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Evaluation of antibiosis resistance to brown planthopper, *Nilaparvata lugens* (Stal) in rice

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Abstract
The study was carried out in the Entomology glass house at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore during June to August 2016. In the present investigation antibiosis parameters of resistance *viz*., nymphal survival, nymphal duration and growth index was evaluated in 26 rice genotypes under glasshouse condition to Coimbatore population of BPH. Low survival rate was recorded on Ptb33 (26.67%), PY 1 and Mapillai Samba (30.00%) whereas prolonged development period of nymphs was recorded in Ptb 41 (14.37 days) and Karuthakar (14.23 days). Low growth index value was observed on Ptb 33 (1.90) and ADT 36 (2.75). Ptb 33 which possess *Bph 3* gene confirmed its high level of antibiosis to local BPH population. The genotypes IR 64 and Mudgo with *Bph1* gene, Chinsaba (*bph 8*), Pokkali (*Bph 9*), IR 65482-7-216-1-2-B (*Bph 18* gene) were recorded with moderate level of antibiosis to the BPH population.

Keywords: Rice, brown planthopper, resistance, antibiosis

1. Introduction
Brown planthopper (BPH) *Nilaparvata lugens* (Stal) is one of the most destructive monophagous insect pests in rice and causes huge yield losses every year throughout tropical, subtropical and temperate areas in Asia [1]. Management of BPH through application of chemical insecticides can cause resurgence and play a major role in inducing outbreaks [2]. Growing resistant varieties is an economical and efficient way for the management of BPH. But release of resistant varieties became susceptible to BPH with in few years after their introduction, because of break down of resistance or development of biotypes [3]. So, understanding the mechanism and genetics of resistance is important before evolving resistant varieties. Antibiosis is one the major mechanism in resistant rice varieties [4]. The typical symptom of antibiosis is disruption of normal metabolic process. It includes death of early instars, lengthened developmental period and reduced growth rate [5]. It is imperative to validate level of antibiosis type of resistance in known resistant varieties to the particular population of BPH. The present study was carried out to evaluate antibiosis parameters in known resistant varieties against BPH population of Coimbatore, Tamil Nadu.

2. Materials and Methods
2.1 Culturing of Brown planthopper
The present investigation was carried out in the Entomology glass house at Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore during the period June to August 2016. Brown planthopper, *N. lugens* population was collected from unsprayed rice fields of Coimbatore and mass cultured in the glass house on the susceptible rice variety Taichung Native-1 (TN 1). The plants were observed periodically and the natural enemies were removed regularly along with the dried leaves and dried plants. The adults were confined on 30 days old potted plants of TN 1 and kept in oviposition cages of size 45x45x60cm having wooden frames, glass top and door and wire-mesh side walls. The insects were removed three days later and plants with eggs were taken out of cages, placed in separate cages for the nymphs to emerge. The emerged nymphs were then transferred to 10 to 15 days old TN 1 seedlings raised in 10 cm diameter clay pots placed in galvanized iron trays of size 64x47x15cm and permitted to feed and develop for multiplication. Culturing of BPH and screening methodologies were followed as per standard IRRI protocol [6].

2.2 Evaluation of antibiosis parameters in rice genotypes

A set of 26 rice genotypes including BPH resistant varieties and promising lines were obtained from various rice research centers. Ten day old seedlings of each test genotypes were planted in 12 cm diameter clay pots. Twenty five days after planting, the potted plants were covered with polyethylene film cage (90 cm height x 10 cm diameter) and three replications were maintained. They were kept in galvanized iron trays filled with water. The adult plants were infested with fresh first instar nymphs @ 10/seedling collected from the culture cages. The mortality of nymphs was observed daily upto adult stage and percent nymphs survived were calculated. The numbers of days taken by individual nymphs to become adult was observed and mean developmental period was calculated on each genotype.

The Growth Index (GI) value was computed by the number of nymphs that became adults and the time taken to reach the adult stage [7].

$$GI = \frac{\text{Percent nymphs survived}}{\text{Development period of nymphs}}$$

2.3 Statistical analysis

The data collected were subjected to statistical scrutiny through Completely Randomized Design (CRD) using analysis of variance (ANOVA) through IRRISTAT statistical software.

3. Results and Discussion

There was significant difference in the data on BPH nymphal survival rate among the genotypes and it ranged from 26.67 percent to 90.00 percent (Table 1). Nymphal survival was very low on Ptb-33 (26.67%) compared to other genotypes whereas more survival was recorded in susceptible check, TN 1 (83.33%). The other genotypes PY 1 and Mapillai Samba (30.00%) has less survival followed by ADT 36 (36.67%), Ptb 19 and OM 4498 (40.00%) which were on par with each other. Lower survival on these genotypes may be due to inadequate nutrients in the plants or toxic substances. Impact of antibiosis was more with increase in plant age [8] where as absence of essential nutrients also results in lower survival rate [9]. Nymphal developmental period also significantly varied in the rice genotypes and it ranged between 8.44-14.37 days on different rice genotypes (Table 1). Significantly prolonged developmental period of BPH nymphs was observed in Ptb 41 (14.37 days) followed by Karuthakar (14.23 days), RP 2068-18-3-5 (13.91 days), Ptb 19 (13.49 days), ADT 36 (13.33 days), Swarnalatha (13.29 days). The prolonged nymphal period of BPH in resistant accessions was due to reduced ingestion of adequate nutrition or lack of vital nutrients required by BPH [10]. Inadequate nutrition of the host, crowding and other environmental factors were responsible for the prolongation of larval period in any insect [11]. In the present study, prolonged development period was observed in Ptb 41 and Karuthakar which are moderately resistant accessions. In the varieties Ptb 41 and Karuthakar the development period was more than the resistant check, Ptb 33 (14.00 day). Prolonged developmental period of BPH nymphs was reported earlier in Ptb 33, IR 36 and ASD 7 [12]. In present investigation, the genotype Swarnalatha (13.29 days) had prolonged nymphal developmental period. It is general concept that resistant lines prolonged the developmental period and reduced the survival rate [5]. Even non - preferred accessions also caused higher mortality [13]. The resistant accession could also support certain level of survival compared to the susceptible accession. Higher nymphal survival of WBPH was recorded in resistant accession IET 10251[14]. Similarly, higher nymphal survival was observed on moderate resistant accession ASD 7 in the present study. The development period on the susceptible check, TN 1 was 12.44 days.

Growth index of an insect provides additional information on antibiosis type of resistance [6]. The growth index computed from the data on survival percent and nymphal developmental period ranged from 1.90 to 9.00 in different genotypes (Fig 1). The highest growth index was observed on Mudgo (9.00) followed by ARC 10550 (7.29) and Babawee (7.11). The lowest growth index was observed on ADT 36 (2.75) and PY 1 (2.84). The susceptible check TN 1 showed a growth index of 6.70 and the resistant check Ptb 33 had a low growth index 1.90 indicating the suitability of TN 1 for the normal growth and development of BPH nymphs.

In most of the earlier studies the resistant scoring is based on the seedling stage susceptibility and its significance and validation at adult plant stages through antibiosis studies confirm the adult plant resistance. In the present study, the genotypes IR 64 and Mudgo which has *Bph1* gene showed moderate antibiosis reaction to the Coimbatore population of BPH. Considerable levels of antibiosis in these rice varieties carrying *Bph1* gene and its moderate resistance to BPH was reported earlier [7]. Various resistance mechanisms were operating in the genotype ASD 7 due to presence of *bph 2* gene [15]. However, in the present study it shows susceptible reaction to local population of BPH. In the antibiosis parameters this genotype was observed with high nymphal survival (90.00%). The variety Ptb 33 which possess *Bph 3* gene has high level of antibiosis whereas another variety Rathuheenathi recorded moderate susceptibility to Andhra Pradesh population of BPH [12]. The variety Ptb 33 was used as resistant check in most of host plant resistant studies against BPH. In the present study also it confirmed that Ptb 33 has high level of antibiosis whereas, Rathuheenathi had moderate level to Coimbatore population of BPH. Presence of *Bph 4* gene in the genotype Babawee and their resistant to Indian population of BPH was recorded earlier [16]. However, in the present study it shows this genotype was observed with moderate nymphal survival (60.00%) and less development period (8.44 days) with high growth index (7.11) indicated that its susceptibility. Similar type of reaction was also reported [12] in the same variety with low level of antibiosis.

The genotype Swarnalatha which possess *Bph 6 gene* [17] was recorded as high nymphal survival (83.33%), prolonged development period (13.29 days) and moderate growth index (6.27) which indicated that its moderate level of antibiosis to Coimbatore population of BPH. Presence of recessive gene *bph 7* in the genotype T 12 confirm its resistant to BPH [17], however, in the present study the genotype recorded susceptible to local population of BPH in adult plant stage. Another recessive gene *bph 8* was reported in the genotype Chinsaba recorded with lower growth index of 4.85 indicates its moderate level of antibiosis for the local BPH population in the present study. The genotype Pokkali have dominant gene *Bph 9* [18] recorded with moderate nymphal survival (66.67%) and growth index (5.50) to local BPH population. The IRRI line IR 65482-7-216-1-2-B (*Bph 18* gene) showed moderate level of antibiosis to BPH population of Andhra Pradesh [12]. In the present study, the genotype recorded less growth index (4.81). RP 2068-18-3-5 a resistant genotype with undetermined genetics showed moderate nymphal survival (63.33%) and prolonged development period (13.91 days) indicated the presence of antibiosis type of resistance.

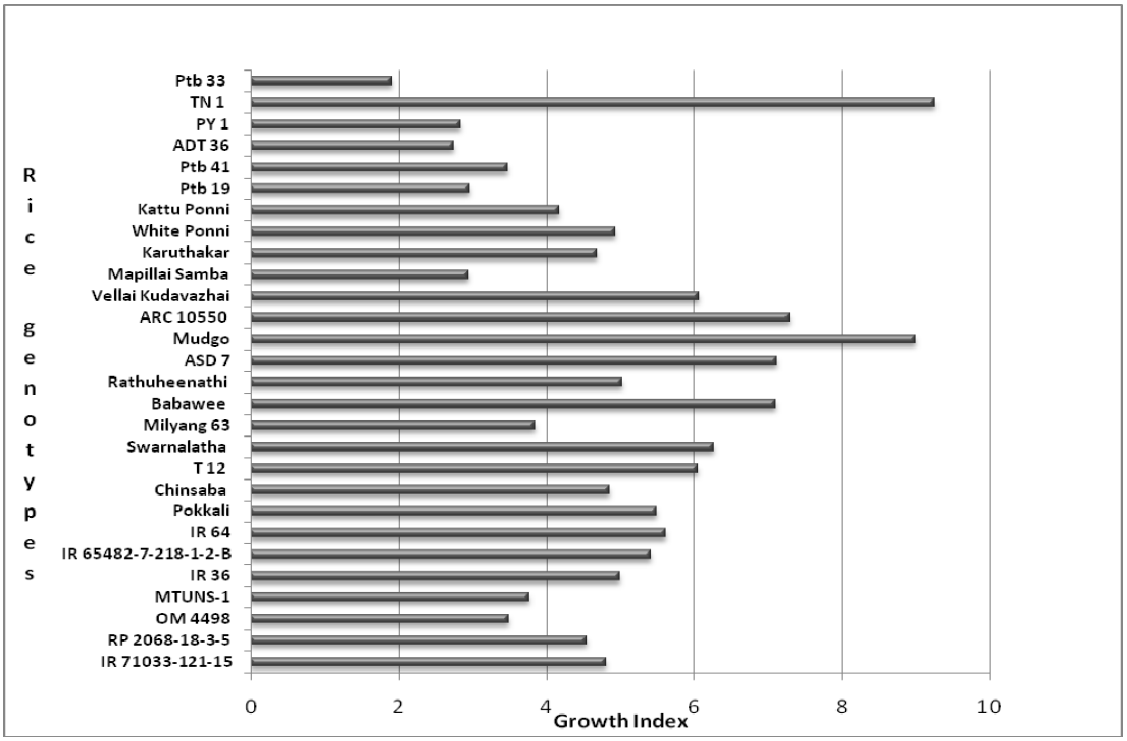

Fig 1: Growth index of BPH on different rice genotypes

Table 1: Antibiosis effect of rice genotypes against brown planthopper, *Nilaparvata lugens*

S. No.	Genotypes	Nymphal survival* (%)	Nymphal duration** (days)
1	IR 71033-121-15	63.33 (53.86)	13.18 (3.63)
2	RP 2068-18-3-5	63.33 (52.78)	13.91 (3.73)
3	OM 4498	40.00 (38.86)	11.46 (3.38)
4	MTUNS-1	43.33 (41.57)	11.48 (3.39)
5	IR 36	66.67 (54.78)	13.33 (3.65)
6	IR 65482-7-218-1-2-B	66.67 (55.08)	12.33 (3.51)
7	IR 64	63.33 (52.86)	11.30 (3.36)
8	Pokkali	66.67 (55.37)	12.12 (3.48)
9	Chinsaba	60.00 (50.85)	12.36 (3.52)
10	T 12	63.33 (52.86)	10.47 (3.24)
11	Swarnalatha	83.33 (69.53)	13.29 (3.65)
12	Milyang 63	40.00 (33.00)	10.41 (3.23)
13	Babawee	60.00 (50.94)	8.44 (2.91)
14	Rathuheenathi	60.00 (50.85)	11.95 (3.46)
15	ASD 7	90.00 (74.45)	12.65 (3.56)
16	Mudgo	86.67 (57.70)	9.63 (3.10)
17	ARC 10550	63.33 (52.78)	8.69 (2.95)
18	Vellai Kudavazhai	73.33 (60.00)	12.10 (3.48)
19	Mapillai Samba	30.00 (33.00)	10.21 (3.20)
20	Karuthakar	66.67 (54.99)	14.23 (3.77)
21	White Ponni	60.00 (51.15)	12.15 (3.49)
22	Kattu Ponni	46.67 (42.99)	11.16 (3.34)
23	Ptb 19	40.00 (39.06)	13.49 (3.67)
24	Ptb 41	50.00 (44.71)	14.37 (3.79)
25	ADT 36	36.67 (37.23)	13.33 (3.65)
26	PY 1	30.00 (33.21)	10.57 (3.25)
	TN 1 (Susceptible check)	83.33 (66.64)	9.00 (3.00)
	Ptb 33 (Resistant check)	26.67 (49.76)	14.00 (3.74)
	S.Ed	8.905	8.90
	CD (P=0.05)	17.84	14.87

* Figures in parentheses are arc sine transformed values.

** Figures in parentheses are square root transformed values.

4. Conclusion

The result of the present study concludes that few resistant varieties identified earlier showed a varied reaction based on antibiosis parameters. Some of the promising genotypes also confirm their resistant reaction to the local population of BPH. The studies on mechanisms of resistance confirming the varieties which possess resistance at adult plant stage also. These genotypes can be used for further breeding programmes for development of varieties with stable and durable resistance to brown planthopper.

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