



Assessment of Barley Varieties Potential to Grain Weevil Infestation at Storage

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ABSTRACT

Crop genetic potential to resist storage pest is very crucial to minimize quantity and quality of grain mass loss during storage. The granary weevil primarily affects barley crop at storage. Due to this reason, an experiment was carried out by using Complete Randomized Design (CRD) with three replications. The work was designed with the objectives to identify resistance potential of barley varieties against weevil (*Sitophilus granarius*) damage and to identify the quantity and physical quality loss of barley varieties against storage weevils. For analysis of variance percentage of weight loss, percent of damaged seeds, and many weevils, data was collected. Analysis of variance (ANOVA) of the collected data revealed a highly significant difference ($P < 0.0001$) among the studied varieties for the percent of damaged seeds and percentage of weight loss, whereas the number of weevils among the tested varieties was non-significantly different. The results of this study show that *Sitophilus granarius* can bring 12.1-25.91% and 3.17-6.17% of both quantity and quality losses respectively on barley crop at storage. The mean comparison between improved barley varieties (Holker, IBON 174/03 and HB 1966) and local variety shows a significant difference for the percent of damaged seeds and percentage of weight loss, but the non-significant difference for HB 1307 barley variety. Among the studied barley varieties, IBON 174/03 variety revealed high susceptibility to granary weevil. Generally, in this study, the local barley variety manifested resistant potential than improved barley varieties to granary weevil infestation for both quantity and quality loss.

Keywords: *Hordeum vulgare*, Loss, Quantity, Quality, *Sitophilus granarius*

HOW TO CITE THIS ARTICLE: Terfa GN, Jima WH. Assessment of Barley Varieties Potential to Grain Weevil Infestation at Storage. Entomol Appl Sci Lett. 2021;8(1):1-5. <https://doi.org/10.51847/05E11dPUUV>

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Received: 09/11/2020

Accepted: 01/02/2021

INTRODUCTION

Barley (*Hordeum vulgare*) is one of the major cereal crops grown in Ethiopia and for millions of people, it has been supplying the necessities of life (food, feed, beverages, and roof thatching) for many in the Ethiopian highlands [1]. Cereals are the staple and nutritive food but their storage is not safe due to the attack of certain stored grain insect pests [2, 3]. So, there is an urge to protect them safely from qualitative and quantitative loss. The effect of crop management options varies with the type of grains, prevailing insect species, environmental conditions, and storage systems [4]. Post-harvest grain loss refers to a decrease in quantity and or quality of grain mass. It is defined as measurable

qualitative and quantitative food loss along the supply chain [5].

Quantitative grain loss refers to the decrease in edible seed and food available for human consumption. In physical terms, this is a grain removed from the postharvest supply chain and not consumed due to, among other causes, spillage, and consumption by pests and also due to physical changes in temperature, moisture content, and chemical changes. The quantity lost would have either deteriorated rendering it inedible or discarded for failure to meet regulated standards to eat as a food or to use as an animal feed [6, 7]. In most cases, the quality deterioration goes along with a significant loss of nutritional value, which might affect the

health and nutrition status of the whole community [8].

Granary weevil (*Sitophilus granarius*) is considered as one of the important and destructive insect pests of stored food grains and lives in the stores all the time because it does not possess the second pair of wings and cannot fly. The larva consumes about 55% of the interior of the wheat kernel and the body of weevil varies from brown to black with a shiny upper surface [4]. The granary weevil primarily afflicts grains such as wheat, barley, rye, and oats, as well as triticale, corn, rice, millet, and sometimes manufactured pasta. The complete development of its larvae from the egg to the imago takes place hidden within the interior of the grain kernel [9].

Therefore, reducing postharvest losses in grains in Ethiopia has the potential for the country to achieve not only its food security requirements, and increased incomes for the agricultural sector but also achieve the overall basic objective to Ethiopia's economic development which aims to build a market economy in which a broad spectrum of the Ethiopian people are beneficiaries, and dependence on food aid is eliminated and rapid economic growth is assured [10]. Based on this, the study was conducted with the objectives to identify the resistance potential of food barley and malt barley varieties against granary weevil (*S. granarius*) and to identify quantity and quality loss of barley due to granary weevil pest.

MATERIALS AND METHODS

Description of the area

The study was conducted at Ambo University Guder Campus, Department of Plant Science Laboratory. The Campus was situated 126 km from Addis Ababa, Ethiopia at 37° N latitude, 77° E longitude, and at about 2010 m.a.s.l. with an average daily temperature of 26°C with 50-60% relative humidity.

Experimental materials and design

The experimental materials were obtained from the Barley breeding unit of the Holeta Research Center. The seeds were kept in a deep freezer at about -20°C in the Holeta Research Center laboratory for two weeks to disinfect from prior natural infestation. The disinfected materials were kept at room temperature for one week

before use in Ambo University Guder Campus laboratory. Granary weevils (*S. granarius*) were taken from Holeta research center laboratory. One hundred grams of each variety were placed in a transparent plastic container with a lid allowing ventilation and replicated three times and arranged in Complete Randomized Design (CRD). The experimental materials are two Malt Barleys IBON 174/03 and Holker and three food barleys HB 1307, HB 1966, and local variety, and a total of five treatments (**Table 1**) were prepared with three replications. In each container, 15 adult weevils of known ages i.e. 1-4 days were introduced.

Table 1. List of Tested Materials

S. No.	Treatment Code	Variety	Type
1	T1	Holker	Malt Barley
2	T2	IBON 174/03	Malt Barley
3	T3	HB 1307	Food Barley
4	T4	HB 1966	Food Barley
5	T5	Local Variety	Food Barley

Data collection

Percentage of weight loss

The total weight of the variety before infestation and after infestation was measured. Then the percent of weight loss was calculated by using the formula indicated by [11].

Percent of Seed Weight Loss =

$$\frac{(w\mu \times ND) - (Wd \times N\mu)}{W\mu \times (Nd + N\mu)} \times 100 \quad (1)$$

Where: $W\mu$ = Weight of Undamaged Grains; $N\mu$ = Number of Undamaged Grains; Wd = Weight of Damaged Grains; Nd = Number of Damaged Grains

Number of damaged seeds

The percentage of damaged seed was calculated by separating healthy grains from the 100 seeds which are randomly sampled by using the formula described by Khattak *et al.* [12] as:

Percent of Grain Damage =

$$\frac{\text{No. of Insect damaged grain}}{\text{Total number of grains in the sample}} \times 100 \quad (2)$$

Number of weevils produced

After five weeks, the number of live weevils was identified and counted as a total number of weevil produced.

Data analysis

The collected data percentage of weight loss, percentage of damaged seed, and many weevil were subjected to SAS, version 9.3 for statistical data analysis.

RESULTS AND DISCUSSION*Analysis of variance (ANOVA)*

Analysis of variance shows that the number of damaged seeds and percentages of weight loss are highly and significantly different ($p < 0.001$) among the varieties, whereas a total number of weevil produced revealed a non-significant difference. This shows that all the studied varieties have different responses to resist the *Sitophilus granarius*. Sharma and Tiwari [4] also reported that grain damage percent was significantly different among the tested maize varieties due to *Sitophilus* spp.

Percentages of damaged seeds

The present study revealed that the percentage of damaged seeds ranged from 3.17 to 6.17 in different barley varieties (**Figure 1 and Table 2**). Local variety (3.17%) was the least damaged followed by HB 1307 (4.0 %) and Holker (4.5 %) varieties, whereas IBON 174/03 (6.17%) variety was highly susceptible followed by HB 1966 (4.67%) varieties. This shows that granary weevil can bring high-quality losses of barley crop at the storage level. In this study, malt barley is more susceptible to weevil than food barley, whereas local variety showed less damaged than both malt and improved food barley varieties. This indicates that the local variety has the potential to resist granary weevil in this study. Similarly, [4] also found the percentage of the damaged seed ranges from 12.43 %- 31.74 % in maize crop varieties due to Maize Weevil *Sitophilus zeamais*. In this study, the variety which accounts for maximum grain damaged also accounts for a high percentage of weight loss. The storage pest deteriorates the quality of the infested commodities, depletes nutritional value, and makes them unfit for human consumption [13].

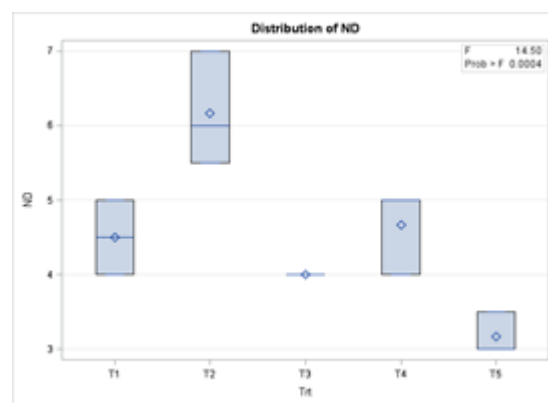


Figure 1. Mean Separation Distribution of Percentage of Damaged Seeds among the Tested Varieties
ND= number of damaged seeds

Table 2. Mean Separation for Barley Varietal Response against Granary Weevil for Damaged Seed, Percentage of Weight Loss and Total Number of Weevils

S/N	Treatment	Mean		
		ND	WL	NW
1	Holker	4.5 ^b	17.69 ^b	42.33 ^{ba}
2	IBON 174/03	6.17 ^a	25.91 ^a	43.00 ^{ba}
3	HB 1307	4.0 ^{bc}	15.22 ^{cb}	44.0a
4	HB 1966	4.67 ^b	18.95 ^b	43.67 ^a
5	Local (Black Barley)	3.17 ^c	12.10 ^c	40.33 ^c
	LSD %5	1.37	3.99	2.93
	Cv	11.11	12.20	3.78

Means represented by the same letters are not significantly different at ($P < 0.05$).

ND=Number of Damaged Seeds, NW=Number of Weevil, WL=Weight Loss

Percentage of weight loss

In the presented data of tested barley varieties, the percentage of weight loss ranges from 12.1 to 25.91 in the different barley varieties (**Table 2 and Figure 2**). Among tested barely varieties local barley variety manifested less percentage of weight loss (12.1%) followed by HB 1307 (15.22%) and Holker (17.69%) barley varieties, whereas IBON 174/03 barley variety accounts for maximum weight loss (25.91%) followed by HB 1966 (18.95 %) variety. Similarly, [14, 15] conform with ours that they investigated weight losses by *S. granaries* in their findings. Our research findings show that storage pests can reduce the number of barley crops in huge amounts, which brings economic loss for barley producers. On top of that, it suggests that granary weevil can bring high yield loss of barley during storage within few weeks.

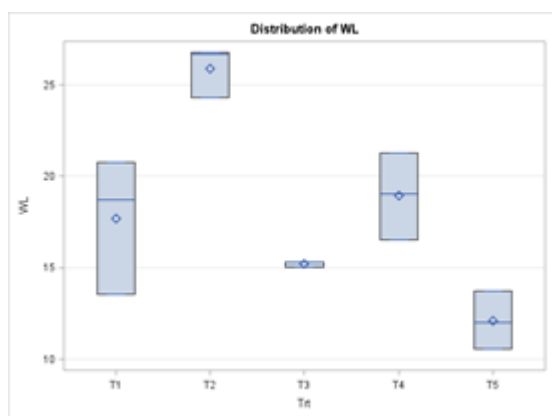


Figure 2. Mean Separation Distribution of Percentage of Weight Loss among the Tested Varieties
NW=Number of Weevil

Number of produced weevils

In this study, the least population in the number of weevils was recorded in local barley variety (40.33) followed by Holker (42.33) and the highest population of weevil recorded in HB 1307 (44) followed by HB 1966 (43.67) (**Table 2 and Figure 3**). This indicates that newly released varieties are more favorable for weevil reproduction than local variety; this means that the chance of those varieties being attacked by weevils may be high. The results of [15] conform with ours that in ten rice varieties they investigated granary weevil produced and [4] also the found number of weevil produced ranged from 32.33 to 74 in maize crop varieties.

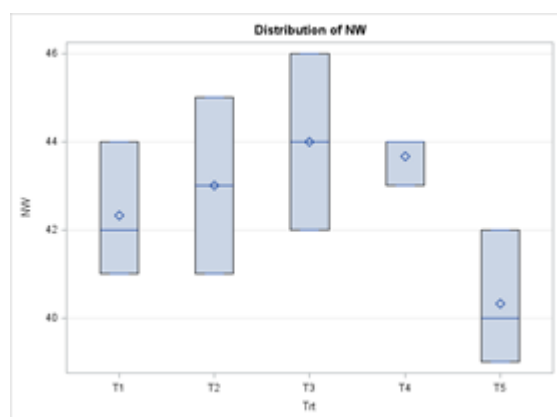


Figure 3. Mean Separation Distribution of Number of Produced Weevil among the Tested Varieties
NW=Number of Weevil Trt = Treatment

Mean comparison of improved barley and local barley varieties against granary weevil

Percentage of damaged seeds

The mean comparison between local variety and all improved barley varieties manifested significant difference, except HB 1307 variety

for a percentage of damaged grain. In this study, local barley varieties revealed a fewer number of damaged seeds when compared with improved barley varieties (**Table 3**). This means that all tested barley varieties are more susceptible to granary weevil for grain damage than local check and also they manifested high physical quality loss.

Weight Loss

The mean comparison for a percentage of weight loss revealed a significant difference between local variables and improved barley varieties except for the HB 1307 variety (**Table 3**). This indicates that local variety has the potential to resist granary weevil infestation. This result was in agreement with [14] that reported significant weight loss in wheat varieties due to *Sitophilus oryzae* infestation.

Table 3. The Mean Comparison between Local and Released Varieties in Response to Barley Weevils for Percentage of Damaged Seed, Percentage of Weight, and Number of Weevils

Treatments	Difference between Means		
	ND	WL	NW
T2 - T5	3.00**	13.81**	2.67 ^{ns}
T4 - T5	1.50**	6.85**	3.33 ^{ns}
T1 - T5	1.33**	5.59**	2.00 ^{ns}
T3 - T5	0.83 ^{ns}	3.12 ^{ns}	3.67 ^{ns}
LSD	1.18	5.18	3.80
P-Value	0.05	0.05	0.05

Astrics ()** and **ns** indicate a significant difference and non-significant difference respectively, ND=Number of Damaged Seed, NW=Number of Weevil, WL=Weight Loss

Number of produced weevils

The mean comparison for many produced weevil revealed the non-significant difference between tested new varieties and local check (**Table 3**). This shows that the reproduction of the weevil does not depend on the type of barley variety in this study. Another researcher [15] also investigated different population numbers produced of granary weevil in different rice varieties.

CONCLUSION

Generally, according to this study, barley producers should use a variety of good potential to resist weevil infestation, since weevils can bring great quantity and quality loss for barley

crops when they attack the crop as observed in the study. Moreover, they must avoid any post-harvest and even in field conditions that facilitate a conducive environment for the reproduction of *S. granaries* in addition to the selection of the most resistant varieties. Therefore, in addition to using resistant varieties, farmers or barley producers should use other recommended technologies like seed dressing chemicals to minimize post-harvest loss.

ACKNOWLEDGEMENT: We acknowledged Ambo University and Holeta Agricultural Research Center for their materials and laboratory equipment support.

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: The work is financial supported by Ambo University.

ETHICS STATEMENT: None

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