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# Antixenosis and Tolerance of Rice Genotypes Against Brown Planthopper

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**Abstract:** Nine genotypes were evaluated under greenhouse conditions for antixenosis and tolerance against brown planthopper (BPH, *Nilaparvata lugens* Stål). In antixenosis studies, proportion of insects settled on a test genotype in relation to the susceptible control TN1 was recorded, with significantly lower proportion of nymphs (55.22%–59.18%), adult males (60.33%–60.75%), and adult females (80.56%–79.26%) settled on RP2068-18-3-5 and Ptb33 in relation to those on TN1. Based on number of feeding sites, the test genotypes were ranked in order from the highest to the lowest as RP2068-18-3-5, Ptb33, MR1523, Rathu Heenati, Sinnasivappu, ARC10550, MO1, INRC3021 and TN1. The order was exactly reverse in terms of fecundity expressed as number of eggs laid per female. In tolerance studies, days to wilt, functional plant loss index and plant dry weight loss to BPH dry weight produced were recorded. RP2068-18-3-5, Rathu Heenati and Ptb33 performed better than the other test genotypes. These results helped in relative quantification of BPH resistance levels in the genotypes. RP2068-18-3-5, a new effective source of BPH resistance, can be used in resistance breeding after tagging of resistant genes/QTLs linked to different parameters of antixenosis and tolerance with selectable molecular markers.

**Key words:** antixenosis; molecular marker; *Nilaparvata lugens*; resistance breeding; rice; tolerance

Rice (*Oryza sativa* L.) is extensively cultivated under the most diverse ecosystems of tropical and sub-tropical regions of the world. With a projected increase in world population to 9–10 billion by 2050 along with the predicted water scarcity, decrease in arable land and the impending global climate change, it is a great challenge to meet the food requirements of these persons. Among various biotic constraints for rice production, insect pests are of prime importance (Heong and Hardy, 2009). Of over 100 species of insects reported as pests of this crop, 20 are of major economic significance (Prakash et al, 2007). The brown planthopper (BPH), *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae), is a typical phloem sap feeder that has remerged as the treat to rice production in Asia (Chen and Cheng, 1978; Normile, 2008; Heong and Hardy, 2009; Prasannakumar et al, 2013). The plant would suffer 40% to 70% yield loss if attacked by 100–200 first instar nymphs of BPH at 25 d after rice seedling transplanting (Bae and Pathak, 1970). The international conference held in 2010 exclusively on rice planthoppers analyzed the causes and consequences of BPH outbreak in many Asian countries (IRRI, 2010).

Both nymphs and adults of BPH suck sap from the lower portion of the plant, which results in yellowing leaves, reducing tillering number and plant height, and increasing in unfilled grains. Feeding also causes the reduction in chlorophyll and protein content of leaves and rate of photosynthesis, and even in case of severe attack, it causes extensive plant mortality referred to as ‘hopper burn’ symptom (Watanabe and Kitagawa, 2000; Liu et al, 2008; Horgan, 2009; Vanitha et al, 2011). BPH also transmits virus diseases like grassy stunt, ragged stunt (Ling et al, 1978) and wilted stunt (Chen et al, 1978). Monitoring of rice fields regularly helps in timely detection of its incidence and helps in effective pest management. Many insecticides are recommended for the pest control, but blanket application of these

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chemicals disrupts the natural balance of rice ecosystem (Sarao and Mangat, 2014). Cultivation of resistant varieties is the better and environmentally safe alternative (Song et al, 2002). Such varieties will also help in conservation of natural enemies, increasing their effectiveness (Gurr et al, 2011) and minimizing the pesticide applications (Panda and Khush, 1995; Sharma, 2007). Hence, breeding programme for development of BPH resistant varieties with different mode of host plant resistance is extremely important.

Screening rice germplasm at global level and breeding BPH resistant rice varieties were initiated during 1970s, and several resistant varieties have been released for cultivation (Khush and Brar, 1991; Jena et al, 2005; Sun et al, 2005; Chen et al, 2006; Brar et al, 2009; Kumar and Tiwari, 2010; Bentur et al, 2011; Li et al, 2011). However, resistance in many of these varieties has been overcome by virulent biotypes. Also, many of the 29 BPH resistance genes identified so far are not effective in India. No detailed studies have been conducted in India to evaluate relative performance of BPH resistant rice genotypes. These studies are especially valuable in resistance gene/QTL tagging and mapping (Fujita et al, 2013; Sai et al, 2013; Ali and Chowdhury, 2014). Keeping this objective in mind, present experiments were conducted to study antixenosis and tolerance levels in selecting rice genotypes with diverse genetic background.

## MATERIALS AND METHODS

### Insects

The source BPH population was collected from rice fields of Punjab Agricultural University, Ludhiana, India. Insects were collected during 2007 and continuously reared under greenhouse conditions on 30-day-old TN1 rice plants at the Rice Research Laboratories of Department of Plant Breeding and Genetics positioned at 30°54′ N and 75°48′ E at (28 ± 2) °Ċ, 75% ± 5% relative humidity and 14 h light/10 h dark photoperiod according to Heinrichs et al (1985).

### Rice materials

The seeds of nine rice genotypes, RP2068-18-3-5, Rathu Heenati, Sinnasivappu, MR1523, MO1, ARC10550, INRC3021, Ptb33 and TN1, were received from the Indian Institute of Rice Research (formerly Directorate of Rice Research), Hyderabad, India. The pre-germinated seeds of the test genotypes were sown in pots or trays, depending on the experiment, containing well puddled soil during wet season in 2010 and 2011. All the test plants were raised in an insect-proof greenhouse. There were three replications of each genotype, and in each replication, there were five plants except for settling behavior studied. The mean of these five plants comprising one replication was used for data analysis.

### Antixenosis studies

*Settling behavior of nymphs*

In this experiment, pre-germinated seeds of the test genotypes were sown in random rows, 3.5 cm apart, in a seed box (45 cm × 35 cm × 10 cm). Each row contained 10 seeds. The susceptible control TN1 was sown in two border rows and in the center of the box. The tray was kept in dark place to enhance seedling growth. The 10-day-old seedlings were infested with the 2nd–3rd instar hopper nymphs with 6–8 nymphs per seedling. The tray was covered with light-transmitting nylon mesh to prevent escape of nymphs. The number of nymphs settled on each seedling was counted at 1, 2 and 3 d after infestation. The seedlings were disturbed after each count for reorientation of the hopper nymphs.

*Settling behavior of adults*

The tested genotypes were grown in small plastic pots and kept in water trough. About 200 pairs of adults were released on 30-day-old seedlings under free choice test. Number of male and female adults alighting on different genotypes was counted at 4, 8, 12, 24, 48, 72 and 96 h after release. The seedlings were disturbed after each count for reorientation of the insects.

*Feeding marks*

In a separate experiment, the feeding marks were observed following the method of Natio (1964). To quantify the role of insects while feeding on different genotypes, a pair of newly emerged adults starved for 1 h was confined in mylar cage on 30-day-old caged uninfested plants of each tested genotype. The feeding marks were observed under microscope after 24 h of feeding by removing the plants from the pots and treated with 0.1% Rhodamine B Analytical Reagent dye for 15 min.

*Number of eggs*

Two pairs of newly emerged adult insects were released on caged uninfested plants. At 5 d after release, the adults were removed and eggs were counted according to the method of Khan and Saxena (1985).

### Tolerance studies

To study the level of tolerance, 30-day-old seedlings of each genotype were covered with a mylar cage with well-ventilated windows. Twenty-five 2nd–3rd instar