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Varietal screening and development of rice weevil, *Sitophilus oryzae* (L.) in advanced rice genotypes at different temperatures

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Abstract

The present study was conducted to screen out six rice genotypes including two course and four fine advanced varieties against Coleopterous insect rice weevil, *Sitophilus oryzae* (L.) under laboratory conditions. Weighing 100g sample of each genotype in plastic jars having capacity of 250g. Thirty adult insects of rice weevil, reared in laboratory were released in each jar. Quantitative losses as weight loss, percent damaged grains, progeny development and frass weight was recorded after 90 days of storage at 28oC, 32oC and 35oC. Percentage damage grains, adult emergence and frass weight was significantly high at 32, 28 and 35°C respectively. Maximum infestation in case of percentage damaged grains recorded in course genotype KSK-133(20.58%) and Basmati-515(16.90%) followed by Basmati-2006(13.033%), and Super Basmati (12.433%) at 28°C. In a similar way but minimum weight loss (0.5%) was observed in KSK-282 at 35°C and (1%) in Basmati-2006 at 32oC. Overall, low resistance level with highest insect development was counted in KSK-133 (114), (101), (86) and Basmati-515(85), (90), (64.3) at 32, 35 and 28°C respectively. But under similar conditions Basmati-385(53), (43), (42) showed resistance in insect multiplication. Findings should be incorporate in breeding programme and can also be helpful in post-harvest storage.

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Introduction

Rice, *Oryza sativa* L. (Poaceae) is produced all over the world particularly in Asian countries like Thailand, Japan, China, India, Bangladesh and Pakistan. In Asian countries *Oryza sativa* L. is fed by two billion human populations while seven hundred million in African countries (IRRI, 1985). Among cereal crops rice is a staple food of some countries provides at least half of the human diet (Swaminathan, 1984). *Oryza sativa* contributes about one fourth of the calories taken in the diet of one billion people (Chang, 1984). In Pakistan rice is second most important economic crop among cereals. Rice crop contributes about 5 percent value added in agriculture and one percent in GDP. Recently in Pakistan, production of *Oryza sativa* L. is about 6.16 million tons (Anonymous, 2011). In the production of Rice 27.7 percent increment has been recorded as compared to last year. Average yield of rice in Pakistan is approximately 2396 Kg ha^{-1} (Anonymous, 2011). Out of sum production, Pakistan exports a reasonable amount of rice to other countries every year.

Due to the infesting tricks of stored product insect pests demand for rice consumption remains high then its production. These insects may cause direct, quantitative losses or indirect losses like distastefulness, odor or poor cocking quality etc. (Chowdhury, 1990; Isman, 2006). Heavy infestation of stored grains insects may cause food spoilage and unfit for germination (Rahman *et al.*, 2003). Every year a number of stored products insect pests like rice weevil, Bean weevil, lesser grain borer, Khapra beetle, Maize weevil, Angoumois grain moth, granary weevil and red flour beetle, infest rice in storage conditions (Ebeling, 2002; Steffan, 1963; Anon., 2007; Mark *et al.*, 2010). In case of paddy rice low infestation has been recorded due to the tough hall covering as compared to the processed polished white rice (Cogburn, 1977). In case of ideal temperature, R.H and poor storage environment, losses may rise up to fifty percent but average losses fall between 5-10% (Maqsood *et al.*, 1988).

Study was conducted to screen out six advanced processed rice genotypes against rice weevil *Sitophilus oryzae* (L.) and its development at three different temperatures.

Materials and methods

Collection and rearing of test insects

Adult insects of rice weevil *Sitophilus oryzae* L. collected from nearby godowns in Faisalabad location. The collected insects of rice weevil were reared for six months in the laboratory under controlled conditions at 28+2°C and 65+5 R.H. Homogenous insects was prepared diet of commercial rice varieties. After six months of rearing homogenous population was used to conduct experiments.

Collection and screening of Rice genotypes

To check the varietal resistance six rice genotypes were taken from Rice Research Institute, Kala Shah Kaku. The varieties studied were Super basmati, Basmati-515, Basmati-2006, Basmati-385, KSK-133 and KSK-282. Diseased and damaged grains were removed from each genotype. After cleaning 100g weighted grain sample of each genotype was taken in the plastic jars of 150g capacity tightly covered with rubber band and muslin cloth. In each sample thirty adult beetles of *Sitophilus oryzae* were released in the center of the jar for free choice of oviposition. Each genotype was replicated thrice. This experiment was repeated at three temperatures viz 28, 32 and 35°C. The temperature of each incubator was maintained with 65 ±5% R.H. Data was collected after 90 days of insect release. Number and weight of damaged and undamaged grains were counted and weight loss was calculated by following equation (Gwinner *et al.*, 1996).

$$\text{Weight loss \%} = \frac{(W\mu \times Nd) - (Wd \times N\mu) \times 100}{(W\mu \times (Nd + N\mu)}$$

The grains were segregated and counted for percent damaged and undamaged grains by using the following equations.

Damaged grains % = $\frac{\text{No. of damaged grains} \times 100}{\text{Total sample grains}}$

Undamaged grains %= $\frac{\text{No. of undamaged grains} \times 100}{\text{Total sample grains}}$

Frass was sieved out from infested samples and weighted with an electrical balance. Adult emergence including dead was calculated after 90 days to determine the progeny development.

Results

Adult Emergence

Data recorded after 90days of experiment showed high weevil progeny development in KSK-133(114), (101), (86) and Basmati-515(85), (90), (64.3) at 32, 28 and 35°C in descending order. In case of interaction, temperature showed significant influence on treatments for rate of weevil multiplication and vice versa. High insect multiplication accrued in KSK-133 (114), (101) and Basmati-515 (90) at above mentioned temperatures. But fewer numbers of insects were counted in Basmati-385, Basmati-2006 and Basmati-282 at all mentioned temperatures.

Table 1. Comparison of mean values of the data regarding No. of adults emergence and weight loss (%) of various rice genotypes infested by rice weevil, Sitophilus oryzae (L.) at different temperatures.

Treatments	No. of adults emergence			% Weight loss		
	28°C	32°C	35°C	28°C	32°C	35°C
KSK-282	86.00b	52.00c	59.00b	7.33abc	1.68c	0.59c
Basmati-385	42.00d	54.67c	43.67c	12.69a	0.67c	1.91c
Basmati-515	64.33c	85.00b	90.33a	6.62abc	4.10c	4.36bc
Basmati-2006	50.00cd	45.67c	62.33b	6.41abc	1.05c	2.13c
KSK-133	101.67a	114.00a	86.00a	12.00ab	12.46a	5.39abc
Super Basmati	57.33c	77.67b	54.67bc	1.61c	7.81abc	0.43c

Weight Loss

Maximum weight loss (9.9536%) due to the infesting of rice weevil S. oryzae (L) was calculated in course rice genotype KSK-133. Rests of the genotypes were similar in response at bar each other. Interaction between mean values of temperatures and treatments showed significant high susceptibility in Basmati-385 (12.690%) and KSK-133 (12.462%) at 28 and 32°C. Overall minimum weight loss was calculated in Super Basmati (0.434%), Basmati-282 (0.597%), Basmati-385 (0.678%) and Basmati-2006 (1.051%) at 32 and 35°C that at bar with each other.

Percentage Insect Damaged grains

Percentage damaged grains calculated showed significant individual and interaction effect of temperatures and treatments. High damage was calculated at 28°C (13.76%) but other two temperatures 32 and 35°C showed almost similar level of infestation (7.45%), (7.30%) respectively. In relation to percentage insect undamaged grains, KSK-133 (20.07%) was most susceptible variety following by Basmati-515(16.90%). Basmati-282 (8.53%) was least damaged by rice weevil but Basmati-2006 (12.43%), Super Basmati (13.03%) and Basmati-385 (11.60%) at bar with each other. In the same way in case of interaction Basmati-282 was most resistant and KSK-133 was most susceptible genotype against *Sitophilus oryzae*.

Frass Development

Due to destructive activities of insect, feces and broken food particles accumulated at the bottom of the container in known as frass that was significantly observed against *Sitophilus oryzae* (L) as shown in following table. Frass weight calculated as a result of insect feeding was (1.1089g), (0.9129g), (0.7054g) at 32, 28 and 35°C correspondingly. Where in case of treatments, there was significant difference in frass weight cause by rice weevil *S. oryzae* (L) in all rice genotypes. Basmati-282 (0.16g) was proved highly resistant following by Basmati-385 (0.30g). But KSK-133 (2.48g) after that Basmati-515 (0.89g) showed high susceptibility with high frass weight values. While in interaction between mean values of temperatures and treatments means, KSK-133 (2.48g) was most susceptible at 32°C and Basmati-282 (0.16g) was most resistant, at bar with other genotypes.

Table 2. Comparison of mean values of the data regarding % damaged grains and Frass weight (g) of various rice genotypes infested by rice weevil, *Sitophilus oryzae* (L.) at different temperatures.

Treatments	% damaged grains			Frass weight		
	28°C	32°C	35°C	28°C	32°C	35°C
KSK-282	8.53d	2.21de	3.43d	0.50d	0.16e	0.38bc
Basmati-385	11.60c	0.99e	7.60b	0.72c	0.41de	0.30cd
Basmati-515	16.90b	8.40bc	8.567b	0.89b	1.77b	1.04a
Basmati-2006	12.43c	5.48cd	5.32c	0.85bc	0.77cd	0.67b
KSK-133	20.07a	20.68a	11.43a	1.76a	2.48a	1.22a
Super Basmati	13.03c	10.06b	8.33b	0.85bc	1.06c	0.06d

Disscussion

This high infestation may be enhanced due to some biotic factors like respiration or feces of red flour beetle. Moisture of the grains may have risen observing from atmosphere. Results are linear presented by Khattak *et al*., (2000) who reported that adult emergence has a great effect on percent insect damage grains and frass weight. High weight loss was due to high moisture contents as well as temperature. Golob *et al*., 1984 reported grain loss between 12 to 20 percent in his findings. Giga *et al*., 1991 also calculated similar kind of results with high weight loss also reported about 80% loss in case of untreated kernels. Due to high temperature, moisture may reduce in the grains that are responsible for low insect infestation. Damage percentage also not depends on the thickness, long or shortness of the grains. Chanbang *et al*., (2008) reported that tolerance or susceptibility in genotypes do not depends on the size or thickness of the grains. That's why in above results if one course variety is susceptible then other shows high resistance against weevil infestation. These results also consistent with others work. Trematerra *et al*., (1998) determined significant interactive action of *Sitophilus oryzae* towards undamaged and damaged kernels of 5 types of cereals. Mulungu *et al*., (2011) assessed the damage due to one of the major stored products insect lesser grain borer on different rice varieties. Quantitative losses like weight loss, percent insect damaged and healthy grains were significantly analyzed along with insect multiplication. Most of the insects like broken or mixture of broken and un-broken grains as in case of secondary insect pest of stored products. Kavallieratos *et al*., (2012) found maximum insect infestation and multiplication in mixture of cracked and un-broken cereal grains. Low percentage undamaged grains can also be point towards the hardness of the rice grains. Chanbang *et al*., (2008) reported that hardness of the kernels grounds less insect infestation, while it is fortified increases with decrease in grain hardness.

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