site, respectively. Following these species, *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica* were the next abundant and frequently appearing as they occurred between 7.26 and 10.74individuals per 100g of grain and as they appeared in the range between 51.85 and 66.67% per 100g of sample wheat grain collected.
Conclusion: The traditional methods and practices used by farmers were inefficient for giving sufficient protection of their stored wheat against insect pests, which implies the presence urgent need for designing management strategies for these pests

Keywords: Stored wheat, insect pests, status, species composition, traditional storages

1. INTRODUCTION

In Ethiopia, in general and Cheha district of Gurage Zone, in particular wheat is one of the most important staple cereal crop which has been produced in large quantity for different purposes, including home consumption, trade and seed purposes [1, 2]. However, shortages of sufficient and affordable (cheep) agriculture inputs have restricted increment in wheat production. These problems have been further complicated with the losses of wheat both in field as well as in storage due to insect pests. Such loses of grains have been affecting the

income, livelihood and food security of resource poor farmers in Ethiopia, including the study area [3, 4, 5]. As a result, there is a need to reduce losses of food grains such as wheat by insect pests, particularly in storages as the losses in storage are non-compensated, so as to reduce food insecurity of poor farmers. To reduce these losses caused by pests, information on the current status of insect pests and their management practices under farmer's storage condition has been indicated to be very vital, since farmers are proven to be wealth in indigenous knowledge [6]. Accordingly, determining the species composition of insect pests found under wheat traditional farmer's storages is the key step in understanding and managing insect problems. Besides, knowledge on the status and abundance of insect pests infesting stored wheat under farmer's traditional storage condition is very vital for designing any management strategies.

Therefore, this study is designed with the objective of assessing the status of stored wheat insect pests in Cheha Woreda of Gurage Zone to gate base line information that will aid in designing and implementing sustainable pest management strategies in the study area, in particular and Ethiopia, in general.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

Survey was conducted in three selected major wheat growing areas (kebeles or peasant associations (Pas)) of Cheha district of Guraga Zone. The localities are namely Grardiber (high land) and Bakanote (high land) and Yemegenase (mid land) of Cheha district of Guraga Zone (Figure 1). Survey was conducted between 1, July 2019 and 30, January 2020 with the interval of one month.

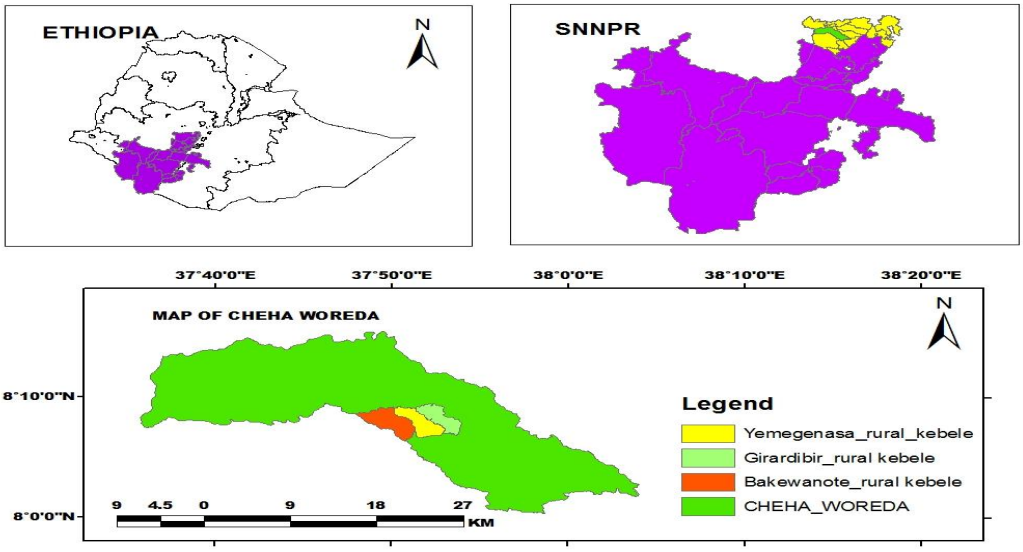

Figure 1. Map of the study area.

2.2. The Study Design and Sampling Techniques: From each kebele (peasant association), about three sub-localities were randomly selected and from each sub-locality, three villages were selected at random with the assistance of the Ministry of Agriculture (MOA) sub-kebele staff using a nested design as adopted by earlier researchers [7, 8]. Kebeles were selected purposefully based on abundance of wheat production, such that

those kebeles growing wheat chiefly were selected for the survey, while villages, representative farmers and their storages were selected randomly.

2.3. Determination of the Relative Abundance and Status of Insect Pests of Stored wheat grain: Half kilogram of wheat grain was sampled from each stores (a total of 260 stores; two store from each villages of 135 randomly selected villages of three peasant associations were considered) using a nested design, such that District was nested under Zone, and Kebeles were nested under District, and sampling stores were nested under Kebeles. Kebeles, District and Zone were purposively selected, while selection of villages and sampling of stores were done randomly as indicated in section2.2 as adopted by previous researchers [7, 8]. The samples were taken from top, sides, center and bottom of the storage structures using different sampling tools such as sampling spear, sampling scoop and human hands among others. Samples taken from different positions of the stores were thoroughly mixed and half kg was taken as a final working sample. Selection of the survey sites and storage methods were made in such a way that they were the representative of each kebeles of the woreda or districts at random.

Each sample at each sampling date from the different storage methods at each villages of the sampling site was collected in sampling bag, labeled with necessary information and kept for further identification of insect pests. The samples at each sampling date from the different farmers' traditional storage structures of each villages of each of the same PAS were sub sampled further after thoroughly mixing them to come up with a standard of 100 g sample. Then the sub sample from stores of each village of each of the same peasant association was sieved (using sieves of different size) for separating the adult insects from the sample grains in Wolikita Entomology laboratory. Alive and dead insects from samples of farmer's traditional methods were collected and immediately preserved in 100 ml capacity bottles or plastic jars and kept for further identification. The subsampled grains were also putted in 1 L glass jars and kept under laboratory conditions (27 ± 3 °C and 55 - 70% RH) to determine species from internal infestation.

Then, the procedures and keys of the books related with stored product insect pests and other arthropods by different authors [9, 10, 11, 12, 13, 14] were used for identification purpose. Besides, keys and pictures from on line available literatures were also used for identification. Then after, insects were sorted according to their orders, families and species, and counted for each subsample grains from each of different farmer's traditional storage methods in each case noting the number.

Then after, the status of insect pests of stored wheat was determined using the formulas indicated below. The average of the sum total of species of arthropods (insect pests) collected from sub-samples from each village of each peasant association was used to determine the status of insect pests. For assessing pest's infestations, the main variables have been included abundance, relative abundance and Constance (frequency) of species found in samples as suggested by pervious scientist [15]. Abundance refers to the total number individuals of a species divided by the total number of samples (in this case the total number of kilograms) and it is expressed by the following formula:

$$\text{Abundance of species} = \frac{\text{Total number of individuals of species}}{\text{Total number of samples}}$$

The relative abundance of species is expressed by the percentage of individuals of the species in a total number of observed individuals as shown in the following formula:

$$\text{Relative Abundance of species} = \frac{\text{Number of individuals of a species}}{\text{Total number of observed individuals}} \times 100$$

Constance (frequency) expresses the percentage of species occurrence. It is obtained by the relationship between the number of samples containing the species and the total number of samples. The following formula is expressing this relationship.

$$\text{Constance of species} = \frac{\text{Number of samples in which the species occurred}}{\text{Total number of sample}} \times 100$$

2.4. Data Analysis

All the data from survey were managed and performed using Microsoft Excel version 2013 and Statistical Program for Social Sciences (SPSS) version 16. Descriptive statistics (means and percentages) were used for compiling and computing data on abundance of insect pests and the associated grain damage and weight of stored wheat grain under farmer's traditional storages in different agro ecology. Significant differences between Means were separated by Tukey's honestly significant difference (THSD) test at 95% confidence interval level.

3. RESULTS AND DISCUSSION

3.1. The Relative Abundance and Status of Insect Pests Stored Wheat Grain under Traditional Storages of Cheha District

The various categories of insect pests identified from stored wheat of farmers traditional storage structures of cheha district are demonstrated in table 1 and 2.

Accordingly, eight major species of insect pests consisting of four primary pests and four secondary pests belonging to five families with in two insect orders were documented or recorded. Of these pests recorded from farmers traditional storages, five species such as *Sitophilus oryzae*, *Sitophilus zeamais*, *Sitotroga cereallella*, *Tribolium castaneum* and *Tribolium confusum*, respectively were the most abundant and the most frequently occurring as they appeared between 12.74 and 33.78 individuals per 100g of grain and as they occurred in the range between 77.78 and 92.26% per 100g of sample wheat grain collected from the survey site, respectively. Following these five species, *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica* were the next abundant and frequently appearing as they occurred between 7.26 and 10.74individuals per 100g of grain and as they appeared in the range between 51.85 and 66.67% per 100g of sample wheat grain collected.

Generally, in terms of abundance, relative abundance, frequency of occurrence and status (economic importance), the 14 arthropod species were found to be in the following descending orders, i.e., as *Sitophilus oryzae* > *Sitophilus zeamais* > *Sitotroga cereallella* > *Tribolium castaneum* > *Tribolium confusum* > *Cryptolestes ferruginous* > *Cryptolestes pusillus* > *Rhyzopertha Dominica*.

The abundance, relative abundance, frequency of occurrence and status (economic importance) the aforementioned eight species of insect pests of stored wheat grain from farmer's traditional storages of the survey site in the present study suggests great economic importance of these pests under farmers traditional conditions. This finding agrees with the result previous researchers in Ethiopia [7, 8, 16, 17] and in different parts of the world [9, 10, 11, 12; 14, 18], in which they were indicated to be the most important and cosmopolitan pests, especially in topical humid areas.

The grouping of insect species in to four primary and four secondary pests in the present study is in accordance with the works or reports of previous scientists [9, 10, 11, 12; 14, 18].

Among the eight insect pests recorded in the current study, most (seven species; *Sitophilus oryzae*, *Sitophilus zeamais*, *Tribolium castaneum*, *Tribolium confusum*, *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica*) were from order coleopteran, while only one (*Sitotroga cereallella*) was from order Lepidoptera, which implies great economic importance of beetles in grain storages than moths, which is in agreement with reports previous researchers [19, 20] in which beetles were shown to be the more diversified and highly destructive than moths, among post-harvest pests.

The occurrence in major status of all species of insect pests recorded in the present study suggests the conduciveness of environment of the study area to pest's propagation likewise that of other tropical areas, less efficacy of the traditional storage methods and management practices used by farmers in protection of their stored wheat grains against insect pests. Similarly, it was reported that the type of storages, the duration of storage and the storage management implemented prior to, and during storage affect level of insect infestation and the associated losses [21]. It was also shown that farmers of Africa in general and Ethiopia in particular use traditional granaries to store their grains, which are not effective against storage pests [22]. Earlier researcher [23] also indicated that together with the use of inappropriate storage facilities, tropical climatic conditions and poor sanitation of grain storage in SSA also encourage insect pest attack.

The circumstance that four species were primary pests and four species were secondary pest's terms of the type, out of eight insect pests species recorded in the current study approves the tangible knowledge of their difference in feeding behavior. Similarly, previous scientist [12] indicated that the insect pests of stored grains can be grouped as primary and secondary pests, whereby the former ones can attack sound grains and the later ones require the grains to be damaged to pose attack. It was also revealed that insect pests of stored grains can be categorized as primary pests, secondary pests and mold feeders where by the former's two attack grain directly through feeding, while the later ones do not affect the grain directly by feeding, instead, contaminate the grain mass through their presence and their metabolic activity [24].

Being equally prevalent of secondary pest's species with that of primary pests species along with more prevalence four secondary pests (*Tribolium castaneum*, *Tribolium confusum*, *Cryptolestes ferrugineus* and *Cryptolestes pusillus*) beyond *Rhyzopertha dominica* in terms of abundance and status in the present study also suggests great economic importance of secondary pests as that of primary pests in grain storages. Accordingly, it was shown that primary pests does not necessarily refers to more importance the pests, but simply implies to the dynamic processes involved whereby secondary pests can cohabitate (follow) primary pests and inflict (cause) serious and economic losses, especially under long-term storage [25].

Table 1. The status of insect pests stored wheat grain under traditional storages of Cheha District

Species of pests	Total number of adult insects	Abundance (average no. insects/ 100 g of grain sample)	Relative abundance (%)	Frequency (% of samples containing each species	Status
Sitotroga cereallella	405	30	19.88	74.07	Major
Rhyzopertha dominica	98	7.26	4.81	51.85	Major
Sitophilus oryzae	456	33.78	22.38	92.26	Major
Sitophilus zeamais	451	33.74	22.14	88.89	Major
Cryptolestes ferrugineus	145	10.74	7.11	66.67	Major
Cryptolestes pusillus	133	9.85	6.53	59.26	Major
Tribolium castaneum	177	13.11	8.69	81.48	Major
Tribolium confusum	172	12.74	8.44	77.78	Major
Total	2037				

Table 2. Taxonomic position of insect pests stored wheat grain under traditional storages of Cheha district

Species of pests	Common name	Order	Family	Pest type
Sitotroga cereallella	Angoumois grain moth	Lepidoptera	Gelechiidiae	Primary
Rhyzopertha dominica	Lesser grain borer	Coleoptera	Bostrichidae	Primary
Sitophilus oryzae	Rice weevil	Coleoptera	Curculionidae	Primary
Sitophilus zeamais	Maize weevil	Coleoptera	Curculionidae	Primary
Cryptolestes ferrugineus	Flat grain beetles	Coleoptera	Cucujidae	Secondary
Cryptolestes pusillus	Merchant grain beetles	Coleoptera	Cucujidae	Secondary
Tribolium castaneum	Red flour beetle	Coleoptera	Tenebrionidae	Secondary
Tribolium confusum	Confused flour beetle	Coleoptera	Tenebrionidae	Secondary

5. CONCLUSION

The present study confirms great economic significance of secondary pests as that of primary pest once the grain is damaged under tradition farmer's wheat storages. Besides, it also confirms the conduciveness the environmental condition of the survey site for pest's propagation like other tropical areas. Thus, any attempt that could be made in managing these pests stored wheat grain should consider the ecology and the behavior of these pests for their effective control and reduction of loss by them.

In the current study, eight major species of insect pests consisting of four primary pests and four secondary pests belonging to five families with in two insect orders were documented or recorded. Among these pests, *Sitophilus oryzae*, *Sitophilus zeamais*, *Sitotroga cereallella*, *Tribolium castaneum* and *Tribolium confusum*, respectively, followed by *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica*, respectively were found to be the most abundant and the most important pests that were responsible for significant loss of stored wheat in the study area.

As a result, the traditional methods and practices used by farmers were inefficient for providing adequate protection of their stored wheat grains against insect pests. Therefore, there is urgent need for designing effective management strategies against insect pests among others of stored wheat grain. Besides, improving the existing traditional storage strictures of farmer's in the survey site by designing relevant strategies so as to reduce the loss of stored wheat grain by insect pests and the associated food insecurity is also greatly required. Moreover, provision of training to farmers and extension workers on safe handling of grains and management of insect pests of stored wheat under farmer's traditional storage conditions are urgently needed by any concerned bodies.

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