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Screening of different pipeline and released variety of bread wheat (*Triticum aestivum* L.) for resistance against maize weevil *Sitophilus zeamais* (Motsch.) in storage condition

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Abstract
The increase in wheat demand is governed by rapidly growing population and increased preference towards wheat and its subsequent products. Maize weevil (*Sitophilus zeamais*) is a cosmopolitan insect and causes great damage to stored grains. Its affinity towards wheat is a growing concern. The experiment was performed in the Entomology laboratory of Lamjung Campus at room temperature. To determine the relative resistance in storage, 9 pipelines and a variety WK 1204 were used as treatments. Treatments were arranged in Completely Randomized Design. The replications were three in number for each treatment. 12 pairs of weevil irrespective of their sex were kept in each jar containing 60 g of wheat and observations were made. Number of damaged seeds and weight loss were recorded at every 20 days interval for five times. The weight loss and numbers of damaged seeds were found to be significantly higher in WK 3025 and WK 2432 consistently. However weight loss and damaged seeds for the 80 and 100 days was found to be significantly higher in WK 3025 only. Among all the treatments WK 3025 was found to be least resistance and WK 2430 was found to be most resistant in terms of damaged seeds and weight loss in storage against maize weevil attack. The germination percentage decrement was also observed by performing initial germination and final germination. However further research and long term effect in large stores of farmers conditions are recommended for further application.

Keywords: Damaged seeds, maize weevil, weight loss, wheat khumal, varietal screening

Introduction
Bread Wheat has been the most extensively grown cereal crops in the world for over a period of time now. It has been cropped at the expanse of about 22 million ha and production reaching about 77 million metric ton (FAOSTAT, 2017) [1]. In regards to Nepal, it is the third highest grown crop in our country preceded by Rice and Maize with area of 7.5 lakh ha, production of 17 lakh metric ton and productivity of 2.3 ton/ha (MOAD, 2016-17)[2]. Terai is a major consumer of produced wheat with maximum increase in wheat production and consumption. (Malla, 2008) [3] Reported that wheat covered 20% of total cultivated area and contributed 18% in total cereal production in our country. The major market products of wheat include flour, noodles, and biscuits which have been a favorite food for all the age groups in our country. They are also used for production of high value products in bakery, spices etc. The nutritive components of wheat as reported by (Pingale, 1978) [4] are moisture (13.3%), protein (12.7%), total ash (1.4%), crude fiber (2.4%), fatty acid (20.5 mg) and gluten (8%). The losses in stored grains are mainly caused by insects and the major insects causing loss in bread wheat include Lesser grain borer (Rhyzopertha dominica), Granary weevil (Sitophilus granaries), Rice weevil (Sitophilus oryzae), Angoumois grain moth (Sitotroga cerealella). Giga *et al*. (1991) [5] reported maize grain loss of 20-90% worldwide due to maize weevil, S. zeamais.
The storage loss accounts for major post-harvest loss in wheat and its subsequent products. Thereby it has been given emphasis in research prioritized sectors (KARI, 2001) [6]. The varietal resistance could be an important asset in management of storage losses in various cereal grains. The relative infestation of insects or affinity of them could provide us with a major solution towards the reduction of post-harvest losses (Sharma *et al*., 2002) [7]. So, host resistance would be reliable option for resource poor farmers to control storage pest in almost no extra cost along with safety.

The research in terms of varietal screening in cereals has been carried out with varying levels of success. If resistant varieties are cultivated, the resource constrained poor farmers who could not afford the insecticides and even botanicals could have the best alternative which is cost free, effective and environment friendly.

The objectives set in the research were to limit the losses in storage of wheat against maize weevil in an economic and environmental friendly way, to screen different released variety and pipelines of wheat against *Sitophilus zeamais* Motschulsky in storage conditions, to gauge the number of damaged seeds and weight loss of wheat by maize weevil and to find out the effect of damage of weevil on germination percentage.

Materials and Methods

Experimental Layout

The experiment was carried out in Entomology Laboratory of IAAS, Sundarbazaar, and Lamjung which is situated at an altitude of about 650 meters altitude. The longitude and latitude of the place is 840 11' - 840 38' E and 280 3' - 280 30' N. The research was conducted in Completely Randomized Design. The wheat seeds used in the research were obtained from NARC. The seeds acquired were untreated and of proper moisture percentage of around 12-13% which was a necessity for the research. Plastic jars of 250 grams capacity were used for storing the wheat seeds. In each plastic jars 60 grams of seeds were weighed with the help of weighing balance and kept. As the 10 treatments were replicated 3 times, 30 jars were used in the research. The research was conducted with 10 treatments consisting of the pipelines of wheat and a released variety of NARC for different ecological region. They belong to the different strains of Wheat Khumal (WK) varieties.

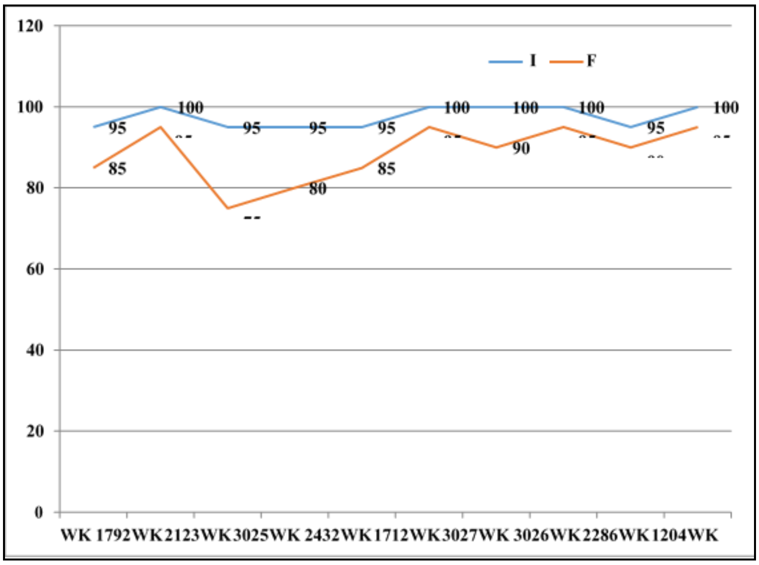
Treatments

T1---	WK 1732	T6---	WK 3027
T2---	WK 2123	T7---	WK 3026
T3---	WK 3025	T8---	WK 2286
T4---	WK 2432	T9---	WK 1204
T5---	WK 1712	T10---	WK 2430

All the treatments were replicated 3 times in identical condition. The maize weevil was reared in Nepal Agriculture Research Council. We participated in the culturing process of maize weevil in the Entomology Lab of NARC and weevils (irrespective of the sex) were acquired for the conduction of the research. The wheat seeds which were procured for the experiment was sun dried for 4 days in order to reduce the moisture to identical and proper level for the storage conditions. The seeds were spread in the plastic sheet and put in sun for eight hours for four days. 60 grams of wheat seeds having proper moisture percentage for storage were taken in each plastic jar of capacity 250 grams. 20 maize weevils irrespective of their sexes were inoculated in each jar. The jars were then enveloped with a clean muslin cloth and made secure with gum band. They were kept in the laboratory for observation. Observations were made for five times at an interval of 20 days. The research parameters recorded throughout the period were tabulated in an Excel sheet and finally analyzed using RSTAT software and the mean comparisons were made by Duncan Test at 5% and 1% level of significance.

Results and Discussion

Comparison between the initial and final germination percentage of seed



X axis- Treatments Y axis- Germination percentage
IG- Initial Germination FG- Final Germination

Fig 1: Germination percentage comparison of different treatments

The initial germination was carried out by putting 20 seeds each of 9 pipelines and 1 wheat variety used as treatments and putting in an incubator. The germination percentage was noted and after carrying out the experiment for 100 days again the germination test was performed by using the same process. The difference or decrement in germination percentage in all the pipelines and a variety was seen (Figure 1). But the most infected pipelines which are WK 3025 and WK 2432 are found to be least germinated in the final count (Figure 1). It can also be inferred as the decrement in germination percentage was found to be the highest in most infected and weight loss pipelines as indicated by the further tables.

Assessment in terms of weight loss of different treatments

Table 1:- Analysis table in weight loss of treatments in five observations

S.no	Treatments	@20days	@40days	@60days	@80days	@100days
1	WK 1792	1.2633333_{c}	1.8566667_{c}	2.1000000_{c}	2.126667_{c}	2.2333333_{c}
2	WK 2123	0.8900000_{d}	1.100000_{d}	1.3300000_{d}	1.483333_{de}	1.7600000_{d}
3	WK 3025	2.0033333_{a}	3.7433333_{a}	4.7333333_{a}	5.316667_{a}	5.6666667_{a}
4	WK 2432	1.7200000_{b}	2.4266667_{b}	2.8533333_{b}	4.503333_{b}	4.7166667_{b}
5	WK 1712	0.7966667_{de}	0.9300000_{e}	1.1466667_{e}	1.610000_{d}	1.9000000_{cd}
6	WK 3027	0.4333333_{g}	0.5400000_{f}	0.7966667_{gh}	1.016667_{f}	1.1133333_{e}
7	WK 3026	0.6933333_{ef}	0.7866667_{e}	0.9266667_{f}	1.053333_{ef}	1.1633333_{e}
8	WK 2286	0.8000000_{de}	0.8533333_{e}	0.9400000_{f}	1.016667_{f}	1.1566667_{e}
9	WK 1204	0.6300000_{f}	0.7766667_{e}	0.9033333_{fg}	1.036667_{f}	1.1666667_{e}
10	WK 2430	0.4200000_{g}	0.4733333_{f}	0.6766667_{h}	0.780000_{f}	0.9233333_{e}
F test (1%)		***	***	***	***	***
Mean		0.965	1.348667	1.640667	1.994333	2.18000
CV%		9.473037	7.239653	4.525711	12.94177	12.36208
LSD		0.1556961	0.1662966	0.1264644	0.4395948	0.4589962

The analysis of variance shows the significant difference among the treatments. In terms of weight seeds, the least infected was WK 2430(Table 1) and the most weight loss was found in WK 3025(Table 1) throughout the observation.

Assessment in terms of number of damaged seeds

Table 2: Analysis Table in number of damaged seeds in five observations

S.no	Treatments	@20days	@40days	@60days	@80days	@100days
1	WK 1792	26.66667_{b}	43.33333_{c}	48.66667_{c}	57.33333_{c}	64.33333_{c}
2	WK 2123	27.00000_{b}	33.33333_{d}	38.00000_{d}	58.00000_{c}	60.66667_{c}
3	WK 3025	41.00000_{a}	81.66667_{a}	124.33333_{a}	132.00000_{a}	149.66667_{a}
4	WK 2432	43.66667_{a}	61.66667_{b}	94.00000_{b}	103.33333_{b}	115.00000_{b}
5	WK 1712	12.33333_{c}	14.00000_{fg}	17.66667_{ef}	36.00000_{d}	42.33333_{d}
6	WK 3027	10.00000_{c}	13.33333_{fg}	22.33333_{e}	27.33333_{e}	32.00000_{e}
7	WK 3026	21.00000_{b}	26.33333_{e}	32.66667_{d}	38.00000_{d}	40.33333_{d}
8	WK 2286	13.66667_{c}	18.66667_{f}	32.66667_{d}	27.33333_{e}	31.00000_{e}
9	WK 1204	12.00000_{c}	15.00000_{fg}	20.33333_{ef}	28.33333_{e}	31.66667_{e}
10	WK 2430	10.33333_{c}	12.33333_{g}	14.00000_{f}	19.00000_{f}	28.33333_{e}
F test (1%)		***	***	***	***	***
Mean		21.76667	31.96667	43.46667	52.66667	59.53333
CV%		16.22121	10.50027	8.83068	6.889728	6.746862
LSD		6.01362	5.716876	6.537498	6.18015	6.841056

In terms of number of damaged seeds, the most infected number of seeds was found in WK 3025 (Table 2) and the least number of seeds was found in WK 2430 (Table 2). The released variety WK 1204 (Table 2) was in par with the most resistant type and quite useful in storage conditions.

The physical properties of the seed with regards to the walls of the ovary i.e. the pericarp and the chemical constituents of various walls which evoke discernible return of the storage product (Baker and Loschiavo 1987) [8] makes impact on the degree with which the insects take advantage of these structures and bestow the cereals fruit for its vigorous surge and augmentation.

The content in terms of oil and protein has fundamental influence in the evaluation of resistance mechanism in wheat. (McGaughey 1990) [9] had done the evaluation in grains from 62 wheat varieties for recording the insect susceptibility in United States. The significant differences were seen among the wheat classes in terms of susceptibility. But as far as the varieties within the classes were concerned, no significant differences were found. The grain size and hardness were also found to be the influencing factor that determined the significant differences in between the classes.

(Singh, 2002) [10] also conducted the similar experiment in terms of preference with ovipositor in Sitophilus oryzae. It coincided with the results as in the WK 2430 and WK 1204 in comparison with WK 3025 (Table 1 and 2).

Conclusion

The experiment concluded that resistivity differs between the pipelines and variety as assessed by number of damaged seeds and weight loss. The WK 2430 pipeline was found to be the most resistant against maize weevil attack whereas the pipeline WK 3025 was found to be the least resistant in storage terms. The released rust resistant variety was also the least affected and can be considered useful in storage terms.

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