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Tolerance mechanism of rice genotypes against brown Planthopper *Nilaparvata lugens* (Stal.)

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Abstract
Seven genotypes along with two resistant checks (PTB33 and BM71) and one susceptible check (TN 1) were evaluated under greenhouse conditions for tolerance studies against brown planthopper (BPH, *Nilaparvata lugens* Stål). Perusal of the results showed significant differences in days to wilting that ranged from 12.21 to 33.21 days across the rice genotypes tested. The susceptible check TN1 succumbed to BPH feeding within 12.21 days and was found to show significantly lowest tolerance level compared to any other test entry. The resistant checks PTB33 and BM71 tolerated to BPH for 33 and 32 days respectively. Among the test entries RNR-28370 recorded significantly highest tolerance level with 30.33 days taken for wilting. The test entry Magic-289 that took 29.45 days for wilting was on par with genotype RNR-28370. The other test genotypes *viz.*, IRUE 45, IRUE 52, and Magic-88 exhibited moderate level of tolerance with 28.67, 27.45 and 26.53 days for wilting and were found to be on par with one another and close to Magic-289 and RNR-28370. Among the test entries relatively low level of tolerance was exhibited by RNR 29325 and Magic-179 which took relatively less number of days (23.78 and 22.25 respectively) to wilt. These results helped in relative quantification of BPH resistance levels in the genotypes. RNR 28370 and Magic 289 was an effective source of BPH resistance, can be used in resistance breeding programme.

Keywords: Tolerance, *Nilaparvata lugens*, resistance, Rice

Introduction
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) [12]. of over 100 species of insects reported as pests of this crop, 20 are of major economic significance (Prakash *et al*, 2007) [23]. 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) [7, 21, 12, 24]. The plant would suffer 40% to 70% yield loss if attacked by 100–200 first instar nymphs of BPH at 25 days after rice seedling transplanting (Bae and Pathak, 1970) [3]. The international conference held in 2010 exclusively on rice planthoppers analysed 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) [31, 20, 13, 30]. BPH also transmits virus diseases like grassy stunt, ragged stunt (Ling *et al*, 1978) [19] and wilted stunt (Chen *et al*, 1978) [8]. 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 chemicals disrupts the natural balance of rice ecosystem (Sarao and Mangat, 2014) [26]. Cultivation of resistant varieties is the better and environmentally safe alternative (Song *et al*, 2002) [28]. Such varieties will also help in conservation of natural enemies, increasing their effectiveness (Gurr *et al*, 2011) [11] and minimizing the pesticide applications (Panda and Khush, 1995; Sharma, 2007) [22, 7].

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) [16, 14, 29, 9, 6, 17, 4, 18]. 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) [10, 25, 2]. Keeping this objective in mind, present experiments were conducted to study Tolerance levels in selecting rice genotypes with diverse genetic background.

Materials and Methods

The experiment on identification of level of tolerance in the selected rice germplasms for BPH was conducted on 30 days old potted rice plants under glasshouse conditions (Plate 20). Five, first instar BPH nymphs were released on a potted rice plant surrounded by a mylar cage and covered with muslin cloth on the top end of mylar cage. Thereafter, the plants were examined daily for 30 days, and the number of days it took each of the selected lines to completely wilt was recorded. The experiment was terminated after 30 days after release of nymphs and data on the lines that did not wilt at the end of the study as well as wilted lines during the period of study were recorded. The experiment was replicated thrice per treatment and their average was recorded and their means was taken as days to wilt.

Results and Discussion

The level of tolerance exhibited by different rice genotypes due to BPH incidence was assessed following days to wilt test. Perusal of the results showed significant differences in days to wilting that ranged from 12.21 to 33.21 days across the rice genotypes tested. The susceptible check TN1 succumbed to BPH feeding within 12.21 days and was found to show significantly lowest tolerance level compared to any other test entry (Table 1). The resistant checks PTB33 and BM71 tolerated to BPH for 33 and 32 days respectively. Among the test entries RNR-28370 recorded significantly highest tolerance level with 30.33 days taken for wilting. The test entry Magic-289 that took 29.45 days for wilting was on par with genotype RNR-28370. The other test genotypes *viz.*, IRUE 45, IRUE 52, and Magic-88 exhibited moderate level of tolerance with 28.67, 27.45 and 26.53 days for wilting and were found to be on par with one another and close to Magic-289 and RNR-28370. Among the test entries relatively low level of tolerance was exhibited by RNR 29325 and Magic-179 which took relatively less number of days (23.78 and 22.25 respectively) to wilt (Fig. 1). The results suggested that the resistant and moderately resistant rice genotypes took more time to wilt compared to susceptible genotypes. BPH feeding was less on resistant entries and hence the plants could withstand wilting compared to the susceptible TN1. Tolerance was attributed to low feeding activity of BPH (Paguia *et al*., 1980). Alagar and Suresh (2007) [1] reported that 30 and 60 day old plants of ARC 10550, KAU1661 and ARC 6650 took significantly longer period (27 to 31 days) for wilting compared to TN1 (18.2 days) due to low population buildup. Jhansi Lakshmi *et al*. (2012) reported that the wild rice accessions survived for more than 34 days after exposure to BPH nymphs as compared to 5-6 days in susceptible check TN1 indicating presence of high level of tolerance mechanism. Present results are similar with the results of Bhanu *et al.* (2014) [5] who reported that number of days required to wilt was more in highly resistant, and started declining as the level of resistance decreased. Very low number of days to wilt in susceptible check (TN1).

Table 1: Level of tolerance exhibited by different rice genotypes to BPH incidence measured following days to wilt test

Sl. No.	Rice Genotype	Days To Wilt
1	Magic-88	26.53^{fg}
2	Magic-179	22.25^{hi}
3	Magic-289	29.45^{cd}
4	IRUE 45	28.67^{de}
5	IRUE 52	27.45^{ef}
6	RNR 28370	30.33^{c}
7	RNR 29325	23.78^{h}
8	PTB-33	33.21^{a}
9	BM-71	32.32^{ab}
10	TN1	12.21^{j}
C.D.		1.32
SE(M)		0.45
SE(D)		0.63
C.V.		2.90

Tolerance is the innate capacity to withstand and ability to produce substantial yield, despite insect infestation and this component of host plant resistance is less exploited. Panda and Heinrichs (1983) identified rice varieties like Triveni, Kanchana and Utrirajapan with tolerance as predominant component of BPH resistance. Similarly, Qiu *et al.* (2014) suggested Bph7 gene in rice variety T12 to account mainly for tolerance component of resistance against BPH. Similarly, Ramesh *et al.* (2014) reported a major dominant gene Wbph12 (t) to confer tolerance to WBPH in Sinnasivappu. Since tolerance trait is believed to exert less selection pressure on the insect, such gene may contribute to durable resistance. It can be concluded that host selection can affect BPH settling and feeding. The restless behavior of BPH on the resistant varieties also increases their vulnerability to the natural enemies. Rice genotypes Magic-289 and RNR 28370 both displayed high levels of antixenosis, antibiosis and tolerance to BPH. This will provide better option for plant breeders and biotechnologists to develop suitable varieties to combat BPH. It is apparent from our study that development of a variety which can disrupt the settling and feeding of BPH as well as low plant biomass loss could play a pivotal role in pest management strategies.

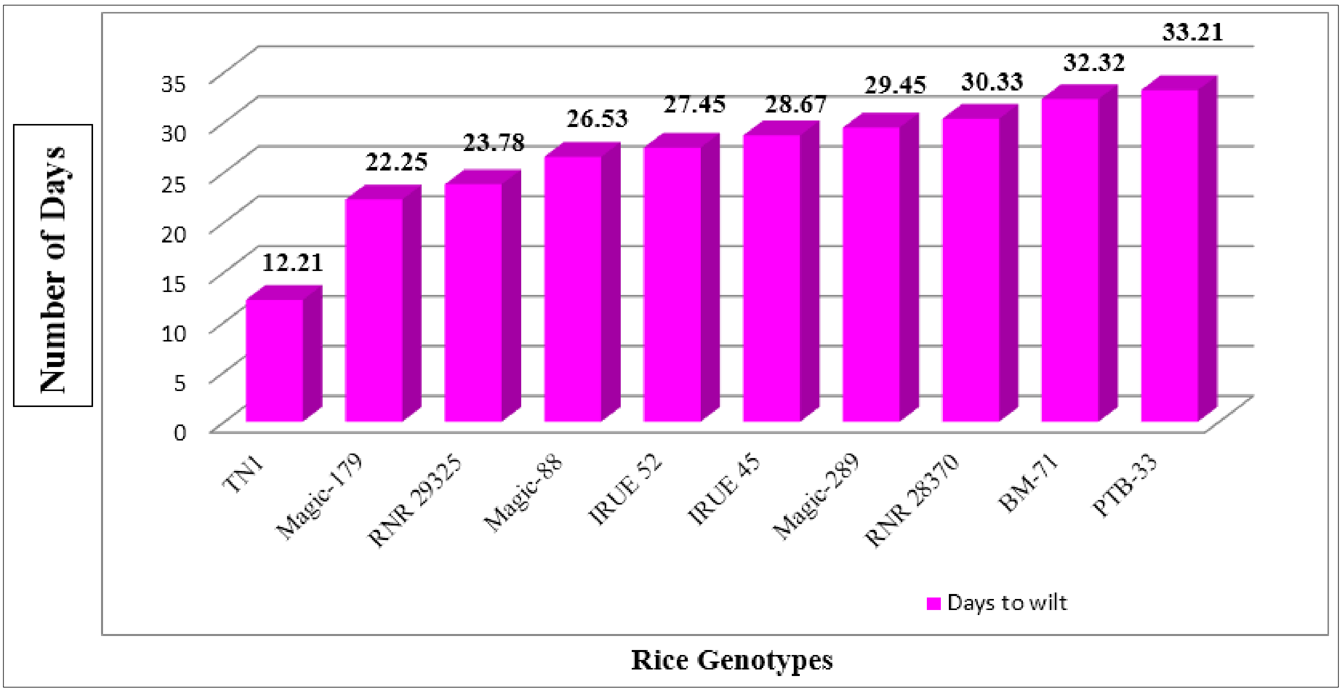

Fig 1: Level of Tolerance in BPH Measured From Days to Wilt

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