

ANTIXENOSIS AND ANTIBIOSIS EFFECTS OF SELECTED RICE CULTURES AGAINST THE BROWN PLANTHOPPER (*NILAPARVATA LUGENS* (STÅL))

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ABSTRACT

Pot culture experiments were carried out in glasshouse at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Institute, Maruteru, West Godavari district, Andhra Pradesh during the period 2010 to 2011 to study the antixenosis and antibiosis effects of twelve rice cultures on rice brown planthopper feeding activity along with resistant check (Ptb 33) and susceptible check (TN1). Among those, the rice cultures which recorded significantly maximum number of feeding marks were MTU 1075 (128.10), MTU IJ 206-7-4-1 (112.80), MTU PLA 99-1-3-1-2 (110.20) and resistant check, Ptb 33 (61.50) than TN1 (24.30). The rice cultures, MTU IJ 206-7-4-1 (25.60 mm²), Ptb 33 (58.80 mm²), NLR 3093 (65.60 mm²) and RGL 7002 (87.80 mm²) excreted significantly less amount of honeydew compared to the susceptible culture, TN1 (450.40 mm²) indicating that these were less preferable for BPH feeding.

Key Words: Brown planthopper, Feeding preference, Feeding rate, Pot culture experiments, Rice cultures.

INTRODUCTION

The brown planthopper (BPH), *Nilaparvata lugens* (Stal) (Homoptera: Delphacidae) is one of the most destructive monophagous insect pests of rice throughout the rice growing countries in Asia. The BPH causes serious yield reduction in rice by sucking the phloem sap and plugging with their feeding sheaths (Hu *et al.*, 2015). Heavy dependence on chemical pesticides for the control of this pest leads to many adverse effects like harmful effects on natural enemies, development of insecticide resistance, environmental pollution and high cost of production. Cultivation of

resistant rice varieties is the most economical and efficient method for the management of BPH (Li *et al.*, 2011) and is an important approach in Integrated Pest Management. Understanding the mechanisms underlying rice resistance to BPH is very essential for developing appropriate breeding strategies. Generally, the insect resistance types with regard to the physiological function were classified into antixenosis (non-preference), antibiosis and tolerance (Painter, 1951). In general, resistant rice plants exhibit two strategies i.e. antixenosis and antibiosis against BPH. The present study was conducted with

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an aim to identify the antixenosis and antibiosis effects of certain identified resistant rice cultures on feeding activity of BPH.

MATERIAL AND METHODS

Plant material

Twelve rice cultures previously identified as highly resistant or moderately resistant in field screening viz., NLR 3090, NLR 3093, MTU 1075, WGL 401, WGL II 218-5-1, MTU PLA 99-1-3-1-2, NLR 20131, BPT 2404, RDR 34, RGL 7001, RGL 7002 and MTU IJ 206-7-4-1 were used to study the antixenosis and antibiosis effects on BPH feeding activity along with resistant check (Pt 33) and susceptible check (TN1). Pot culture experiments were carried out in the glasshouse facility of Andhra Pradesh Rice Research Institute and Regional Agricultural Research Institute, Maruteru, West Godavari district, Andhra Pradesh during the period 2010 to 2011. The mean temperature during the study period ranged from 25°C to 32°C and the relative humidity ranged from 54% to 86 %.

Mass culturing of BPH

To obtain different instar nymphs and adults of BPH required for the study, the insect was mass reared in the greenhouse and iron framed rearing cages covered with fine mesh wire net. Four to six weeks old potted plants of susceptible rice variety, Taichung Native 1 (TN1) were used for culturing the BPH. To start the culture of BPH, the potted TN1 plants were cleaned and the dried, outer leaf sheaths were removed. They were then placed in an oviposition cage. Gravid females of BPH obtained from the maintenance cage were released on to the potted TN1 plants for oviposition and exposed for three days. Then the oviposited plants were placed in maintenance cage for hatching of the eggs. The host plants in culture maintenance cage

were changed twice a week and replaced them with fresh potted plants (Sarao and Bentur, 2016).

Antixenosis effect on feeding preference

Two adult female hoppers were enclosed in a parafilm sachet attached to the leaf sheaths of each test culture and allowed to feed for 24 hours. Each test culture was replicated ten times. After 24 hours, the insects were removed and the test plant was stained by dipping in 0.1% erythrosine dye for 10-15 minutes to distinguish the feeding marks on the test entries. The pink stained feeding marks were counted by using microscope. The feeding preference was determined on the basis of average number of stylet sheaths/plant among the cultures (Sarao and Bentur, 2016).

Antibiosis effect on feeding rate

The antibiosis resistance of rice to BPH was assessed by estimating the amount of honeydew excreted by the adult hoppers. Whatman No.1 filter paper was dipped in a 0.02% bromocresol green solution in ethanol was placed around the base of the feeding chamber and infested with five freshly emerged female BPH hoppers, pre-starved for four hours. The BPH adults were allowed to feed for 24 hours at the base of the stem. Honeydew excreted by BPH was absorbed onto the filter paper and appeared as a blue spot. The area blue spots appeared on filter paper was measured by graph method. Area of the spot was proportional to the honeydew production and therefore to the amount of BPH feeding (Sarao and Bentur, 2016). Data were subjected to analysis of variance (ANOVA) in a randomized block design (RBD) after appropriate data transformation (Gomez and Gomez, 1984). Treatment means were compared using the critical difference (CD) test at $P=0.05$.

RESULTS AND DISCUSSION

Antixenosis effect on feeding preference

The stained salivary sheath (feeding) marks as a result of stylet probing were counted and used as a parameter to assess the antixenosis effect on feeding activity. The number of feeding marks on the leaf sheaths due to BPH feeding on the tested rice cultures along with resistant and susceptible check was presented in table 1 and fig. 1. The results indicated that the feeding marks on leaf sheath differed significantly among the rice cultures. The number of feeding marks (Plate 1) ranged from 12.50 to 128.10. The feeding marks were observed to be significantly higher in rice cultures, MTU 1075 (128.10), MTU IJ 206-7-4-1 (112.80), MTU PLA 99-1-3-1-2 (110.20) and were higher than the resistant check, Ptb 33 (61.50). These were followed by NLR 3090 (105.40), WGL II 218-5-1 (97.10), BPT 2404 (91.80), WGL 401 (62.00), NLR 20131 (56.80), RGL 7001 (51.30), NLR 3093 (48.80) and RDR

34 (39.40). RGL 7002 (12.50) recorded significantly lower number of feeding marks than susceptible check, TN1 (24.30).

In the present investigation, some of the rice cultures *viz.*, MTU 1075, MTU IJ 206-7-4-1 and MTU PLA 99-1-3-1-2 recorded maximum number of feeding marks compared to resistant check, Ptb 33 indicating that the BPH does not find a suitable feeding site on those and making numerous probes in an attempt to locate a suitable feeding site. Whereas, the rice culture RGL 7002 recorded significantly lower number of feeding marks even than the susceptible check, TN1 indicated that it was more preferable for BPH feeding. Significantly higher feeding marks in rice cultures like MTU 1075, MTU IJ 206-7-4-1 and MTU PLA 99-1-3-1-2 from the present study were in concurrence with the results of Sarao and Bentur, 2016, who reported a greater number of feeding marks in RP2068-18-3-5, Ptb33, MR1523, Rathu Heenati, Sinnasivappu, ARC10550, MO1 and INRC3021 compared to susceptible TN1.

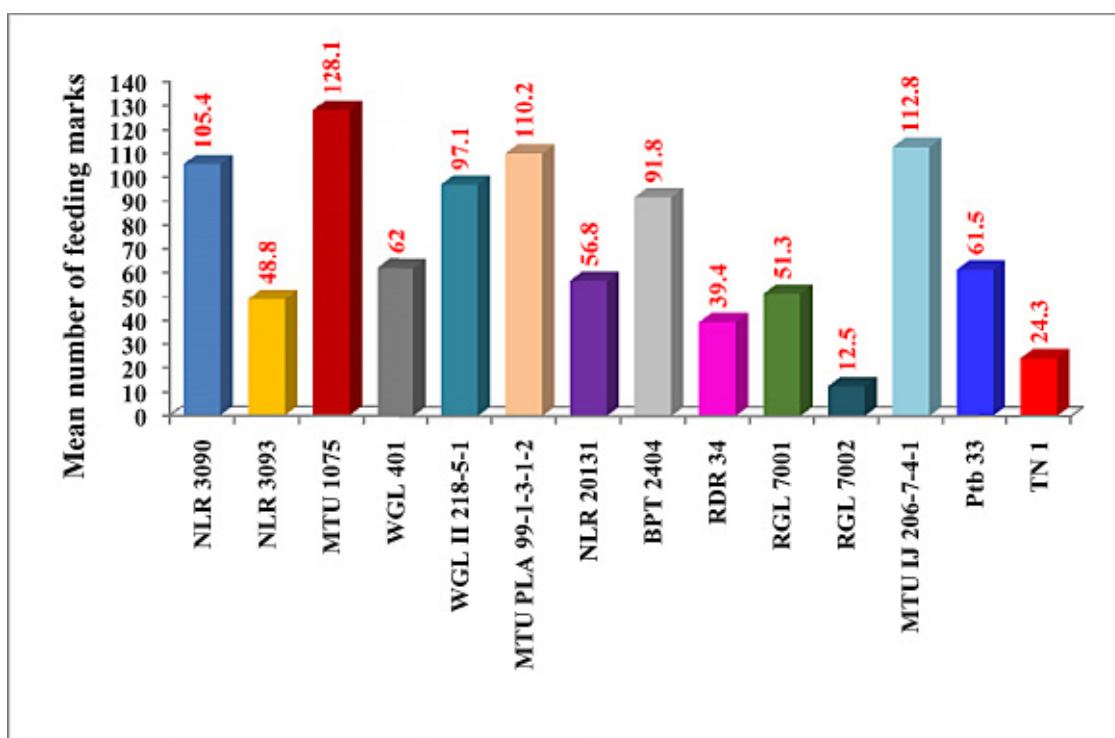


Fig. 1. Feeding marks of BPH adults on tested rice cultures

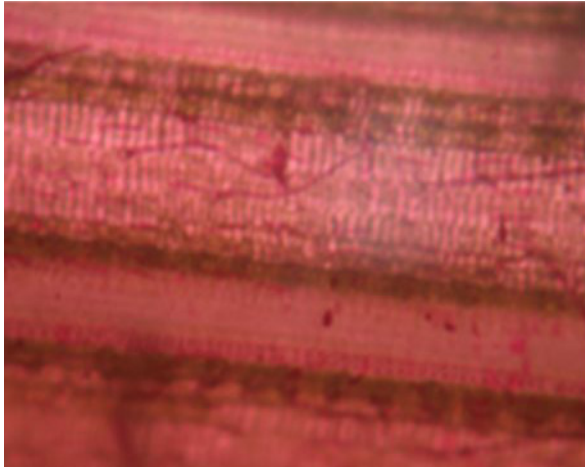


Plate 1a. Leaf sheath without feeding marks Plate 1b. Leaf sheath with feeding marks

Greater number of feeding marks on the resistant genotypes may be because of BPH does not find a suitable feeding site on those and moves around, making numerous probes in an attempt to locate a suitable feeding site (Khan and Saxena, 1986) or due to the presence of certain feeding deterrents or toxic chemicals present in the plant sap (Sogawa, 1982).

Antibiosis effect on feeding rate

The quantity of excretion of honeydew by brownplanthopper, in general, is directly related to intake of plant sap. Therefore, the amount of honeydew excreted by the insect in unit time when fed on different rice cultures is considered as an index of antibiosis mechanism of resistance on BPH feeding rate. The honeydew excreted area of BPH adults in mm² on selected rice cultures in comparison to the susceptible and resistant check were presented in table 1 and fig. 2. The amount of honeydew excreted in the present study ranged from 25.60 mm² to 456.40 mm² (Plate 2). The results indicated that all the resistant rice cultures showed significantly less amount of honeydew excretion as compared to susceptible check, TN1 (456.40 mm²). Among the resistant rice cultures, MTU IJ 206-7-4-1 recorded lowest honeydew excreted area of 25.60 mm² and followed by resistant check, Ptb 33 (58.80 mm²), NLR 3093

(65.60 mm²) and RGL 7002 (87.80 mm²). The rice cultures viz., RGL 7001 (133.20 mm²), MTU 1075 (160.80 mm²), NLR 20131 (164.00 mm²), WGL II 218-5-1 (168.20 mm²) recorded moderate honeydew excreted area and MTU PLA 99-1-3-1-2 (200.80 mm²), NLR 3090 (218.40 mm²), WGL 401 (260.80 mm²) and BPT 2404 (340.60 mm²) recorded highest honeydew area among the rice cultures tested.

In the present investigation, the BPH excreted significantly higher amounts of honeydew on the susceptible TN1, but significantly low quantities were excreted when the insects were confined onto the resistant and moderately resistant cultures. Significant variation was also observed among the resistant cultures. The resistant culture MTU IJ 206-7-4-1 (25.60 mm²) recorded lowest honeydew excreted area than the resistant check, Ptb 33 (58.80 mm²). These results corroborate the findings of Udayasree and Rajanikanth (2018) who also noted lower honeydew excretion in resistant genotypes, suggesting reduced sap ingestion as a resistance mechanism. Alagar *et al.* (2007) and Boopathi and Bharathi (2008) also reported similar results. It was also observed from the present investigation that the rice culture RGL 7002 though it doesn't show antixenosis effect on BPH feeding but exhibited antibiosis effect

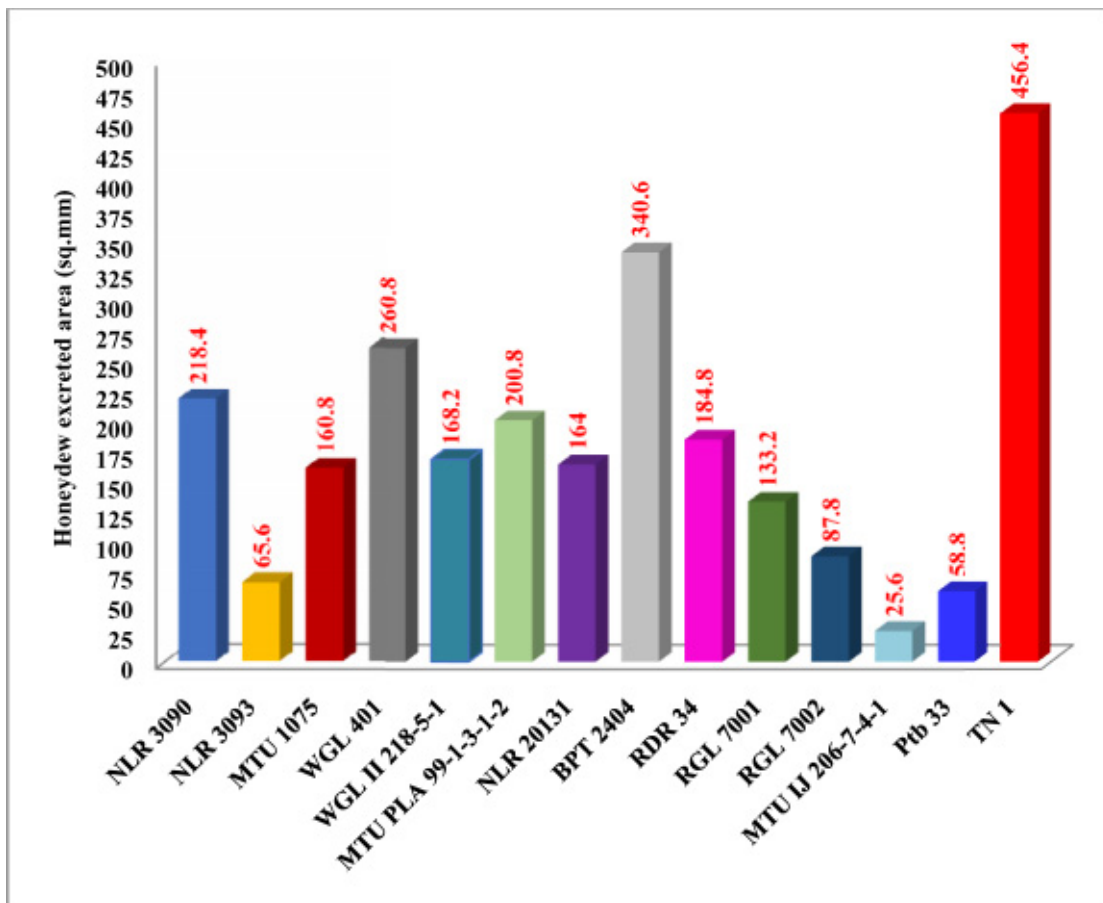


Fig. 2. Honeydew excreted area (mm²) by females of BPH on tested rice cultures

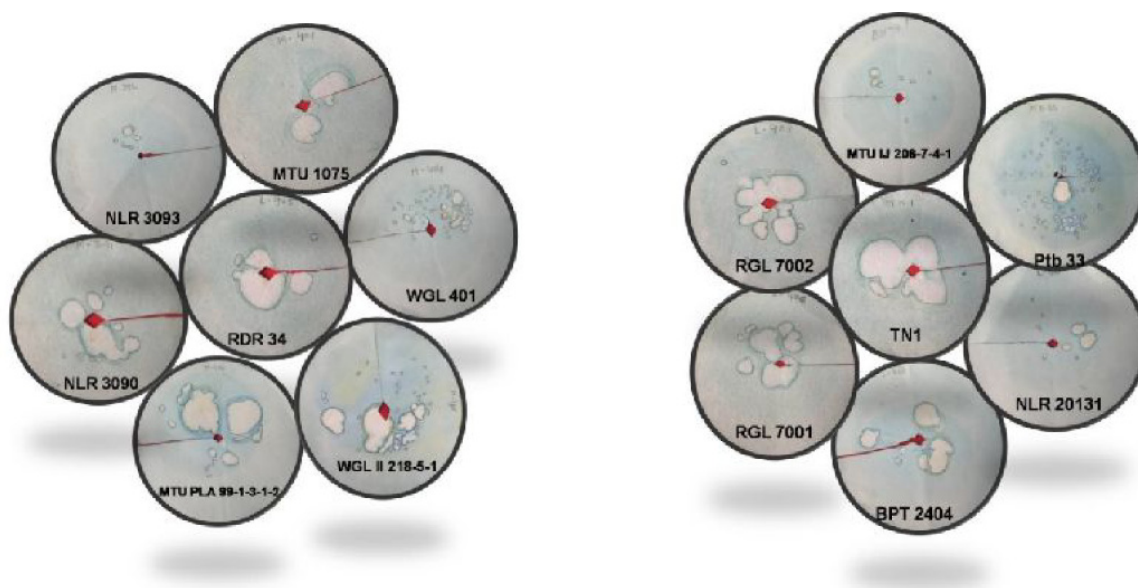


Plate 2. Bromocresol green treated filter paper with honeydew excretion spots on selected rice cultures

Table 1. Antixenosis and antibiosis effect of certain rice cultures on feeding activity of brown planthopper, *Nilaparvata lugens* (Stal)

Rice culture No.	Field reaction to BPH	Mean no. of feeding marks	Honeydew excreted area (mm ²)
NLR 3090	MR	105.40(10.05)	218.40 (14.63) ^d
NLR 3093	MR	48.80(6.83) ^{cd}	65.60 (8.06) ^b
MTU 1075	R	128.10(11.27) ^g	160.80 (12.58) ^{cd}
WGL 401	MR	62.00(7.67) ^{cd}	260.80 (16.05) ^{de}
WGL II 218-5-1	MR	97.10(9.68) ^e	168.20 (12.93) ^{cd}
MTU PLA 99-1-3-1-2	MR	110.20(10.46) ^{fg}	200.80 (13.97) ^d
NLR 20131	MR	56.80(7.32) ^{cd}	164.00 (12.75) ^{cd}
BPT 2404	MR	91.80(9.45) ^e	340.60 (18.29) ^e
RDR 34	MR	39.40(6.24) ^{bc}	184.80 (13.48) ^{cd}
RGL 7001	R	51.30(7.05) ^{cd}	133.20 (11.49) ^c
RGL 7002	R	12.50(3.37) ^a	87.80 (9.33) ^b
MTU IJ 206-7-4-1	HR	112.80(10.20) ^{efg}	25.60 (4.89) ^a
Ptb 33	HR	61.50(7.77) ^{cd}	58.80 (7.62) ^b
TN 1	HS	24.30(4.90) ^b	456.40 (21.63) ^f

HR= Highly resistant; R=Resistant; MR= Moderately resistant; HS= Highly susceptible

Figures in parenthesis are square root transformed values

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

with lesser area of honeydew excretion. This might be due to that the BPH experiences no difficulty in reaching the vascular bundles indicating that there is no mechanical barrier in the resistant varieties preventing stylet insertion and location of a sucking site, and the insect's behavior is normal, at least up to the exploratory probing phase even on resistant varieties (Sogawa and Pathak, 1976).

CONCLUSION

A higher number of feeding marks observed on resistant genotypes reflects the antixenosis mechanism, where BPH makes repeated probing attempts without establishing prolonged feeding. In this study, all the rice cultures, except RGL 7002, exhibited sustained feeding of BPH. Low honeydew excretion in MTU IJ 206-7-4-1, Ptb 33, NLR 3093, and RGL

7002 further confirmed the role of antibiosis in conferring resistance. These cultures can be considered as effective sources of resistance against BPH and hold promise as donor parents in breeding programs aimed at developing durable BPH-resistant rice varieties.

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