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# FIELD COMPARISON OF DIFFERENT RICE (*ORYZA SATIVA* L.) GENOTYPES FOR THEIR RESISTANCE AGAINST RICE STEM BORERS (PYRALIDAE: LEPIDOPTERA)

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## ABSTRACT

The use of pest resistant crop varieties is one of the important tools of integrated pest management (IPM) practices. Such crop varieties are extensively used in pest prone areas as a principal method of pest suppression. In the present experiment, 23 non-aromatic rice genotypes were sown for assessing their resistance or susceptibility combined with seed yield against rice stem borers for two consecutive years (2011 and 2012). Pooled data on different rice genotypes revealed that genotypes, IR6-300-1 (S1) and IR6-30 proved to be the most tolerant with minimum borers' incidence (0.25 & 0.30% deadhearts and 3.17 & 3.97% whiteheads, respectively) and higher grain yield (1941.7 & 1915.0 g per 3 $m^2$, respectively). The genotype IR6-25-2 and shandar also produced good results showing 0.57 & 0.64% deadhearts, 4.97 & 4.87% whiteheads and grain yield of 1787.7 & 1715.3 g per 3$m^2$, respectively. Three genotypes (IRON-2k5-27, CR-42 and CR-43) were ranked as highly susceptible, where higher infestation (2.60, 2.22 & 1.80 deadhearts and 17.83, 15.38 & 15.07% whiteheads) and lower grain yield (893.7, 910.0 & 1023.3 g per 3$m^2$) were recorded, respectively. The rest of rice genotypes were intermediate in tolerance or susceptibility to the attack of stem borers.

**Keywords:** Rice, genotypes, stem borer, infestation, resistance, susceptibility.

## INTRODUCTION

Rice (*Oryza sativa* L.) is an important staple diet for more than one third of the world's population and occupies 11% of the world's cultivated land (Khush, 1993). It is the most important food source in areas with high population and low dietary levels (Kinoshitai and Mori, 2001). It is reported to have been providing 27% of the dietary energy and 20% of dietary protein in the 3rd world countries (Cantrell and Hettel, 2004). Rice is among the major exports of Pakistan and contributes huge amount of foreign exchange earnings. It has been reported that per hectare yield of rice is lower in our country as compared to other major rice producing countries. Insect pest attack is one of the major yields limiting factors

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which may cause 20-30% losses every year (Salim *et al.,* 2001). It has been reported that the rice crop is attacked by more than 100 insect species of which, stem borers are major menace (Sarwar, 2013). The increase in rice production is an immediate requirement in Pakistan due to its rapidly growing population. However, achieving this task seems impossible due to the attack of various insect pests especially rice stem borers. According to Srivastava *et al.* (2003) rice stem borers are serious pests, and of regular occurrence to infest the crop at all stages of crop growth. Yield losses due to stem borers range from 10-30% (Khush and Toenniessen, 1991). Intensive selection and cultivation of resistant varieties have increased rice production. The damage caused by rice borers (*Tryporyza incertulas* Walker [*Scirpophaga incertulas*], *Chilo suppressalis* Walker and *Sesamia inferens* Walker) has become more serious, year after year (Jiang *et al.,* 2005). It has been estimated that each year the insect pests alone caused about 25-30% losses in yield (Ashraf *et al*., 1986).

A huge number of broad-spectrum insecticides are being used annually for the control of these pests which are continuously deteriorating the environment. Pesticides that miss their target pests end up in the air, surface water, ground water, bottom sediments, food and non-target organisms, including human and wildlife (Miller, 2002). One of the safe measures to evade such a situation is to grow resistant crop genotypes (Ahmad *et al.,* 2011). Plant breeding for resistance to insects is separated into two steps. First one is to create novel genetic variation and second one is to select improved variants (Jackson, 1995). First step depends on screening of rice germplasm to identify novel donors of resistance. The second step involves use of these donors in sexual hybridization with commercial varieties to create novel combinations of genes (Panda and Khush, 1995). According to Sehgal *et al.* (2001) the use of pest resistant crop varieties is the easiest, effective, compatible, economical and practical method among all the pest management practices. Such crop varieties are extensively used in pest prone areas as a principal methods of integrated pest management or as a supplement to other pest management strategies. It can counter the pest problems and is free from all adverse effects of pesticide uses (Sarwar *et al.,* 2010).

The objective of this study is to analyze the rice plant resistance to control the outbreaks of rice stem borer *S. incertulas,* which would be critical for introduction of a new concept of sustainable pest management method.

## MATERIALS AND METHODS

The present research studies were conducted at the experimental farm of Nuclear Institute of Agriculture, Tandojam during two consecutive years (2011 and 2012). Twenty three different non-aromatic rice genotypes were selected for assessing their resistance or susceptibility combined with seed yield against rice stem borers. Seeds of all the rice genotypes were grown in nursery. Thirty five day-old nursery of these genotypes was transplanted in well puddled soil. The plot sowing was done by keeping plant to plant and row to row distance of 20 cm. The experiment was designed in a Randomized Complete Block with three replications. Soil of the plots was kept moist with standing water at the time of transplanting and subsequent growth stages. All the standard agronomic practices were followed for raising the crop and no control methods were applied for insect pests. To control weeds, the first weeding was done at 15 days after transplanting followed by second and third weeding done at 15 days interval after first and second weeding. A basal dose of N and phosphorus at the rate of 30 kg as urea and 50 kg $ha^{-1}$ as triple super phosphate, respectively were uniformly incorporated in the soil at the time of sowing, and then 30 kg N as urea added at tillering stage.

Stem borers damage was recorded as deadhearts percentage at vegetative growth and whiteheads percentage at maturity stage by counting number of deadhearts and whiteheads per 1 $m^2$ area of rice plants in each replication. Total number of plants in selected area was counted, total number of tillers in an area was recorded and then numbers of deadhearts $hill^{-1}$ were counted to calculate above percentage. At the later stage, data for borers' infestation were taken from 1 $m^2$ hills selected randomly and determined on whiteheads basis. Then percent infestation as whitehead was thus calculated. After harvesting, paddy yield data was taken per 3 $m^2$ and subjected to proper statistical analysis for testing the significance of results by using Statistix 8.1 software. The mean differences among the treatments were compared by multiple comparison tests using LSD range test.

## RESULTS AND DISCUSSION

The rice genotypes screened out differ from one another with respect to stem borer infestation based on deadhearts, whiteheads and yield. On the basis of percent damage, none of the genotypes was totally free from stem borer damage.

### Rice stem borers incidence and grain yield in 2011

Most of the genotypes tested during 2011 showed significant differences in deadhearts and whiteheads percentage which ranged between 0.22 to 2.86 and 3.86 to 17.28%, respectively (Table 1). In field conditions, minimum borers' incidence and severity (0.16 % deadhearts and 3.66% whiteheads) and increased seed yield (1650 g/3 $m^2$) were expressed by genotypes IR6-300-1 (S1). It was followed by genotype IR6-30-1 showing 0.22% dead hearts, 4.36% whiteheads and 1636.7g yield per 3 $m^2$. Sarshar and IR6-25-2 proved to be the next successful genotypes in terms of lower borers' occurrence and higher yield compared to all other tested genotypes (0.61% deadhearts, 5.03 & 5.66% whiteheads and each having grain yield of 1580 g/3$m^2$, respectively). The genotypes IRON-2k5-27, CR-42 and CR-43 were found the most susceptible which peaked in holding pest intensity (2.86, 2.51 & 2.03% deadhearts and 17.28, 15.20 & 15.17% whiteheads) and decreased yield (966.7, 986.7 & 11.53.3 g per 3 $m^2$), respectively. The rest of non-aromatic rice genotypes were intermediate in tolerance or susceptibility to pest prevalence (Table 1).

Table 1. Screening of non-aromatic rice genotypes against rice stem borers and grain yield (2011).

| Genotypes | Deadhearts (%) | Whiteheads (%) | Yield g/3m$^2$ |
|---|---|---|---|
| Shandar | 0.61 IJ | 5.03 MN | 1580.0 ABC |
| IR6-300-1 (S1) | 0.16 K | 3.66 O | 1650.0 A |
| IR6-1.0-2 | 1.23 DEFG | 8.73 FG | 1483.3 CDEF |
| IR6-25/B | 0.65 I | 6.05 KL | 1553.3 ABC |
| NIA=1.0-2 | 0.99 FGHI | 7.05 HIJ | 1506.7 CD |
| IR6-25-12/B | 1.49 CDE | 10.32 E | 1380.0 EFG |
| NIA-625 | 1.31 DEF | 6.80 IJK | 1500.0 CD |
| IR6-20-35 | 1.55 CDE | 11.97 D | 1380.0 EFG |
| IR6-20/A | 1.44 CDE | 9.48 EF | 1416.7 DEFG |
| IR6-15/E | 1.15 EFGH | 7.36 HI | 1490.0 CDE |
| IR6-30-1 | 0.22 JK | 4.36 NO | 1636.7 AB |
| IR8-178 | 1.64 BCD | 13.53 C | 1370.0 FG |
| IR6-P | 0.98 FGHI | 6.96 IJK | 1500.0 CD |
| IR6-200-4 | 1.35 CDEF | 7.92 GH | 1483.3 CDEF |
| IR6-25-4 | 0.82 GHI | 5.73 LM | 1556.7 ABC |
| IRON-2k5-10 | 0.75 HI | 6.31 JKL | 1543.3 ABC |
| IR6-25-2 | 0.61 IJ | 5.66 LM | 1580.0 ABC |
| IRON-2k5-1 | 1.73 BC | 13.91 C | 1340.0 G |
| IR8-P | 0.84 GHI | 6.94 IJK | 1533.3 BC |
| IR8-25-4/B | 0.97 FGHI | 6.33 JKL | 1513.3 CD |
| IRON-2k5-27 | 2.86 A | 17.28 A | 966.7 I |
| CR-43 | 2.03 B | 15.17 B | 1153.3 H |
| CR-42 | 2.51 A | 15.20 B | 986.7 I |
| LSD | 0.41 | 0.95 | 113.43 |

The values followed by same letters are not significantly different ($P<0.05$) by LSD range test.

**Rice stem borers incidence and grain yield in 2012**

Data regarding stem borer incidence on different rice genotypes during 2012 revealed almost the same pattern as that of 2011. The results manifested that on an average basis of all tested rice genotypes, IR6-300-1 (S1) and IR6-30-1 were most efficient for holding reduced pest infestation (0.27 & 0.43% deadhearts and 2.67 & 3.57% whiteheads) and enhanced yield (2223.3 & 2193.3 gm per 3 m$^2$) , respectively (Table 2). The next successful genotypes with respect to borers' prevalence and increased yield were IR6-25-2 and Shandar (0.53 & 0.67 deadhearts, 4.28 & 4.72 whiteheads and 1995.0 & 1850.0 g per 3m$^2$ grain yield, respectively). The genotypes, IRON-2k5-27, CR-42 and CR-43 exhibited more pest susceptibility responses (2.34, 1.94 & 1.57% deadhearts and 18.38, 15.55 & 14.96% whiteheads) and low yield (820.0, 833.0 & 1053.3 gm per 3 m$^2$), respectively. The remaining rice genotypes were moderately tolerant to pest incidence (Table 2).

**Pooled data (2011-2012)**

Pooled data of two consecutive years i.e. 2011 and 2012 on different rice genotypes revealed that IR6-300-1 (S1) and IR6-30 were the most tolerant genotypes with minimum borers' incidence (0.25 & 0.30% deadhearts and 3.17 & 3.97% whiteheads, respectively) and higher grain yields (1941.7 & 1915.0 g per 3 $m^2$, respectively). The genotype IR6-25-2 and Shandar also performed well showing 0.57 & 0.64% deadhearts, 4.97 & 4.87% whiteheads and grain yield of 1787.7 & 1715.3 g per $3m^2$, respectively. Three genotypes (IRON-2k5-27, CR-42 and CR-43) were ranked as highly susceptible, where higher infestation (2.60, 2.22 & 1.80 deadhearts and 17.83, 15.38 & 15.07% whiteheads) and lower grain yield (893.7, 910.0 & 1023.3 g per $3m^2$) were recorded, respectively. The rest of rice genotypes were intermediate in tolerance or susceptibility to the attack of stem borer (Table 3).

Table 2. Screening of non-aromatic rice genotypes against rice stem borers and grain yield (2012).

| Genotypes | Deadhearts (%) | Whiteheads (%) | Yield g/$3m^2$ |
|---|---|---|---|
| Shandar | 0.67 HIJ | 4.72 NO | 1850.0 C |
| IR6-300-1 (S1) | 0.27 K | 2.67 Q | 2233.3 A |
| IR6-1.0-2 | 1.34 CDE | 10.72 E | 1250.0 KL |
| IR6-25/B | 0.83 GHI | 5.32 MN | 1700.0 DE |
| NIA=1.0-2 | 1.07 EFG | 6.78 IJK | 1456.7 GHI |
| IR6-25-12/B | 1.41 CD | 11.75 D | 1223.3 LM |
| NIA-625 | 1.32 CDE | 7.68 HI | 1366.7 HIJK |
| IR6-20-35 | 1.33 CDE | 8.83 FG | 1300.0 JKL |
| IR6-20/A | 1.32 CDE | 9.79 EF | 1316.7 IJKL |
| IR6-15/E | 1.16 DEF | 8.56 GH | 1333.3 IJKL |
| IR6-30-1 | 0.43 JK | 3.57 PQ | 2193.3 A |
| IR8-178 | 1.36 CDE | 12.60 CD | 1100.0 MN |
| IR6-P | 1.12 DEFG | 5.87 KLM | 1510.0 FG |
| IR6-200-4 | 1.29 CDE | 10.24 E | 1290.0 JKL |
| IR6-25-4 | 0.89 FGH | 5.00 MNO | 1826.7 CD |
| IRON-2k5-10 | 0.80 GHI | 5.50 LMN | 1643.3 EF |
| IR6-25-2 | 0.53 IJK | 4.28 OP | 1995.0 B |
| IRON-2k5-1 | 1.60 C | 13.30 C | 1053.3 N |
| IR8-P | 0.96 FGH | 6.32 JKL | 1500.0 GH |
| IR8-25-4/B | 1.11 DEFG | 7.16 IJ | 1400.0 GHIJ |
| IRON-2k5-27 | 2.34 A | 18.38 A | 820.0 O |
| CR-43 | 1.57 C | 14.96 B | 1053.3 N |
| CR-42 | 1.94 B | 15.55 B | 833.3 O |
| LSD | 0.32 | 0.97 | 142.30 |

The values followed by same letters are not significantly different ($P<0.05$) by LSD range test.

Table 3. Pooled data of non-aromatic rice genotypes against rice stem borers and grain yield (2011-2012).

| Genotypes | Deadhearts (%) | Whiteheads (%) | Yield g/3m$^2$ |
|---|---|---|---|
| Shandar | 0.64 LM | 4.87 M | 1715.3 BC |
| IR6-300-1 (S1) | 0.25 N | 3.17 O | 1941.7 A |
| IR6-1.0-2 | 1.28 EFGH | 9.73 F | 1366.7 HIJ |
| IR6-25/B | 0.74 LM | 5.69 L | 1626.7 CD |
| NIA=1.0-2 | 1.033 HIJK | 6.92 IJ | 1482.0 FG |
| IR6-25-12/B | 1.4533 DE | 11.04 D | 1302.0 JK |
| NIA-625 | 1.32 EFG | 7.25 I | 1433.7 FGH |
| IR6-20-35 | 1.4467 DE | 10.40 E | 1340.3 IJ |
| IR6-20/A | 1.39 EF | 9.64 FG | 1367.0 HIJ |
| IR6-15/E | 1.16 FGHI | 7.96 H | 1412.0 GHI |
| IR6-30-1 | 0.30 N | 3.97 N | 1915.0 A |
| IR8-178 | 1.5033 DE | 13.07 C | 1235.3 KL |
| IR6-P | 1.06 GHIJ | 6.42 JK | 1505.0 EF |
| IR6-200-4 | 1.32 EFG | 9.08 G | 1387.0 HIJ |
| IR6-25-4 | 0.86 JKL | 5.37 LM | 1692.0 C |
| IRON-2k5-10 | 0.78 KLM | 5.91 KL | 1593.3 DE |
| IR6-25-2 | 0.57 M | 4.97 M | 1787.7 B |
| IRON-2k5-1 | 1.6733 CD | 13.61 C | 1197.0 L |
| IR8-P | 0.90 IJKL | 6.63 IJ | 1516.7 EF |
| IR8-25-4/B | 1.04 HIJK | 6.75 IJ | 1456.7 FGH |
| IRON-2k5-27 | 2.60 A | 17.83 A | 893.7 N |
| CR-43 | 1.80 C | 15.07 B | 1023.3 M |
| CR-42 | 2.22 B | 15.38 B | 910.0 N |
| LSD | 0.27 | 0.63 | 91.35 |

The values followed by same letters are not significantly different (P<0.05) by LSD range test.

The results regarding incidence of rice stem borer and mean comparison of yield parameters indicated that genotypes IR6-300-1 (S1) and IR6-30-1 proved to be significantly better compared to all other genotypes. Three genotypes (IRON-2k5-27, CR-42 and CR-43) were ranked as highly susceptible where higher borer infestation and significantly lower yields were recorded. A number of research studies have been documented on the screening of rice genotypes against rice stem borer with varieties of results. Shafiq *et al.* (2000); Khan *et al.* (2005); Suharto and Usyati (2005) reported that rice genotype varied in degree of resistance to stem borers infestation and yield which are in agreement with our findings. Different host plant resistance studies revealed that the tolerant lines might express considerable range of variations in phenotypic and genotypic differences indicating the importance of these characters for breeding stem borer resistant varieties. In our observations, a cultivar was highly infested compared to its counterparts, but in other observations this cultivar had low infestation, however borer infestation on the tolerant and susceptible genotypes was more or less the same in both the years. This suggests that most of the rice cultivars tested did not have completely resistant gene to stem borers. These results are in line with those of earlier researchers (El-Hity and El-Keredy (1992); El-Malky *et al*. (2006); Patil *et al*. (1992). The causes of resistance in tolerant varieties may be that plants commonly accumulate lectins and proteinaceous protease inhibitors in their various tissues, sometimes in high concentrations. Much evidence suggests that one of the functions of these proteins is to serve as defenses against insects (Murdock and Shade, 2002). The knowledge generated in this study will help to find out stem borer resistance in segregating population of rice germplasm that would enhance the selection of stem borers resistant lines at early seedling stages with better accuracy to avoid environmental influence of stem borer attack. Varietal resistance to rice stem borer can play an important role in the management of rice stem borer and there dire need to integrate this component of IPM into a unified pest management strategy to maximize yield and improve quality of grain.

## CONCLUSION

It can be concluded from the present research studies that rice genotypes, IR6-300-1 (S1) and IR6-30 produced significant results in terms of minimum borer incidence and higher grain yields. Three genotypes (IRON-2k5-27, CR-42 and CR-43) were highly susceptible in which high borer attack and lower grain yields were recorded.

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