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FEEDING BEHAVIOUR OF DIFFERENT INDIAN BROWN PLANT HOPPER, *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae) POPULATIONS ON RESISTANT VARIETIES OF RICE

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ABSTRACT

The virulence levels of different Brown planthopper (BPH) *Nilaparvata lugens* (Stål) populations collected from Ludhiana (Punjab), West Godavari (Andhra Pradesh) and Nalgonda (Telangana) regions of India against popular resistant rice cultivars in terms of honeydew excretion by BPH females were assessed. Populations and varieties have shown significant difference in honeydew excretion where Ludhiana population showed highest honeydew excretion followed by Nalgonda and West Godavari. In the varieties, highest honeydew excretion was noticed on TN1 and lowest on PTB-33.

INTRODUCTION :

The rice brown planthopper (BPH), *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae), is a typical phloem sap feeder that has emerged as the threat to rice production in Asia (Chen and Cheng, 1978; Normile, 2008; Heong and Hardy, 2009, Sunil *et al.*, 2017). In India, it has emerged as a major pest after 1973 due to the introduction of high yielding short duration fertilizer responsive rice varieties. Recently, BPH has spread to the unconventional areas and most of the rice fields in those areas have shown hopper-burn symptoms sometimes with 100% yield loss. This is due to the injudicious use of fertilizers and insecticides especially synthetic pyrethroids and repeated use of the same insecticide which leads to pest resurgence, insecticide resistance (Jhansi Lakshmi *et al.*, 2010a) and destruction of natural enemies (Jhansi Lakshmi *et al.*, 2010b). Outbreaks of BPH in tropical rice fields have been mainly attributed to the misuse of pesticides that disturbs the natural control of the pest by killing predators and parasitoids (Heinrichs and Mochida 1984). Host plant resistance is the most practical and economical method to tackle this problem (Chelliah, 1985). Mechanisms such as antixenosis and antibiosis often provide basis for resistance in rice varieties against *N. lugens*. Antixenosis is generally expressed in terms of low feeding rate by the planthoppers in many resistant varieties (Song *et al.*, 1972) and measuring honeydew excretion provides a tool for assessing the feeding activity of sucking insects in resistant and susceptible varieties as low honeydew excretion is related to BPH resistance (Nagendra Reddy *et al.*, 2016). The most popular rice varieties, IR 64 and MTU 1010 are moderately resistant to BPH in the adult plant stage. The mechanisms of resistance are not studied in these varieties and the study will aid in incorporating the resistance into the susceptible high yielding varieties. BPH populations from different regions also exhibit variation in their virulence to different cultivars in terms of mechanisms of resistance. Based on the virulence reaction, the resistant variety suitable for that region can be selected. Hence, an attempt was made to study the resistance mechanism in these two cultivars by measuring the honeydew excretion (antixenosis for feeding) of brown planthopper populations collected from different parts of India such as Ludhiana (Punjab), Nalgonda (Telangana) and West Godavari (Andhra Pradesh) along with resistant and susceptible checks viz., PTB33 and TN1 respectively.

MATERIALS AND METHODS

Mass Culturing of BPH

BPH populations were collected from three different areas of the country viz., Ludhiana (Punjab state) with hot semi arid climate representing north-west India where rice crop is grown only during May to September (Wet season); West Godavari District (Andhra Pradesh state) and Nalgonda district

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(Telangana state) with hot sub-humid to semi arid climate in South India where rice is grown in two seasons (Dry and Wet) (agricoop.nic.in). The populations were separately reared on young rice seedlings (cvTN1) using modified Japanese method (Heong *et al.*, 2011) in flexi cages to avoid mating and intermixing of the three populations in the greenhouse at the Indian Institute of Rice Research, Hyderabad, India. The popular cultivated rice varieties resistant to BPH viz., MTU-1010 (unknown genetics) and IR-64 (Bph 1+ gene), along with resistant check PTB-33 (bph2+Bph3+unknown factors) and susceptible check TN-1 were selected and grown and 30 days old plants were used for honeydew excretion test and the experiment was replicated five times.

Measurement of honeydew excretion

The amount of honeydew excreted by the adult hoppers of BPH in selected rice cultivars was measured which is an indication of the feeding preference. Whatman No.1 filter paper was dipped in a 0.02% bromocresol green solution in ethanol and allowed to dry for one hour and dipped again till the filter paper turned yellowish orange (Fig 1). The treated paper was then placed on the wooden plank with a central hole kept at the base of 30-days old plant and a single stem was inserted into the hole of the plastic cup placed over the filter paper. Five freshly emerged female hoppers, pre-starved for 1 hour were released into the plastic cup and the hole was closed with cotton. The BPH adults were allowed to feed for 24 hours at the base of the rice stem. The honeydew droplets excreted by the adults when come into contact with the filter paper turn into blue spots. The area of blue spots appeared on filter paper as a result of honeydew excretion was measured by using ImajeJ software. The xylem spots (light white spots) and phloem spots (blue spots) were measured separately and the data analysis was done by using Analysis of variance (ANOVA) and statistix 8.1 software. The preference/ non-preference for feeding among the rice varieties was determined by comparing the average area of honeydew excreted in mm^2.

RESULTS & DISCUSSION

The results revealed that there was significant difference among the three populations in the amount of honeydew excreted in different varieties with varying levels of resistance (Table 1 and Fig 2). Among the populations, total honeydew excretion was more in Ludhiana population (88.0 mm^2) followed by Nalgonda (86.8 mm^2) and West Godavari (65.9 mm^2) populations. Among the varieties, significantly lowest honeydew excretion was noticed in the resistant PTB-33 (18.7 mm^2) and highest in the susceptible TN1 (200.7 mm^2). In the moderately resistant cultivars *viz.*, IR-64 and MTU-1010, the area of honeydew excretion was 30.7 mm^2 and 58.9 mm^2 respectively. Xylem spots which are faint white in colour were found on the honeydew paper and these were measured separately. The area of xylem spots on different resistant varieties was 9.5 mm^2 on PTB-33, 10.3 mm^2 on IR-64 and 7.2 mm^2 on MTU-1010. There were no xylem spots in the susceptible variety TN1. In West Godavari population, lower area of phloem sap (8.4mm^2) and higher area of xylem sap (9.1 mm^2) was observed on PTB-33. Similarly in MTU-1010 almost equal area of phloem (13.6 mm^2) and xylem spots (10.2 mm^2) were observed whereas in IR-64 higher area of Phloem (20.1 mm^2) and lower xylem sap (3.2 mm^2) were recorded. It is observed that higher phloem sap was recorded on

Fig. 1. Honeydew experimental set up and honeydew spots by feeding of BPH

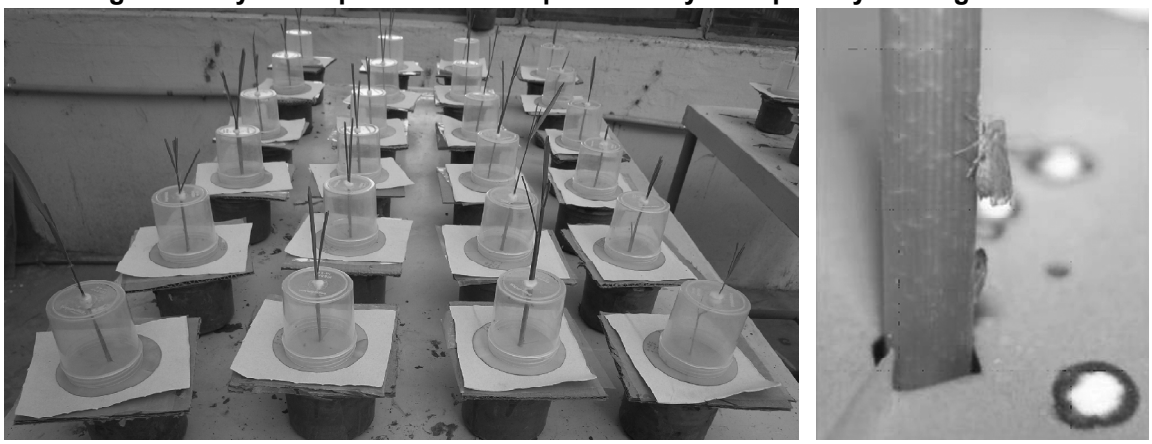

Table 1. Honeydew excretion by female adults of BPH populations on different rice genotypes

BPH populations	Resistant varieties	Area of Phloem spots mm²	Area of Xylem spots mm²	Total Honeydew excreted mm² (phloem+xylem)
West Godavari	MTU1010	13.6±3.2	10.2±4.6	23.8±2.2b
	PTB-33	8.4±1.2	9.1±1.1	17.5±1.4b
	IR-64	20.1±1.5	3.2±0.7	23.3±1.8b
	TN1	199.1±17.6	0	199.1±17.6a
Ludhiana	MTU1010	95.4±44.3	8.5±3.5	103.9±43.8ab
	PTB-33	32.8±14.5	13.4±3.1	46.2±15.4b
	IR-64	52.8±18.6	22.1±5.3	74.9±20.3ab
	TN1	153.2±12.2	0	153.2±12.2a
Nalgonda	MTU1010	67.7±26.2	3.1±0.9	70.8±26.3b
	PTB-33	15.0±3.4	5.9±3.1	20.9±6.3b
	IR-64	19.0±6.0	5.7±1.6	24.6±7.2b
	TN1	230.8±20.2	0.0	230.8±20.2a
CD (0.05) interactions	2.98			
Resistant varieties	MTU1010	58.9±18.3	7.2±2.0	66.1±18.1b
	PTB-33	18.7±5.4	9.5±1.6	28.2±6.2c
	IR-64	30.7±7.4	10.3±2.8	41.0±9.2bc
	TN1	200.7±13.1	0	200.7±13.1a
	CD (0.05) varieties	1.67		
Populations	West Godavari	60.3±8.9	5.6±1.5	65.9±18.1b
	Ludhiana	75.8±16.5	12.2±2.6	88.0±15.8a
	Nalgonda	83.1±21.6	3.7±1.0	86.8±21.1ab
CD (0.05) populations	1.62			

susceptible variety TN1 (199.1 mm²) and on which no xylem spots were observed. In Ludhiana population, significantly higher amount of honeydew excretion was recorded on susceptible variety TN1 (153.2 mm²) and lower on PTB-33 (32.8 mm²). However, no significant difference was observed in moderately resistant varieties MTU-1010 (95.4 mm2) and IR-64 (52.8 mm²). The amount of xylem spots were also observed in almost all resistant varieties viz., IR-64 (22.1 mm²), PTB-33 (13.4 mm²), MTU-1010 (8.5 mm²). In Nalgonda population significantly highest phloem sap was observed on TN1 (230.8 mm²) followed by MTU-1010 (67.7 mm²) IR-64 (19.0 mm²), PTB-33 (15.0 mm²). Similarly xylem spots were observed on resistant varieties viz., PTB-33 (5.9 mm²), IR-64 (5.7 mm²) and MTU-1010 (3.1 mm²). In general, the amount of honeydew excreted by BPH is directly related to the intake of plant sap. Therefore, the amount of honeydew excreted by the insect in unit time when fed on different rice varieties is considered as an index for its feeding preference. In our results, among the rice genotypes significant differences were observed with lower

honeydew in PTB-33 and higher in TN1. Similar results were observed by Vasantha Bhanu *et al*. (2014) with lower amount of honeydew excretion in PTB-33 (79 mm^2) and higher in susceptible variety TN1 (1461 mm^2). In the present study, lower honeydew excretion area in PTB-33, IR 64 and MTU 1010 indicates the non-preference for feeding. The little sap intake or lower honeydew excretion area might be due to the presence of certain undesirable gustatory factors that block the sustained sucking by the insect. When the phloem sap is not suitable for feeding, the insect shifts to the xylem. In the resistant varieties, xylem feeding was observed in all the populations but in susceptible TN1 variety, no xylem feeding was observed. This indicates that the BPH was able to feed on phloem sap in TN1 but there was some inhibition for phloem sap sucking in resistant varieties and it switched to xylem. Similar results were observed by Jena *et al*. (2017) where they observed most of the pyramided NILs having two to three gene combinations showed higher consumption of xylem sap and reduced consumption of phloem sap compared with the NILs having single R genes. This result indicated that BPH cannot feed normally on these pyramided NILs; hence, these NILs were highly resistant. In West Godavari population, higher xylem spots and lower phloem sap on PTB-33 indicated that Bph 2 + Bph 3 combined genes showed an increased level of resistance. Similarly Jena *et al*. (2017) recorded that NIL-*BPH 4* + NIL-*BPH 26* has a high consumption of xylem sap and minimal consumption of phloem sap in the Laguna BPH colony, with an excreted area of 52 mm^2, compared with NIL-*BPH4* and NIL-*BPH26* alone having an excreted area of 675 and 587 mm^2, respectively.

Moreover, *N.lugens* feed less and excretes less honeydew when feeding on rice plants deficient in nitrogen (Sogawa, 1982). Sakai and Sogawa (1976) observed that certain amino acids, sucrose, and organic acids act as feeding stimulants. Low concentrations of asparagine may deter extended feeding (Sogawa and Pathak, 1970). Therefore, amino acid content could vary between rice varieties, and differences in planthopper performance on different varieties were observed.

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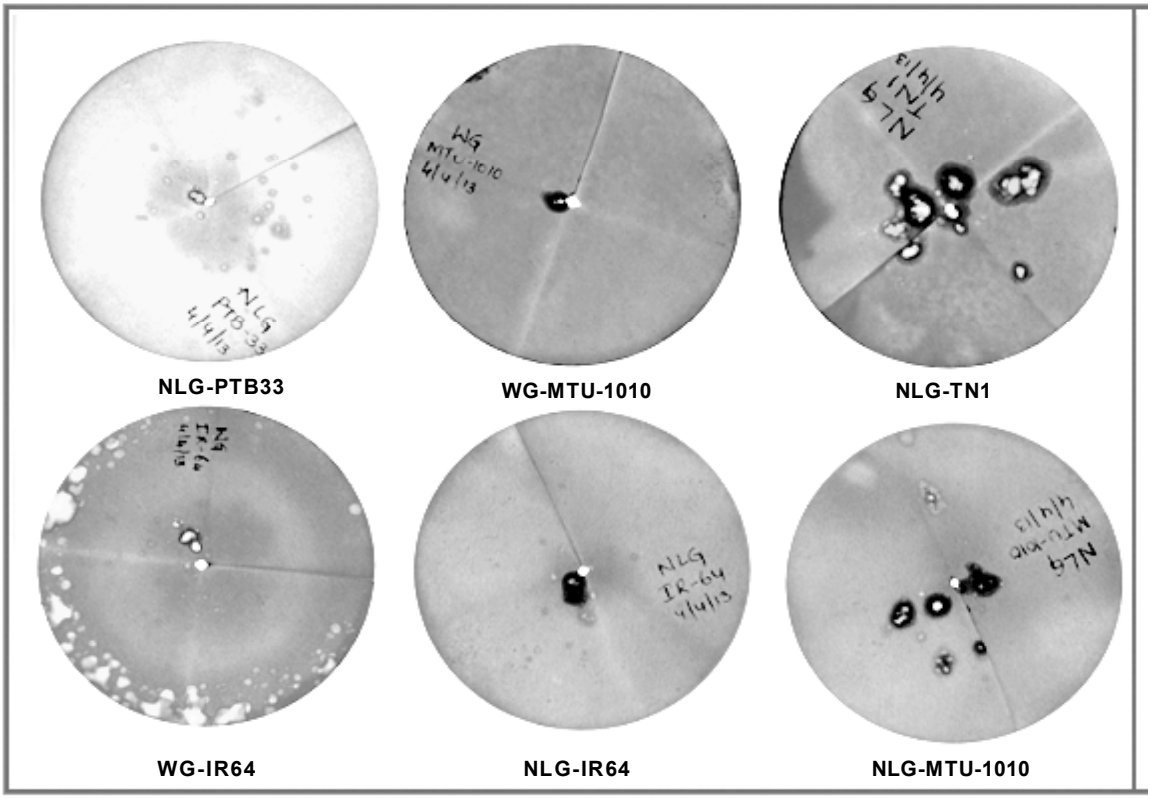
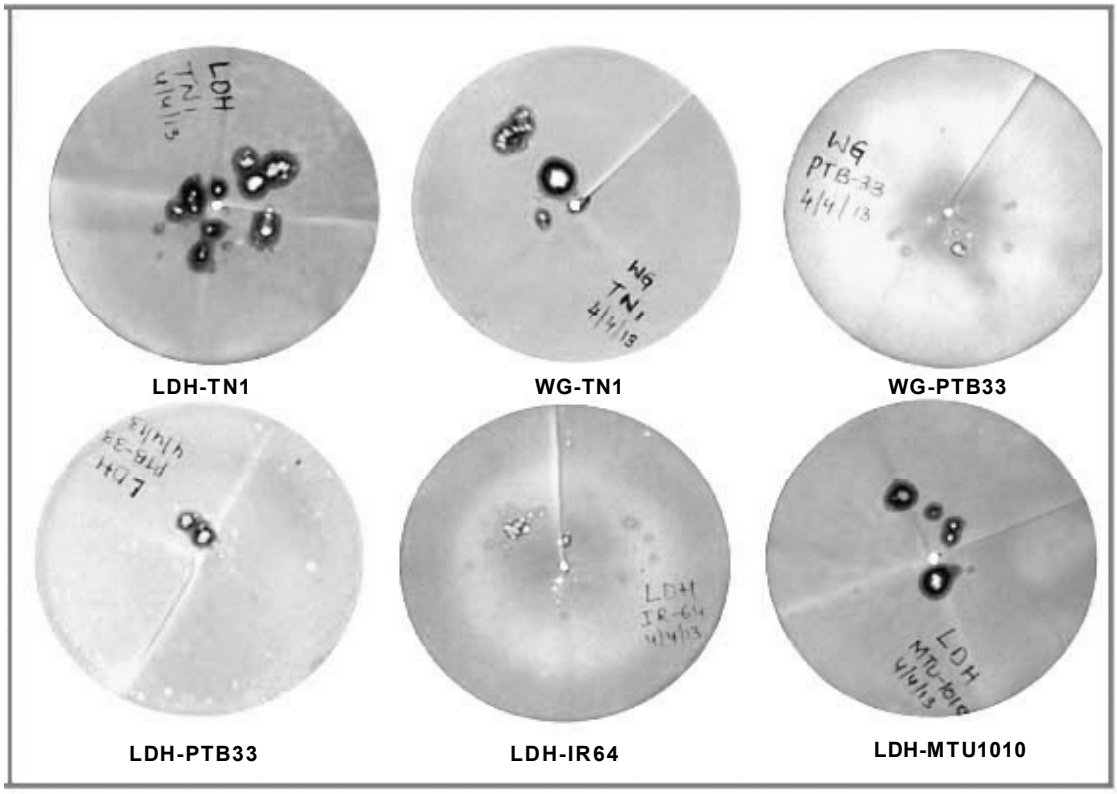
Fig. 2. Honeydew excreted by different adult BPH populations on resistant rice varieties





REFERENCES

Agri.coop.in(http://agricoop.nic.in/Agriculture% 20Contingency% 20Plan/AP/AP6-Krishna% 2031.1.11.pdf)

Chelliah, S. 1985. Genetics of resistance in rice to planthoppers and leafhoppers. Rice Genetics I (In 2 Parts). Proceedings of the International Rice Genetics Symposium, International Rice Research Institute, Manila, Philippines. 27 – 31 May 1985. Pp. 513-522.

Chen, C. N and Cheng, C. C. 1978. The population levels of *Nilaparvata lugens (*Stal) in relation to the yield loss of rice. International Plant Protection Bulletin, 20 (3): 197–209

Heinrichs, E.A and O. Mochida. 1984. From secondary to major pest status: the case of insecticide induced rice brown planthopper, *Nilaparvata lugens*, resurgence. Protection Ecology. 7: 201-218.

Heong, K. L and Hardy, B. 2009. Planthoppers: New Threats to the Sustainability of Intensive Rice Production Systems in Asia. Los Baños, the Philippines: International Rice Research Institute: 1–470.

Heong, K.L., Tan, K.H., Garcia, C.P.F., Fabellar, L.T and Lu, Z. 2011. Research methods in toxicology and insecticide resistance monitoring of rice planthoppers. Los Baños (Philippines): International Rice Research Institute. 101 p.

Jena, K.K., Sherry Lou Hechanova, Holden Verdeprado, Prahalada, G. D and Sung Ryul Kim. 2017. Development of 25 near isogenic lines (NILs) with ten BPH resistance genes in rice *(Oryza sativa L.)*: production, resistance spectrum, and molecular analysis. Theoretical and Applied Genetics. 130: 2345–2360.

Jhansi Lakshmi, V., Krishnaiah, N.V., Katti, G.R., Pasalu, I.C and Chirutkar, P.M., 2010b. Screening of selected insecticides for toxicity to rice hoppers and their predators. Oryza, 47(4): 295-301.

Jhansi Lakshmi, V., Krishnaiah, N.V., Katti, G., Pasalu, I.C and Vasantha Bhanu, K. 2010a. Development of insecticide resistance in rice brown planthopper and whitebacked planthopper in Godavari delta of Andhra Pradesh. Indian Journal of Plant Protection, 38 (1): 35-40.

Nagendra Reddy, B., Jhansi Lakshmi, V., Uma Maheswari, T., Ramulamma, A and Katti. G.R. 2016. Non-preference/antixenosis mechanism of resistance to brown planthopper *Nilaparvata Lugens* (Stal) in selected rice entries. The Journal of Research, PJTSAU. 44 (1&2): 1-10.

Normile, D. 2008. Reinventing rice to feed the world. Science. 321: 330–333.

Sakai, T and Sogawa, K. 1976. Effects of nutrient compounds on sucking response of the brown planthopper, *Nilaparvata lugens.* Applied Entomology and Zoology. 11: 82-88.

Sogawa. K. 1982. The rice brown planthopper: feeding physiology and host plant interactions. Annual Review of Entomology. 27: 49-73.

Sogawa, K and Pathak, M.D. 1970. Mechanisms of brown planthopper resistance in mudgo variety of rice (Hemiptera: Delphacidae). Applied Entomology and Zoology. 5: 145-158.

Song, Y.H. Choi, S.Y and Park, J.S. 1972. Studies on the resistance of Tong-il variety (IR 667) to the brown planthopper *Nilaparvata lugens* Stal. Korean Journal of Plant Protection. 11 (2): 61-68.

Sunil Vailla, Jhansi Lakshmi Vattikuti, Chiranjeevi Konijeti, Sampathkumar Muthuswamy, Rohini Alavala, Jagadish S. Bentur, Chitra Shanker and G.R. Katti. 2017. Response of Indian brown planthopper, *Nilaparvata lugens* (Stal) populations to crowding. International Journal of Current Microbiology and Applied Sciences. 6 (12): 2147-2158.

Vasanta Bhanu, K., Jhansi Lakshmi, V., Katti, G and Vishnuvardhan Reddy, A. 2014. Antibiosis and tolerance mechanisms of resistance in rice varieties carrying brown planthopper resistant genes. Asian Journal of Biological and Life Sciences. 3 (2): 108-113.