Effect of Preliminary Infestation of Three Stored Grain Insect Pests *Tribolium castaneum, (H) Sitophils oryzae* (L.) and *Trogoderma granarium (E)*, their Population Buildup, Loss of Germination and Consequently Wheat Loss during Storage

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Abstract: Population buildup of *Tribolium castaneum* (H), *Sitophils oryzae* (L.) and *Trogoderma granarium* (E) at 6, 8 and 10 pairs per 500 gm wheat per specie of initial insect infestation and resultant loss of wheat was calculated under laboratory conditions during storage period of six (06) months. Average increase number ranged from 20 to 3900 insects. Loss of germination, kernel damage and weight loss were 2.49 to 50.0, 2.79 to 63.69 and 1.99 to 15.38 respectively during the study period. *Sitophilus oryzae* was found to cause higher weight loss, kernel damage and loss of germination as compared to *Trogoderma granarium* and *Tribolium castaneum*.

Keywords: Fumigation, Wheat grain, Infestation, Inqlab.

INTRODUCTION

In Pakistan wheat grown on an average of about 65% area of agricultural land [1]. Pakistani farmers produced 25-million-ton wheat from 6.8 million hectares in the year 2009 [2]. Stored grain insect pests are responsible for a substantial loss in field and during storage of food grains of worth millions of rupees [3, 4]. The damage caused by stored grain insect pest to stored wheat is between 10 to 20 percent [5]. Main causes of losses are (1) untrained staff (2) misuse of phosphine and other chemicals for the control of stored grain insect pests (3) procurement of substandard wheat (4) very old and unmaintained warehouses etc. [6, 7].

Tribolium castanum (Herbst) red flour beetle is an important cosmopolitan stored grain insect pest [8, 9]. *Trogoderma grainrium* (Everts) Khapra beetle is the most destructive and quarantine pest of wheat and other grains [10-13]. Attack of khapra beetle larvae damage the grain and its nutritive quality [14]. *Sitophilus* spp. and *Rhyzopertha dominica* L. are among the major pests and are cosmopolitan in nature, they cause severe losses in rice, maize, barley, wheat, and other crops [15]. The damage caused by these spp. ranged between 16.25%, 8.50%, and 6.25%, in wheat, barley, and maize respectively [16].

After the attack of three major and one minor stored grain insect pests viz. *Sitophlius oryzae, Rhyzopertha dominica, Trogoderma granarium* and *Tribolium cataneum* respectively wheat becomes susceptible for the attack of scavengers [5, 17]. Saw-toothed grain beetle, *Tribolium castaneum* and *confusum* are the examples of scavengers [8, 9].

Pest control practices based on substandard chemicals develop the resistance in stored grain insect pests [18, 19] such resistant strains are very difficult to control by normal practices [20-23]. The resistance against phosphine in stored grain insect pests has been reported by [22-26].

All these pests however, do not infest the produce simultaneously, obviously due to varied requirements of environmental factors. These factors lead to variations of insect population and thus affect the extent of storage loss inflicted by the insects. Besides, length of storage period and level of initial infestation of insect species also have bearing on their population build-up.

From the studies on loss of wheat at a particular population level of insect species by [27- 30] no detailed study is available regarding the effect of length of storage period and level of initial infestation of different insect species on their population build-up and the resultant loss of stored wheat and loss of germination.

The present study was therefore, planned to study in detail the effect of storage period ranging from 1 to 6 months and three levels i.e. 6, 8 and 10 pairs/500 gm wheat/species of initial infestation of rice weevil (*S.oryzae*), khapra beetle (*T. granarium*) and rust red

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flour beetle (*T. castaneum*) on their population build-up, the resultant weight and germination losses of stored wheat under different laboratory conditions.

MATERIAL AND METHODS

Grains of freshly harvested wheat variety Inqlab were cleaned and sieved with 4 mesh/m^2 sieve to remove small fractions of grains and insects. After cleaning grains were disinfested by fumigation in air tight container. For this purpose, ALP tablets were applied @ of 3 tablets /m^2. The container was kept closed for 10 days to ensure the total mortality of insects if any [31]. After this treatment, wheat grains were kept overnight at room temperature before adjusting their moisture content to 14 percent by adding tap water as per formula [32]. This was done to acclimatize insects with the environment [33-36].

Test insect species were released at three levels i.e. 6, 8 and 10 pairs/500 g wheat of initial infestation. One day old adult pairs of each specie were released in the jars. The mouth of jars was covered with muslin cloth which was kept tight with the help of rubber bands after the release of insects. The experiment was conducted in room conditions from June 2012 to November 2012 (six months) and each treatment contained 500 g wheat in the glass jars (15 cm X 10 cm). Six sets of all treatments were run at a time. One set was removed and discarded every month after recording the observations.

For recording the observations, wheat grains were sieved thoroughly with 4 mesh/cm^2 sieve to separate the frass and insects. The insects along with grain frass were kept at 5^OC in the incubator for future observations. Left over grain after sieving were weighed on a single pan top loading triple beam balance (sensitivity=0.1 g) to calculate the loss of weight of grains on wet weight basis. One hundred grains were randomly collected from each replicate for observation of damage kernel. For germination testing 100 grains were also collected randomly from each jar and sterilized by dipping in 0.02 percent Aureofungin solution for 3-4 hours against the fungal growth during the test and were washed with tap water. Germination of grains was tested by blotter paper technique in glass Petri-dishes, which were incubated at 20± 1^OC temperature in the incubator for 4 days as per recommendations [37].

After separating the test insects from the frass by 23 mesh/cm^2 sieve were killed by exposing those at 100°C in oven for 60x10 seconds for easy counting of dead insects. The adults of *T. castaneum* of being comparatively lower were counted directly. While, the weight of killed insects of other species was 2 or greater than 2 g, the number of insects were calculated by weighing and multiplying with a number per unit weight of that particular species. The average weight loss, germination loss and kernel damage of wheat were worked out accordingly.

RESULTS AND DISCUSSION

1. Insect Population Build-Up

i) Storage Period Effect

Average population of all the adult insect test species collectively increased with the increase of storage period. It being 20, 304, 1500, 2649, 3135 and 3900 from first to sixth month (June to November) respectively (Figure **1a**). Similar trend of increase in population of *Sitophilus oryzae* L. and *Rhizopertha dominica* F. with the increase in storage period was reported by [30, 38].

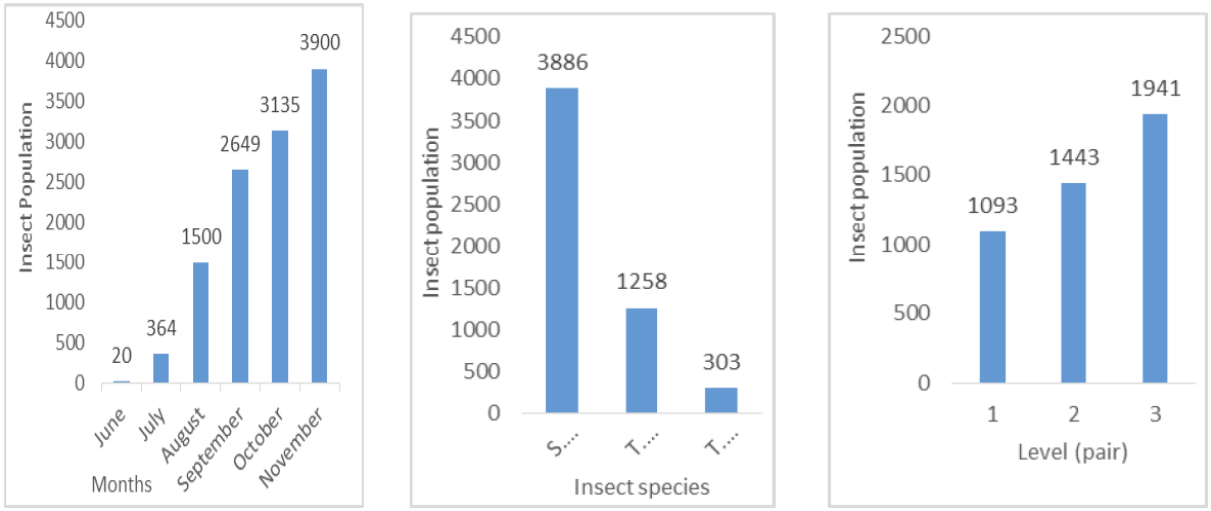
ii) Effect of Different Levels of Initial Infestation

The insects at 10 pairs level produced higher progeny than 8 and 6 pairs. It was recorded as 1941, 1443 and 1093 respectively (Figure **1b**). Similar trend of increase in population at higher level of initial infestation i.e. 3 pairs than 1 pair/10-100 gm wheat in case of *S. oryzae* and *R. dominica* and 12 pairs /250 gm of wheat in case of Trogoderma *granarium*, *Rhizopertha dominica* F., *T. castaneum* and *S. oryzae* respectively was reported in earlier studies [30, 38].

Individually, in case of *T. castaneum* different levels of initial infestation had no variable effect. In *T. granarium* population of the insects at 10 pair level was at par with 6 pairs, whereas, in case of *S. oryzae,* the population build-up at 10 pair was higher than 8 and 6 pairs, the latter two being at par with each other.

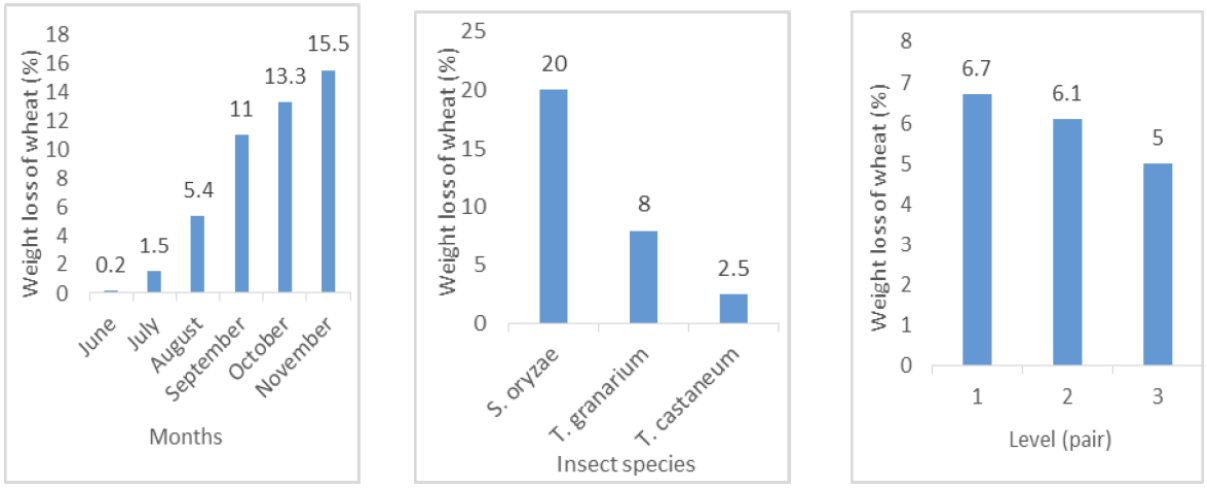
iii) Comparative Population Build-Up

Average population of *S. oryzae* after six months' storage period was higher than *T. granarium* and *T. castaneum,* it remained 3880, 1250 and 303, respectively (Figure **1b**). It was noted that *S. oryzae* was found multiplying throughout the storage period from (June to November) which indicated that insect being cold tolerant was not so adversely affected from October to November, when the average room temperature varied from 21.0 to 15.5°C. The moisture



(a) **(b)** **(c)**

Figure 1: Insect population as affected by (**a**) months (**b**) insect species and (**c**) level (pair).



(a) **(b)** **(c)**

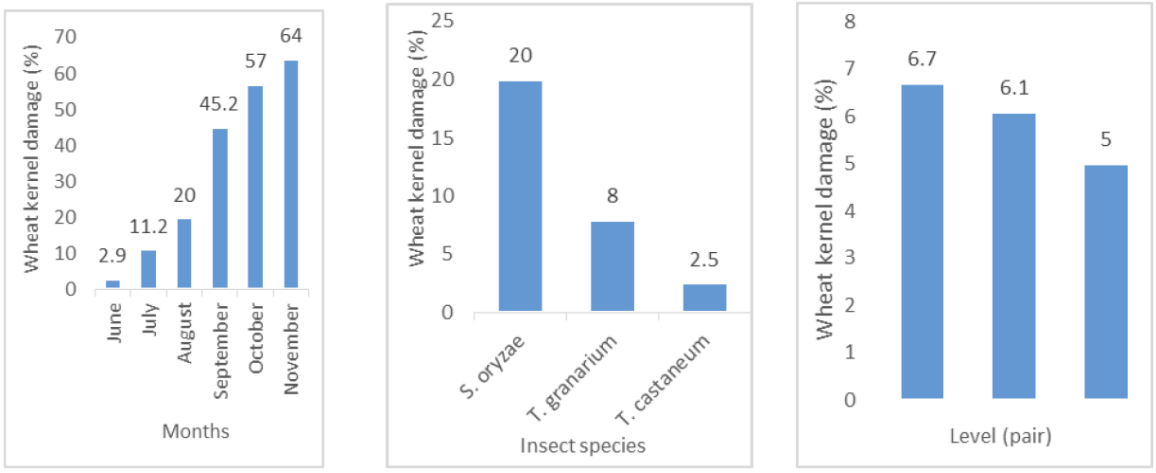
Figure 2: Weight loss of wheat (%) as affected by (**a**) months (**b**) insect species and (**c**) level (pair).

content of grains was raised from 13.9 to 18.0 percent by *S. oryzae* as compared with 12.1 and 11.3 percent moisture of grain infested by *T. granarium* and *T. castaneum*, respectively. This quality of raising the moisture content of grain by *S. oryzae* might have also benefited these species at low room temperature levels. The population of *T. granarium* also increased with increase in storage period, but the rate of increase in population was much lower than that of *S. oryzae*. This could be due to the slow down activities of this insect because of induction of larval diapause in response to low room temperature as reported by [39]. On the other hand, the population of *T. castaneum* increased up to August and thereafter its population remained unchanged which might be attributed to sub-optimal (9.8 to 11.0 percent) moisture content of grain from August to November and room temperature (27.4-15.6°C) from September to November. For the rapid development and multiplication of this pest, a combination of 30°C x 13/16 percent moisture content of food was reported by [39].

2. Wheat Loss

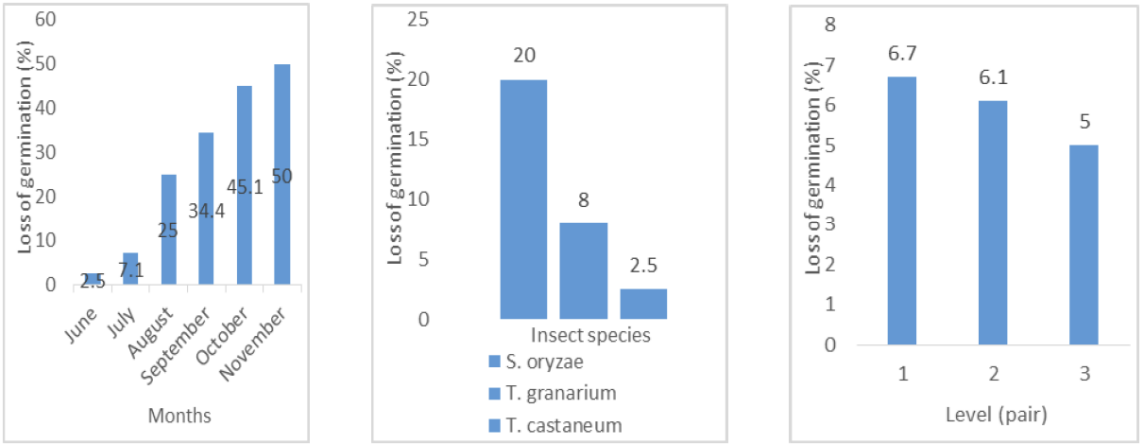
i) Effect of Storage Period

The percentage loss of wheat, i.e. kernel damage, loss of germination and loss in weight increased with the increase in storage period as a function of increase in the population build-up of insects. The weight loss, kernel damage and loss of germination was 0.2, 1.5, 5.4, 11.0, 13.3 and 15.5 percent (Figure **2a**); 2.9, 11.2, 20.0, 45.3, 57.0 and 64.0 percent (Figure **3a**) and 2.5,



(a) **(b)** **(c)**

Figure 3: Wheat kernel damage (%) as affected by (**a**) months (**b**) insect species and (**c**) level (pair).



(a) **(b)** **(c)**

Figure 4: Loss of germination (%) as affected by (**a**) months (**b**) insect species and (**c**) level (pair).

7.1, 25.0, 34.4, 54.1 and 50.0 percent (Figure **4a**) from first to sixth month respectively. The similar trend of increase in wheat loss infested by *T. granarium* with the increase in storage period was reported earlier [30, 40] while worked with *R. dominica*.

ii) Effect of Different Levels of Initial Infestation

The average loss of wheat was higher at 10 pairs of initial infestation than at 6 and 4 pairs (Figures **2c, 3c, 4c**). The proportional increase in kernel damage of maize was due to *Sitophilus zeamais* with respect to initial damage [41]. Maize grain with initial kernel damage of 0, 1.2, 3.5 and 6.3 percent recorded < 1.0, 34.7, 43.0 and 63.0 percent kernel damage, after six months of storage, respectively.

iii) Comparative Effect of Different Insect Species

S. oryzae was found to cause higher loss of wheat than *T. granarium* and *T. castaneum*. The average kernel damage, loss of germination and loss in weight was 20.0, 45.4 and 51.4 percent in case of *S. oryzae*; 8.0, 35.4 and 40.0 percent due to *T. granarium* and 2.5, 18.0 and 17.3 percent in case of *T. castaneum*, respectively (Figures **2b, 3b, 4b**). It was reported by workers that *S. oryzae* was more serious pest of wheat and rice than *R. dominica*, *T. castaneum*, *Cryptolestes pusillus* (Schoen.) and *Oryzaephilus surinamensis* L [30, 42].

CONLUSION

To sum up, the loss of wheat increased with an increase in storage period that resulted in enhanced insect population. The *Sitophilus oryzae* caused higher losses in weight, kernel damage and reduction in germination of wheat than *Trogoderma granarium* and *Tribolium castaneum*. The higher (10 pairs) level of initial infestation of wheat by these insect species

produced higher loss of wheat than 8 and 6 pairs. In order to minimize grain losses from stored grain insect pests, improvement and maintenance of warehouses along with training of staff deputed at place is suggested. Besides, this use of recommended doses of insecticide such as phosphine or other chemicals is suggested so that resistant of stored grain insect pest against these chemicals is controlled.

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