Assessment of barley (Hordeum vulgare L.) varieties potential to grain weevil (Sitophilus granarius L.) infestation at storage for quantity and quality loss

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Abstract
Barley (Hordeum vulgare L.) is a stable food and industrial crops in Ethiopia. But most of the time it was susceptible to storage pests. Different crop varieties have their own degrees of resistivity and susceptibility in addition to Environmental impacts on stored crop products. Based on this an experiment was carried out at Gudar Campus laboratory by using complete randomized design(CRD) with three replications, with the objectives to identify resistance potential of barley varieties against weevil (Sitophilus graneries) damage and to identify quality and quality loss of barley varieties against storage weevils . In this study different barley verities Holker, IBON 174/03 and HB 1307, HB 1966 and local variety which are Malt and Food respectively were manifested to storage weevils (Sitophilus granarius L.). For analysis of variance percentage of weight loss, percent of damage seeds and number weevils data were collected. Analysis of variance (ANOVA) of the collected data revealed highly significant different ($P<0.0001$) among the studied varieties for percent of damage seeds and percentage of weight loss, whereas number of weevils among the tested varieties were non- significant difference. According to this study Sitophilus granaries can bring 12.1-25.91% and 3.17-6.17% of both quantity and quality losses respectively on barley crop at storage. Mean comparison between improved barley varieties (Holker, IBON 174/03 and HB 1966) and local variety shows significant difference for percent of damage seeds and percentage of weight loss, but non-significant different for HB 1307 barley variety. Of the studied barley varieties IBON 174/03 variety revealed highly susceptible 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.

Keyword: Sitophilus granerius L., Hordeum vulgare L., quantity, quality

1. Introduction

Barley (Hordeum vulgare) is one of the major cereal crops grown in Ethiopia and for millions of people it has been supplying the basic necessities of life (food, feed, beverages and roof thatching) for many in the Ethiopian highlands (Mulatu and Grando, 2011). As cereals are the staple and nutritive food but their storage is not safe due to the attack of certain stored grain insect pests. So, there is an urge to protect them safely from qualitative and quantitative loss. The effect of crops management options varies with type of grains, prevailing insect species, Environmental conditions and storage systems (Sharma and Tiwari**,** 2017). 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 (Aulakh and Regmi, 2013).

Quantitative grain loss refers to the decrease in edible seed and food available for human consumption. In physical terms, this is 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 (Zewdie, 2015). 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 (Hussen et al., 2013).

Granary weevil is considered as one of the important and destructive insect pests of stored food grains and lives in the stores all 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 shiny upper surface (Sharma and Tiwari, 2017).The granary weevil primarily afflicts grains such as wheat, barley, rye, and oats, as well as triticale, corn, rice, millet, and sometimes manufactured pastas. The complete development of its larvae from the egg to the imago takes place hidden within the interior of the grain kernel (Emami et al., 2017).

Therefore reducing postharvest losses in grains in Ethiopia has the potential for the country to achieve not only its food security requirements, 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,

dependence on food aid is eliminated and rapid economic growth is assured (FAO, 2018). Based on this the study was conducted with the objectives to identify resistance potential of food barley and malt barley varieties against granary weevil (Sitophilus graneries) and to identify quantity and quality loss of barley due to granary weevil pest.

2. Materials and Methods

The study was conducted at Ambo University Guder Campus 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 Experimental Design

The experimental materials were obtained from Barley breeding unit of the Holeta Research center. The seeds were kept in deep freezer at about -20^{o}c in the Holeta Research center laboratory for two weeks in order to disinfest 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 (Sitophilus granarius) were taken from Holeta research center laboratory. One hundred grams of each variety were placed in a transparent plastic container with 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, totally five treatments were prepared with three replications. In each container, 15 adult weevils of known ages i.e. 1-4 days were introduced.

Table1 List of tested materials

S.No.	Treatment	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

3. Data Collected

Percentage of Weight loss:

A total weight of variety before infestation and after infestation was measured. Then the Percent of weight loss was calculated by using formal indicated by (Gwinn et al., 1996).

$$\textbf{Percent seed weight loss} = \frac{(W\mu * Nd) - (Wd * N\mu)}{W\mu * (Nd + N\mu)} * 100$$

Where: Wμ = weight of undamaged grains; Nμ = number of undamaged grains; Wd = weight of damaged grains; Nd = number of damaged grains.

Number of damaged seeds

The percentage of damage seed was calculated by separating healthy grains from the 100 seed which are randomly sampled by using the formula described by Khattak et al. (1987) as:

Percent grain damage:

Number of weevils produced

After five weeks, number of life weevil were identified and counted as a total numbers of weevil produced.

Data Analysis

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

4. Result and Discussion

Analysis of variance (ANOVA)

Analysis of variance shows that number of damaged seeds and percentages of weight loss highly significantly different ($p<0.001$) among the varieties, whereas total number of weevil produced revealed non-significant difference. This shows that all the studied varieties have different response to resists the Sitophilus graneries. Sharma and Tiwari (2017) also reported that grain damage percent was significantly different among the tested maize varieties due to Sitophilus spp.

Percentages of Damaged seed

The presented study revealed that percentage of dammed seeds ranged from 3.17 to 6.17 in different barley varieties (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 as granary weevil can bring high quality losses of barley crop at 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 potential to resist granary weevil in this study. Sharma and Tiwari, (2017 also found percentage of damaged seed range from 12.43 %- 31.74 % in maize crop varieties due to Maize Weevil Sitophilus zeamais. In this study variety which is account maximum grain damaged also accounts high percentage of weight loss.

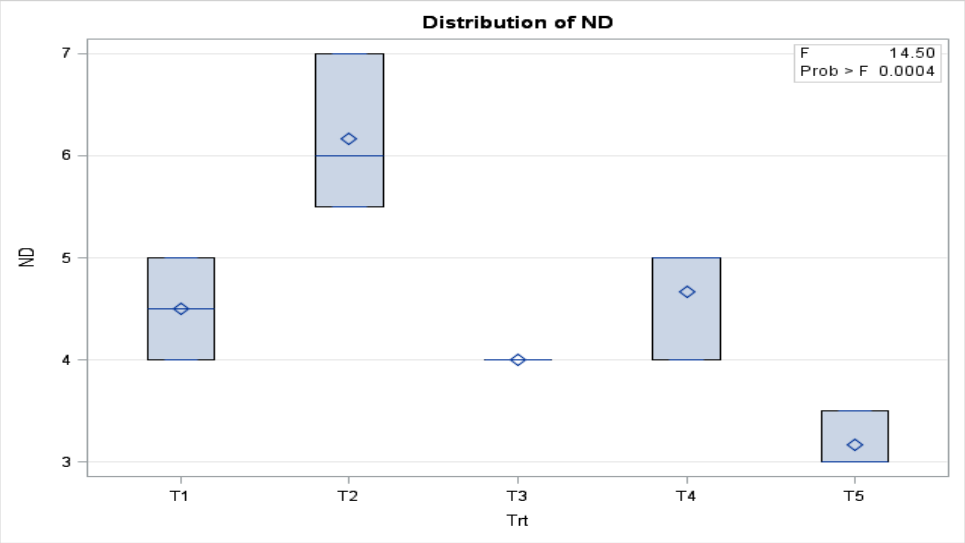

Fig. 1. Mean separation distribution of percentage of damaged seeds among the test varieties

ND= number of damaged seed

Table 2. Mean Separation for barley varietal response against granary weevil for damaged seed, percentage of weight loss and total number of weevils

		Mean		
S/N	Treatment	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 seed, NW=number of weevil, WL=weight loss

Percentage of Weight loss

In 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). Among tested barely varieties local barley variety was 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 was accounts maximum weight loss (25.91%) followed by HB 1966 (18.95 %) variety. Similarly (Yadav et al., 2018; Fida et al., 2017) are conformity with ours that; they investigated weight losses by S. granaries in their findings. Our find result shows as storage pest can reduce quantity of barley crop in huge amount, which bring economic loss of barley producer. On the top of that it tells as granary weevil can bring high yield loss of barley during storage within few weeks.

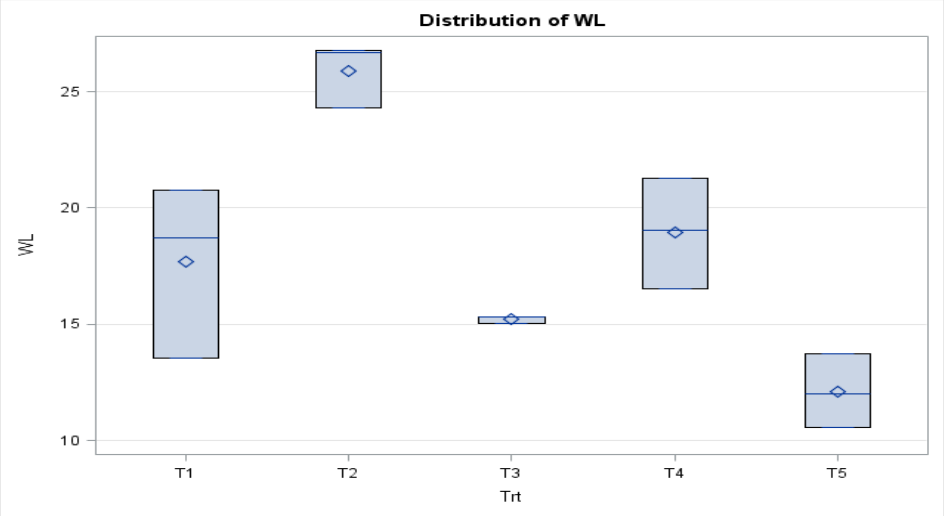

Fig.2 Mean separation distribution of percentage of weight loss among the test varieties

NW=number of weevil

Number of weevils produced

In this study the least population in 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). This indicates that new released varieties more favorable for weevil reproduction than local variety, this mean the chance of those varieties to be attacked by

weevils may be high. The results of (Fida et al., 2017) are conformity with ours that in ten rice varieties they investigate granary weevil produced and Sharma and Tiwari (2017) also found number of weevil produced range from 32.33 to 74 in maize crop varieties .

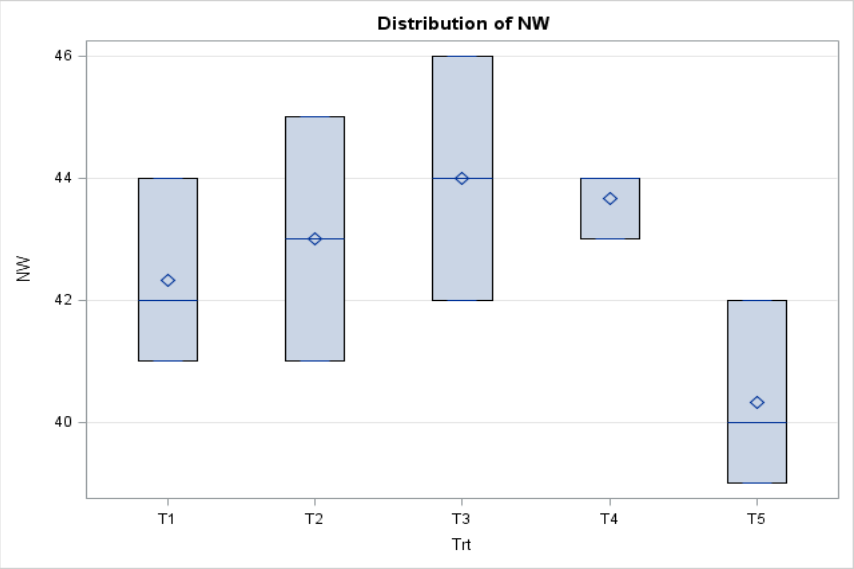

Fig.3. Mean separation distribution of number of produced weevil among the test varieties NW=Number of weevil

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 percentage of damaged grain. In this study local barley variety revealed less number of damaged seed when compared with improved barley varieties (Table 3). This mean that as all tested barley varieties is 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 percentage of weight loss revealed significant difference between local variety and improved barley variety except for HB 1307 variety (Table 3). This indicates that as local variety has a potential to resist granary weevil infestation. This result was agree with (Yadav et al., 2018) findings which was done on wheat varieties due to Sitophilus oryzae infestation.

Table 3. Mean comparison between local and released varieties in response to against 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**	2.00ns
T3 - T5	0.83ns	3.12 ns	3.67 ns
LSD	1.18	5.18	3.80
P-Value	0.05	0.05	0.05

**Astrics (**) and ns indicates a significant differences and non-significant different respectively, ND=number of damaged seed, NW=number of weevil, WL=weight loss

Number of weevils produced

The mean comparison for number of weevil produced was revealed non-significant difference between tested new varieties and local check (Table 3). This shows that reproduction the weevil does not depend on type of barley variety in this study. Another researcher (Fida et al., 2017) also investigated different population number produced of granary weevil in different rice varieties.

5. Conclusion

In this study barley varieties are revealed different genetic potential to resist to granary weevils (Sitophilus graneries) infestation. All the studied improved barley varieties manifested low potential to resist Sitophilus graneries than the local check which was collected from farmer. Above of all malt barley varieties revealed highest loss in both quantity and quality aspect. The best variety is Local check followed by HB 1307. This shows the direction for barley producer as they should have to test new released variety before going to produce on a field and it give an assignment for barley breeder to test potentials of newly developed barley against weevil before going to release. Generally according to this study barley producer should have to use variety with good potential to resist weevil infestation, since weevils can bring great quantity and quality loss of barley crops when they attach the crop as observed in the study. Avoiding any post-

harvest and even in field conditions that facilitate conducive environment for the reproduction of S. granaries in addition to the selection of the host resistant varieties. Therefore in addition to using resistant varieties farmers or barley producers better to use other recommended technologies like seed dressing chemicals so as to minimize post harvest loss. More over further studies should have to be conducted on these studied materials for more justification of the study since this study was done at single location and season.

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