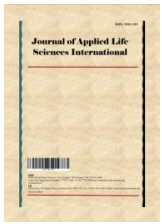

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The Status of Insect Pests Prevailing in Stored Wheat Grain under Traditional Storages of Cheha District of Gurage Zone of South Central Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Author TW designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BH managed the analyses of the study, managed and corrected over all write up and approved the final manuscript.

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ABSTRACT

Aim: To assess the status of the insect pests of stored wheat grains in Cheha destrict of Gurage Zone of Southern Ethiopia.
Study Design: Peasant associations were selected purposefully based on intensity of wheat production, such that those peasant association growing wheat predominantly were selected for the survey, while villages, representative farmers and their storage systems were selected randomly using a nested design.
Place and Duration of Study: Survey was conducted between 1, July to 30, December 2019 with the interval of one month in major wheat growing peasant associations of Cheha district 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 taxonomic keys 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

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recorded, *Sitophilus oryzae*, *Sitophilus zeamais*, *Sitotroga cereallella*, *Tribolium castaneum* and *Tribolium confusum*, respectively were the most prevalent and frequently occurring as they appeared between 12.74 and 33.78 individuals per 100 g of grain and as they occurred in the range between 77.78 and 92.26% per 100 g of sample wheat grain collected from the survey sites, respectively. These were followed by *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica* which occurred between 7.26 and 10.74 individuals per 100 g of grain and in ranges between 51.85 and 66.67% per 100 g of sample wheat grain collected.

Conclusion: The traditional methods and practices used by farmers were inefficient for sufficient wheat grains protection against insect pests in storages; this implies for the urgent need for designing management strategies for more effective and sustainable methods of control.

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 quantities for different purposes, including home consumption, trade and seed production [1,2]. However, shortages of sufficient and affordable agricultural inputs have restricted increment in wheat production. These problems have been further complicated with the losses of wheat both in the fields 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 was 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. MATERIALS 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 (Fig. 1). Survey was conducted between 1, July to 30, December 2019 with the interval of one month.

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, fifteen 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 predominantly were selected for the survey, while villages, representative farmers and their storage systems 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 store (a total of 270 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 section 2.2 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. Samples taken from different positions of the stores were thoroughly mixed and half kg (0.5 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 village of the sampling site was collected in sampling bag, labelled 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 peasant associations 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 collected in 1 L glass jars and kept under laboratory conditions (27±3ºC and 55-70% RH) to determine species from internal infestation.

Taxonomic keys of identifications related to 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

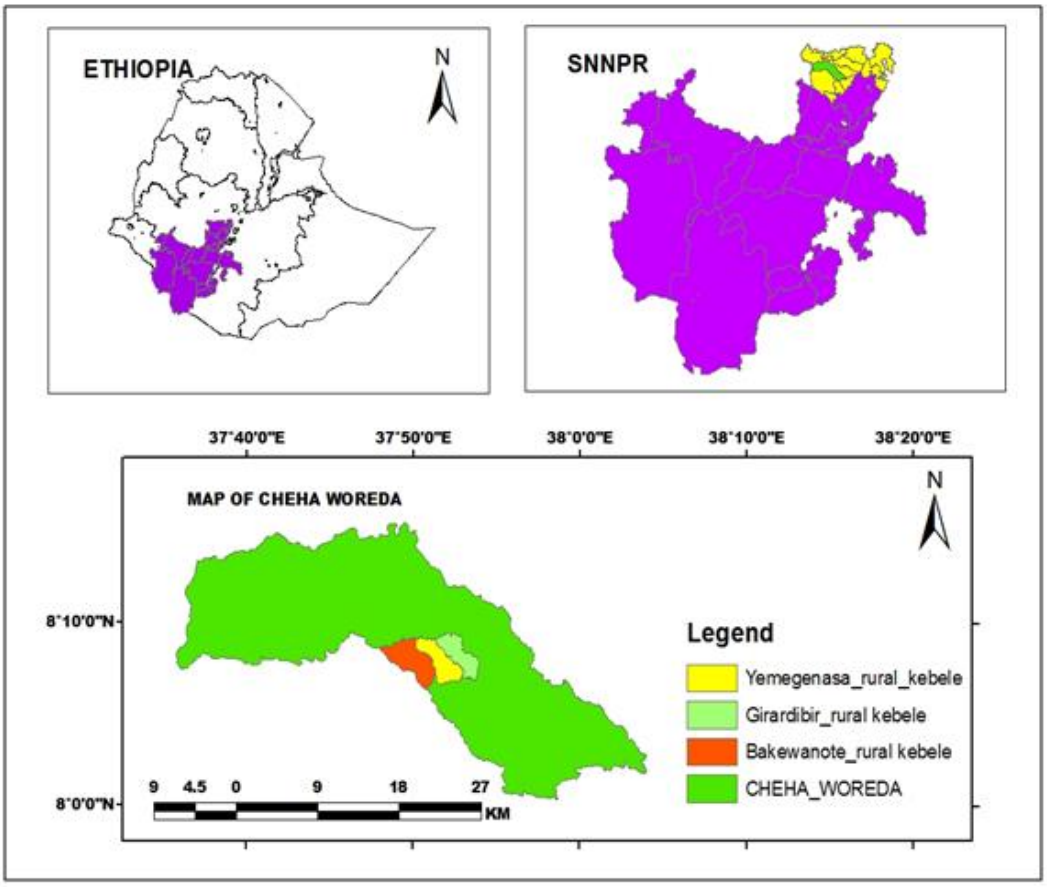

Fig. 1. Map of the study area

also used for identification. Thereafter, 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.

Moreover, the status of insect pests of stored wheat was determined using the formulas indicated below [15]. The average insect pests collected from sub-samples from each village of each peasant association were 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 (36 kg, i.e. total weight of sample collected from the study area)) and it is expressed by the following formula:

> Abundance of species = Total number of individuals of species / 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:

> Relative Abundance of species = (Number of individuals of a species / Total number of observed individuals) x 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.

> Constance of species = (Number of samples in which the species occurred / Total number of sample) x 100

2.4 Data Analysis

All the data gathered from field survey were managed and performed using Microsoft Excel version 2013 and Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics (means, frequencies 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 of Stored Wheat Grain under Traditional Storages in Cheha District

The various categories of insect pests identified from stored wheat of farmers traditional storage structures of cheha district are demonstrated in Tables 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 recorded. Five species such as *Sitophilus oryzae*, *Sitophilus zeamais*, *Sitotroga cereallella*, *Tribolium castaneum* and *Tribolium confusum*, respectively were the most abundant and frequently occurring as they appeared between 12.74 and 33.78 individuals per 100 g of wheat grains and in ranges between 77.78 and 92.26% per 100 g of sample wheat grains collected from the survey site, respectively. Following these five species were *Cryptolestes ferrugineus*, *Cryptolestes pusillus* and *Rhyzopertha dominica* that frequently appeared between 7.26 and 10.74 individuals per 100 g of wheat grains and in ranges between 51.85 and 66.67% per 100 g of sample wheat grains collected.

Generally, in terms of the abundance, relative abundance, frequency of occurrence and status (economic importance), the eight insect pest 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*.

i. The abundance, relative abundance, frequency of occurrence and status (economic importance) the aforementioned eight species of insect pests of stored wheat grain from 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], which 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*) is from the order Lepidoptera, which implies great economic importance of beetles in grain storage than moths, which is in agreement with reports from previous researchers [19,20] in which beetles were shown to be the most 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 as well as 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 storage, the duration and the storage management implemented prior to, and during storage affects the level of insects infestation and the associated losses [21]. It was also shown that African farmers 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 Sub Saharan Africa (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 wheat 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 pest species along with more prevalence four secondary pests (*Tribolium castaneum*, *Tribolium confusum*,

Table 1. The status of insect pests of stored wheat grain under traditional storages in 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	30C	19.88C	74.07C	Major
Rhyzopertha dominica	98	7.26H	4.81H	51.85H	Major
Sitophilus oryzae	456	33.78A	22.38A	92.26A	Major
Sitophilus zeamais	451	33.74B	22.14B	88.89B	Major
Cryptolestes ferrugineus	145	10.74F	7.11F	66.67F	Major
Cryptolestes pusillus	133	9.85G	6.53G	59.26G	Major
Tribolium castaneum	177	13.11D	8.69D	81.48D	Major
Tribolium confusum	172	12.74E	8.44E	77.78E	Major
Total	2037				

Means followed by the different letters within columns (upper case letters) are significantly different, p < 0.05% using Turkey's studentized range test (HSD)

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

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 storage. Accordingly, it was shown that primary pests does not necessarily refers to be more important 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].

4. CONCLUSION

In the current study, eight major species of insect pests consisting of four primary pests and four secondary pests belonging to five families within 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.

The present study confirms great economic significance of secondary pests as that of primary pest once under traditional 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 of stored wheat grain should consider the ecology and the behavior of these pests for their effective control and management.

The traditional storage methods and practices used by farmers were inefficient for 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 areas 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bishaw Z. Cereal, pulse and oilseed balance sheet analysis for Ethiopia update. World food program, food for development, discussion paper no. 4. WFP, Ethiopia; 2004.
2. CSA (Central Statistical Authority). Agricultural sample survey: Report on area and production for major crops. Statistical bulletin 388, Addis Ababa, Ethiopia; 2007.
3. Worku M, Twumasi-Afriyie S, Wolde L, Tadesse B, Demisie G, Bogale G, et al. Editors. Meeting the challenges of global climate change and food security through innovative maize research. Proceedings of the Third National Maize Work Shop of Ethiopia. 2012;223-289.
4. Hiruy B, Emana G. Insect pest's infestation and the associated loss in stored maize grains in four farmer's traditional storages in southern Ethiopia. Int J Mod Chem and App Sci. 2018;5(1):571-576.

5. Hiruy B, Emana G. Insect pests associated to stored maize and their bio rational management options in Sub Sahara Africa. Int J Acad Res and Dev. 2018;3(1):741-748.
6. Obeng-Ofori D. Protecting grain from insect pest infestations in Africa: Producer perceptions and practices. Stewart Post-har Rev. 2011;7:1-15.
7. Emana G. Studies on the distribution and control of Angoumois grain moth. Sitotroga cerealella in Sidama administrative region. M.Sc. Thesis, Alemaya University of agriculture, Alemaya, Ethiopia. 1993;85.
8. Hiruy B. Status, species composition and management of stored maize grain insect pests in Southern Ethiopia, a PhD Thesis, Addis Ababa University, Ethiopia. 2018; 176.
9. Hagstrum DW, Subramanyam B. Fundamentals of stored-product entomology. AACC International, U.S.A. 2006;334.
10. Hagstrum DW, Subramanyam B. Stored-product insect resource. AACC International, Inc., U.S.A. 2009;518.
11. Rees D. Insects of stored products. Csiro Publishing, Australia. 2004;192.
12. Rees D. Insects of stored grain. A pocket reference. 2nd edition. Csiro publishing, Australia. 2007;81.
13. FGIS. Stored grain insect's reference. Agricultural handbook 500. Bulletin 1260. Prepared by the Federal Grain Inspection Service of United States, Department of Agriculture, Washington, D.C. 2015; 76.
14. Athanassiou CG, Arthur FH. Recent advances in stored product protection. Springer, Germany. 2018;277.
15. Bueno, VHP, Souza MB. Ocorrência e Diversidade de Insectos Predadores e Parasitóides na Cultura de Couve *Brassica oleracea* Var. Acephala em Lavras MG, Brazil; 1991. Latin.
16. Tadesse A. Insects and other arthropods recorded from stored maize in Western Ethiopia. Afr Crop Sci J. 1995;4:339-343.
17. Tadesse A, editor. Increasing crop production through improved plant protection – volume I. Plant Protection Society of Ethiopia (PPSE), 19-22 December 2006. Addis Ababa, Ethiopia. PPSE and EIAR, Addis Ababa, Ethiopia. 2008;598.
18. Haines CP. Insects and arachnids of tropical stored products: Their biology and identification. Training manual. NRI; 1991.
19. Chimoya IA, Abdullahi G. Species compositions and relative abundance of insect pest associated with some stored cereal grains in selected markets of Maiduguri metropolitan. J Amer Sci. 2011; 7:355-358.
20. Upadhyay RK, Ahmad S. Management strategies for control of stored grain insect pests in farmer stores and public warehouses. World J Agri Sci. 2011;7: 527-549.
21. Nukenine EN. Stored product protection in Africa: Past, present and future. 10th international working conference on stored product protection proceeding. Ngaoundere, Cameroon; 2010.
DOI: 10.5073/jka.2010.425.1
22. Tefera T, Mugo S, Likhayo P. Effects of insect population density and storage time on grain damage and weight loss in maize due to the maize weevil, *Sitophilus zeamais* and the larger grain borer *Prostephanus truncates.* Afr J Agri. 2011; 6(10):2249-2254.
23. Talukder FA. Isolation and characterization of the active secondary Pithraj (*Aphanamixis polystachya*) compounds in controlling stored-product insect pests. PhD Thesis, University of Southampton, United Kingdom; 1995.
24. Mason LJ, McDonough M. Biology, behavior and ecology of stored grain and legume insects. St Prod Prot. 2012;7:1-14.
25. Semple RL, Hicks, PA, Castermans A. Towards integrated commodity and pest management in grain storage. A Training Manual for Application in Humid Tropical Storage System. 2011;277.

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