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Evaluation of Different Wheat Genotypes Against Rice Weevil (Sitophilus Oryzae (L.) (Coleopteran: Curculionidae)

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Abstract
An experiment was conducted using twelve different wheat genotypes to determine their resistance to Sitophilus oryzae (L.) at Agriculture Research Institute Tarnab, Peshawar during the year 2013. The experiment was laid out in Completely Randomized Design (CRD) with three replications in a control temperature of 29±2˚c with 60±65% relative humidity. A sample of 100 gm of wheat grains were kept in a plastic jar of 240 gm capacity. Six pairs of newly emerged adults of S. oryzae of uniform age from laboratory stocked culture were released in each jar. Results were evaluated on the basis of percent weight loss, percent grains damaged, adult population and proximate composition of wheat grains against the infestation of S. oryzae. Among all the genotypes percent weight loss (6.21%), percent grains damaged (5.32%) and adult population (82) were found lowest in A2-92 and was found to be comparatively the most resistant genotype, while the highest adult population (145), percent weight loss (16.99%) and percent damaged grains (9.53%) were recorded in genotype A2-95 and was found the most susceptible genotype against the infestation of pest, while the other genotypes were intermediate in response to the pest attack.
Keywords: Wheat, Sitophilus oryzae (L.), weight loss, grains damaged, adult population

INTRODUCTION

During storage varieties of different cereals perform differently to store grain insect attack. Such differences in susceptibility have been known earlier but in the last two decades much of the efforts have been made. It is now very important to develop such varieties that should be less susceptible or more resistant to the store grain pest. In case of screening wheat varieties against stored grain pests, little work has been done in Pakistan.

Wheat (Tritium aestivum L.) being a major staple crop of Pakistan was cultivated on an area of about 8 million hectares with the production of 2787 (kg ha^{-1}) during the year 2012-13 (Economic Survey of Pakistan, 2013). The procurement and storage of wheat is dealt by private and government agencies to meet the food requirement of the people round the year. Losses caused by insect after harvest may be direct or indirect. A direct loss is the disappearance of the commodity as a result of insect feeding. The indirect loss is lowering the quality of the commodity to the extent to lower its price or to reject it completely (Boxall, 2001). Store grain pest of wheat and rice are cosmopolitan insects which are spread worldwide due to international exchanges. Although distribution of wheat weevil is limited to cold and moderate areas, hence rice weevil is seen at tropical and semitropical areas. These pests feed on grains such as wheat, barley, rye, corn and sorghum to cause heavy loss (Bagheri-Zenouz, 1996). Stored product serious damage is caused by insect pest to the stored commodities. The resistant varieties, especially in village cooperative and farmer's stores, can be kept for longer time without use of pesticides. (Semple., 1985). There is improper storage ability in public sector of 4.34 million tons (Ahmad and Ahmad, 2002). High moisture content of grains, relative humidity and high environmental temperature during storage provide suitable condition for insect's production (Ahmad et al., 1998; Dars et al. 2001). As a result insects develop rapidly and inflict huge losses ranging from 5 to 30 percent. Important stored grain insects are beetles (Trogoderma granarium Everts, Rhyzopertha domenica F.), weevils (Sitophilus oryzae L., S. granarius) and moths (Sitotroga cerealella Oliv.) (Shafique et al. 2003). Sitophilus oryzae is a serious grain pest in multinational stores. The adults fed on endosperm, hence declining the carbohydrate contents. The larvae feed on the germ of the grain and reducing great amount of protein and vitamins (Belloa et al., 2000). The females insert their ovipositor into hole and lay one egg inside (Throne and Cunninghem 1994). Weevil has a life cycle of 34.8 days at 27˚C and 69% relative humidity (Osman et al. 2012). Chemical control of these pests gives residues and develops insect resistance. Lot of variation has been reported in grains for resistance to storage insects (Shafique and Ahmad, 2003). Keeping in view the importance of the crop and huge losses caused by stored insect Sitophilus oryzae to wheat, the present study was carried for the response of wheat genotypes for resistance to S. oryzae and resistant in the selected genotype for safe storage in future.

MATERIALS AND METHODS

In order to evaluate the resistance in different wheat genotypes to Sitophilus oryzae (L.), an experiment was conducted in Agriculture Research Institute Tarnab, Peshawar, during the year 2013. The test insects were obtained from different store houses in Peshawar. Wheat genotypes were obtained from cereal Crop Research Institute Pirsabak, Nowshera. The material were brought into the laboratory and treated with heat treatment at 120˚C for twenty minutes in auto clave to eliminate any prior infestation before starting the experiment.

Preparation of uniform age groups of Sitophilus oryzae (L.)

For uniform age of group of Sitophilus oryzae 2 kg of wheat grain (Cultivar, Atta Habib) was taken in a large glass container of 4 liter capacity and sufficient number of Sitophilus oryzae (L.) adults collected from different wheat stores houses in Peshawar were released on wheat samples for egg-laying. After 24 hours of storage, the grains were sieved to separate the adults. The wheat grains with eggs were stored in a separate container, labeled with date and incubated at 30˚C for egg hatching. The larvae after hatching out from eggs were allowed to feed on wheat grains and the ultimate adults emerging on the same day were used in the study as a uniform age.

Resistance test of wheat genotypes against Sitophilus oryzae

A sample of 100 g of wheat grains of each genotype i.e. (A3-23, A2-92, A1-21, A1-29, A1-27, A2-95, A1-15, A2-75, A2-93, A2-89, A3-43 and A2-73), were filled in plastic jars of about 240 g capacity and tightly covered with rubber band and muslin cloth. Six pairs of adults (male and female) of S. oryzae of uniform age group from the stocked culture were released in each jar and replicated three times. There were total 180 treatments (12 varieties × 3 replications × 5 months of store) with one control treatment. The experiment was maintained at a 29±2˚C and 60-65% RH in a rearing chamber. Observation of adult population, percent grain damage and percent weight loss were recorded at monthly intervals. For removing frass, samples were sieved through a 60 mesh sieve. Sound and infested grains were separated and weighted. For determining the percent weight loss, the method of Khatak et al. (1987) were calculated according to the following expression

$$\% \text{ Wt loss} = \frac{\text{Weight of control sample} - \text{Weight of infested sample}}{\text{Weight of control sample}} \times 100$$

The data were analyzed for Percent grains damaged by Sitophilus oryzae, percent weight loss and adult populationof S. oryzae.

RESULT AND DISCUSSION

Percent grains damaged

Table 1.1 shows percent grain damaged by Sitophilus oryzae during five months of storage. The minimum percent grains damaged during the first month of storage was 0.4% in genotype A2-92, while the maximum percent grains damage was in A2-95 (1.4%) genotype. The remaining ten genotypes were intermediate between them. After the second month of storage the minimum percent damage grain was 0.9% in A2-92 and maximum was 2.6% in A2-95. Similarly after 3, 4 and 5 months of storage the minimum percent grain damage was 5.5, 8.3 and 11.2% in A2-92 and maximum damage was 10.4, 14.7 and 18.4% in A2-95 respectively. All other tested genotypes showed mixed response to the insect attack.

The data shows that the damaged grains increased gradually and progressively with the passage of storage. Statistical analysis of the data revealed that there was significant difference in the percent grain damage after five month of storage. Genotype A2-92 showed significant response to the pest feeding and proved least susceptible in term of low percent of grains damaged (5.32%), followed by genotype A2-75 (6.33%) and A1-21 (6.54%), (these two being statistically non-significant from one another), while genotype A2-95 (9.53%) had the maximum percent grains damage showed least resistance/susceptibility for having significantly maximum percent grains damaged.

The results of the present investigation revealed that on the basis of percent grains damage in the tested genotypes A2-92 (5.32%) was found to be more resistant genotype followed by A2-75 (6.33) and A3-43 (6.54%). While genotype A2-95 (9.53%) was found to be the most susceptible genotype, it had the maximum percent damaged grains. These results are more or less in conformity with those obtained by Suleman et al. (2000), Subedi et al. (2009) In free choice test polished rice was the most preferred host, 18.75 percent grains damage, weight loss was 14.11 % and adult F1 progeny was 138.8 under no choice conditions wheat was the most preferred host followed by polished rice in the same manner. In wheat percent weight loss (17.72%) and f1 progeny (122.5 adult weevils) were maximum they tested different wheat cultivars against the same pest in various localities and recorded different degree of resistance in them.

Percent weight loss by Sitophilus oryzae in different wheat genotypes

Data given in Table 1.2 shows percent weight loss of different wheat genotypes by Sitophilus oryzae in five months of storage the minimum weight loss during the first month of storage was 1.80% in A2-92 and maximum weight loss was 7.00% in A2-95. Similarly after the second month of storage the minimum weight loss was 2.90% in A2-92 while maximum weight loss was 12.46 in A2-95. After 3, 4 and 5 month of storage the minimum weight loss was 5.26, 8.23 and 12.76% in A2-92 and maximum weight loss was 15.86, 21.23 and 28.36% in A2-95 respectively, while the other genotypes were found intermediate between the tested lot. The table shows that increased weight loss occurred gradually and progressively during the storage. After five month of storage the mean weight loss was 10.49, 6.21, 9.87, 11.89, 13.39, 16.99, 10.11, 12.43, 12.43, 12.03, 11.89 and 12.63% respectively in genotypes A3-23, A2-92, A1-21, A1-29, A1-27, A2-95, A1-15, A2-75, A2-93, A2-89, A3-43 and A2-73.

The grain weight loss in different wheat genotypes caused by Sitophilus oryzae varied significantly (P□0.05). Statistical analysis of the revealed significant difference in percent weight loss of different wheat genotypes due to infestation. Genotypes suffering from minimum loss of weight show least preference or maximum resistance for insect pest. Genotype A2-95 was significantly more preferred or least resistant for infestation by Sitophilus oryzae during storage. On the basis of weight loss of wheat grains due to Sitophilus oryzae infestation in storage, genotype A2-92 (1.80%) was found to be relatively resistant genotype followed by A1-21(9.87%), A3-23(10.49%) and A1-15 (10.11%) respectively. While maximum weight loss occurred in A2-95 (16.99%) and was found to be susceptible genotypes followed by A1-27 (13.39%) and A2-73 (12.63%). The present findings are in conformity with that of Jayakumar and Jeyaraj (1995), who reported that some varieties of wheat are more susceptible, while the other are least susceptible to the attack of Sitophilus oryzae. High weight loss was due to high carbohydrate and low protein. (Golob et al., 1984) reported grain loss between 12 to 20 percent in his findings. The present results are in conformity with that of results obtained by (Ram and Singh., 1996). Giga et al., 1991 also calculated similar kind of results with high weight loss reported about 80%. High weight loss was due to large number of insect population in genotype A2-95.

Adult population:

Data given in Table no: 1.3 shows the number of adults in different wheat genotypes in five month of storage. The minimum number of adults after the first month of storage was 9 in genotype, A2-92 and maximum number was 24 in A2-95, while the remaining was found intermediate between the tested genotypes. After second month of storage minimum adult population was 17 in tested genotype A2-92 and maximum was 50 in A2-95. Similarly after 3, 4 and 5 months of storage the minimum number of adults were 64, 137 and 166 in A2-92 and maximum number of adults was 170, 226 and 257 in accession A2-95. After five month of storage mean highest population of adult built up was recorded in genotype A2-95 that contains 145 adults, followed by A1-15 and A1-27 harboring 131 and 130 adult insects respectively. The lowest population was recorded in A2-92 having 83 adults, followed by A2-73, A1-21 and A1-29 genotype where 109, 110 and 110 adults were counted, respectively. The data shows the number of adults increased accordingly in all the tested genotypes with the time of storage. Statistical analysis of the data revealed that line, A2-95 developed significantly highest population of Sitophilus oryzae showing its greater preference/ susceptibility, while, the line A2-92 developed significantly least population showing its greater resistance to Sitophilus oryzae. Regarding population buildup, highest numbers of adults were produced on genotype A2-95 (145) followed by A1-15 (131), while it was least in genotype A2-92 (83) followed by A2-72 (108) at 150 days after storage. These genotypes also showed minimum percent infestation and percent damaged grains by pest indicating that these genotypes were comparatively the most resistant genotypes in the present study. Gomez et al., 1983 studied that chemical factors may be involved in avoidance of the germ end during oviposition. In my findings there was a highly significant positive correlation between adult population, percent infestation and percent grains damaged. As the same positive correlation has been reported between pest population increase, grain weight loss and grain moisture by (Syed et al., 2001; Khan et al. 2005). Varietal protein content was negatively associated with progeny production of Sitophilus oryzae (Amos et al., 1986, Ram and Singh 1996). Since there is no evidence to make critical discussion on this issue but according to (Borikar and Tayde., 1979) who reported that hybrids were comparatively had less incidence of rice weevil than the local genotypes. This may be attributed to genotypic character having thick per carp.

Conclusion

It is concluded that among all wheat genotypes, A2-92, and A3-23 were found to be resistant to Sitophilus oryzae. The A2-95, A1-27 and A1-15 were regarded comparatively susceptible wheat genotypes on the basis of adult population, percent grains damaged and percent weight loss. Among the above two resistant genotypes, the A2-92 was decided more resistant or less susceptible to Sitophilus oryzae and was found to be most safest for storage in future due to high population and weight loss as the main index of susceptibility. Furthermore the A2-95 genotype was the most susceptible to rice weevil. It is recommended in general that for prolong storage, most susceptible genotypes should be avoided. For practical point of view such varieties should be considered which are safe both in the field and for storage.

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Table No 1.1. Percent grains damaged in different wheat genotypes by Sitophilus oryzae in five month of storage.

S.No	Name of genotypes	No of grains damaged in five month					
		August	September	October	November	December	Mean
1	A3-23	0.7d	1.6c	8.3bc	11.2bc	15.1bc	7.44de
2	A2-92	0.4e	0.9d	5.5e	8.3e	11.2f	5.32a
3	A1-21	0.8cd	1.9bc	3.4cd	9.4de	13.0de	6.54bc
4	A1-29	0.8cd	1.4c	8.2bc	10.5bcd	15.4bc	7.31cde
5	A1-27	1.0bc	2.2ab	9.5ab	11.3bc	15.1bc	7.86e
6	A2-95	1.4a	2.6a	10.4a	14.7a	18.4a	9.53f
7	A1-15	1.1d	2.3ab	9.1ab	12.0b	15.9bc	8.11e
8	A2-75	0.8d	1.7c	6.5de	9.6cde	12.9def	6.33b
9	A2-93	0.7d	1.5c	8.2bc	10.5bcd	16b	7.39de
10	A2-89	0.9bc	2.5a	8.6bc	11.1bcd	14.2cd	7.51de
11	A3-43	0.7d	1.7c	8.2bc	9.4de	12.4ef	6.52bc
12	A2-73	0.7d	1.4c	8.2bc	11.9b	12.ef	6.92bcd

Means followed by different letters and different columns are significantly different from one another (P< 0.05) using DMR test.

Table No 1.2. Percent weight loss in different wheat genotypes during five month of storage by Sitophilus oryzae.

S.No.	Genotypes	Percent Weight loss During Five Month of Storage					
		August	September	October	November	December	Mean
1	A3-23	4.43bc	6.30c	10.30d	13.50cd	17.90ef	10.49ab
2	A2-92	1.80e	2.90d	5.36e	8.23e	12.76g	6.21a
3	A1-21	4.33bcd	6.00c	12.30bcd	11.66de	15.06fg	9.87b
4	A1-29	4.53bc	8.63b	11.76cd	15.20bc	19.33cde	11.89cd
5	A1-27	4.16bcd	7.06bc	14.23bcd	17.76ab	23.73b	13.39e
6	A2-95	7.00a	12.46a	15.86a	21.23a	28.36a	16.99f
7	A1-15	6.20c	6.20c	10.40d	13.76cd	17.13ef	10.11b
8	A2-75	5.26ab	8.63b	12.83bcd	16.16bc	19.23cde	12.43e
9	A2-93	3.86bcde	7.23bc	11.66cd	17.86ab	21.53bcd	12.43e
10	A2-89	5.63ab	6.86bc	12.00bcd	16.03bc	19.43cde	12.03
11	A3-43	3.83bcde	7.63bc	11.80cd	18.06ab	18.13cdef	11.89cd
12	A2-73	2.26de	6.60c	14.66ab	17.83ab	21.76bc	12.63e

Means followed by different letters and different columns are significantly different from one another (P< 0.05), using DMR test.

Table No 1. 3. Adult population of Sitophilus oryzae in five month of storage

S.No.	Name of genotypes	Adult population in different month of storage					
		August	September	October	November	December	Mean
1	A3-23	13de	24de	133b	184bc	218bc	115bc
2	A2-92	9e	17e	64c	137d	166d	83a
3	A1-21	17bcd	35bcd	127b	187bc	208bc	110b
4	A1-29	19abc	40abc	132b	166cd	190cd	110b
5	A1-27	20abc	42ab	150ab	207ab	240ab	130cd
6	A2-95	24a	50a	170a	226a	257a	145e
7	A1-15	20abc	38bc	161ab	202ab	235ab	131d
8	A2-75	19abc	40abc	161ab	201ab	223abc	130cd
9	A2-93	21ab	42ab	156ab	180bc	207bc	120bcd
10	A2-89	18bc	39abc	147ab	184bc	207bc	121bcd
11	A3-43	18bc	37bc	152ab	181bc	210bc	119bcd
12	A2-73	15cd	30cd	140ab	163cd	196cd	108b

Means followed by different letters and different columns are significantly different from one another (P< 0.05), using DMR test.