FEEDING ACTIVITY AND POPULATION BUILDUP OF BROWN PLANTHOPPER (BPH), *NILAPARVATA LUGENS* (STAL°) ON SELECTED RICE CULTURES

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ABSTRACT: Experiments were conducted to assess the antibiosis mechanism of resistance *viz.,* feeding activity and population buildup of brown planthopper (BPH), *Nilaparvata lugens* in some selected resistant rice cultures. The feeding activity was analyzed in terms of honeydew excreted by BPH. The honeydew excretion was significantly minimum on MTU IJ 206-7-4-1 followed by resistant check Ptb 33, while it was significantly higher on TN 1. Significantly maximum per cent of macropterous and minimum per cent of brachypterous forms of BPH were observed on the rice culture RGL 7002 and MTU IJ 206-7-4-1 respectively. The rice culture, MTU IJ 206-7-4-1 and resistant check, Ptb 33 recorded significantly lowest female and male population respectively. Population buildup in terms of first generation nymphs was significantly lowest on WGL II 218-5-1 and followed by other rice cultures. All the rice cultures took longer days to wilt than susceptible check, TN 1.

Keywords: Rice cultures, brown planthopper, honeydew excretion, population buildup.

Introduction: Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50% of the daily calorie intake (Khush, 2005). Increasing production of rice is an important requirement to meet the needs of ever increasing population in India. Insect pests and diseases remain the key biotic stresses limiting rice production significantly. Among the serious insect pests of rice, brown planthopper (BPH), *Nilaparvata lugens* Stal° (Homoptera: Delphacidae), is one of the most destructive insect pests causing significant yield losses (Park *et al*., 2008). It is a rice specific herbivore damaging the plants by sucking assimilates from the phloem resulting in a condition called "hopper burn" and transmits virus diseases like grassy stunt, ragged stunt and wilted stunt (Sogawa, 1982). In recent years major out breaks of BPH were recorded in several rice growing countries like China, Korea, Japan, India, Indonesia, Malaysia, the Philippines, Thailand and Vietnam (Heong and Hardy, 2009). The most commonly used method for controlling BPH is the use of insecticides. However, the improper and consistent large scale use of these insecticides causes; first resurgence of the BPH and secondly insects developed resistance against insecticides (Tanaka *et al*., 2000; Lakshmi *et al*., 2010) and thus aggravating the BPH problem. In the management of BPH, no single control component is in itself a panacea. Among the various methods available for managing BPH, cultivation of resistant rice varieties is the most economical and efficient method. Since the release of IR 26 in 1973, several resistant varieties to BPH have been developed and released in India; they became susceptible to BPH within a few years after their introduction, because of breakdown of resistance or development of biotypes. So, it is also necessary to understand the mechanisms of resistance *viz.,* antixenosis, antibiosis and tolerance that are responsible for manifesting the resistance among the plants and is essential for the development of varieties with durable resistance. Hence, the experiment was conducted to study the antibiosis mechanism of resistance such as feeding activity and population buildup in selected highly resistant (HR), resistant (R) and moderately resistant rice cultures along with the resistant check (Ptb33) and susceptible check (TN1).

Material And Methods: The advanced rice cultures developed at various Rice Research Stations under Acharya N. G. Ranga Agricultural University was screened initially in laboratory and later in field against BPH to identify resistant cultures as per the standard methods (Heinrichs *et al*., 1985). The rice cultures identified as highly resistant to moderately resistant were used to study the feeding activity and population buildup of BPH. The study was carried out in the glasshouse as pot culture experiments under controlled conditions at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Institute, Maruteru, West Godavari district, Andhra Pradesh during the period 2010 to 2011.

Insect culture: The BPH was mass cultured in the greenhouse on the susceptible rice variety Taichung Native 1 (TN 1). Initial BPH population was collected from rice fields. The adults were confined on 30 days old potted plants of TN 1 placed in oviposition cages having wooden frames, glass top and door and wire-mesh side walls. The ovipositing insects were removed three day 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 10-15 days old seedlings raised in plastic pots and were allowed to develop to different instars until they became adults. The host plants in culture maintenance cage were changed twice a week and

replaced them with fresh potted plants (Heinrichs *et al.*, 1985).

Rice cultures: For this experimental study, twelve rice cultures *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, MTU IJ 206-7-4-1 and the resistant check (Ptb33) and susceptible check (TN1) were used.

Feeding rate: The preference of BPH for each selected rice culture was assessed by estimating the amount of honeydew excreted by the adult hoppers as 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. The treated paper was then placed on the wooden plank kept at the base of 30-days old plants. A plastic cup was placed over the filter paper and five freshly emerged female hoppers, pre-starved for four hours and were released into the feeding chamber having bromocresol green treated filter paper (Pathak and Heinrichs, 1982). The BPH adults were allowed to feed for 24 hours at the base of the stem. The honeydew droplets excreted by the adults when came in contact with the filter paper turned into blue spots. The area blue spots appeared on filter paper as a result of honeydew excretion was measured by graph method. The antibiosis effect on feeding among the test cultures were determined by comparing the average area of honeydew excreted in mm^2.

Population buildup: The population buildup of BPH on different test cultures along with the resistant and susceptible checks was studied by releasing ten first instar nymphs on 30-days old Mylar film caged plants. Each culture was replicated five times. The wing forms (% macropterous and % brachypterous) and sex (% females and % males) of emerging adult hoppers were observed during the development. Further, the surviving adults were then allowed to feed and reproduce on the same plant. The number of nymphs emerged after hatching was recorded as first generation nymphs, and were allowed to feed (Heinrichs *et al.*, 1985). When the plants started to wilt, the days taken to wilt was also recorded.

Statistical analysis: The data on per cent nymphal survival, % brachypterous adults, % macropterous adults, % female and % males were transformed to *arc sin* values The data on honeydew excreted area in sq.mm was transformed to square root values and was subjected to randomized block design. The mean values were compared using Duncan's Multiple Range Test (DMRT).

Results And Discussion

Feeding rate : The quantity of excretion of honeydew by brown Planthopper, 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 for its feeding preference. The honeydew excreted area of BPH adults in mm^2 on selected rice cultures in comparison to the susceptible and resistant check were presented in table 1. The amount of honeydew excreted in the present study ranged from 25.60 mm^2 to 456.40 mm^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 mm^2). Among the resistant rice cultures, MTU IJ 206-7-4-1 recorded lowest honeydew excreted area of 25.60 mm^2 and followed by resistant check, Ptb 33 (58.80 mm^2), NLR 3093 (65.60 mm^2) and RGL 7002 (87.80 mm^2). The rice cultures *viz*., RGL 7001 (133.20 mm^2), MTU 1075 (160.80 mm^2), NLR 20131 (164.00 mm^2), WGL II 218-5-1 (168.20 mm^2) recorded moderate honeydew excreted area and MTU PLA 99-1-3-1-2 (200.80 mm^2), NLR 3090 (218.40 mm^2), WGL 401 (260.80 mm^2) and BPT 2404 (340.60 mm^2) recorded highest honeydew area among the rice cultures tested.

Measurement of honeydew excretion as a tool in assessing resistance and susceptibility of a variety. In BPH, low honeydew excretion was related to the resistance of the rice variety. In the present investigation, the BPH copiously excreted honeydew on the susceptible TN1, but significantly low quantities were excreted when the insects were confined onto the resistant and moderately resistant cultures. Alagar and Suresh (2007) and Boopathi and Bharathi (2008) also reported similar results.

Population buildup of BPH: Four parameters *viz.*, wing forms and sex of the emerging adults developed on each selected rice culture, population of first generation nymphs and number of days taken for wilting of each test culture were studied in the experiment (Table 2).

Macropterous form: The effect of rice cultures on the development of macropterous forms was presented in table 2. The per cent macropterous forms ranged from 24.05 to 64.05. Significantly maximum per cent of macropterous forms of BPH were observed on the rice culture RGL 7002 (64.05) and was on par with WGL II 218-5-1 (60.04), MTU PLA 99-1-3-1-2 (56.14), NLR 3093 (56.05) and RDR 34 (52.05). These were 8.0 to 20.0 and 28.0 to 40.0 per cent higher than the susceptible check, TN1 (44.05) and resistant check, Ptb 33 (24.05) respectively. The rice cultures, MTU IJ 206-7-4-1 (36.05) and RGL 7001 (36.05) recorded minimum per cent of macropterous adults among the cultures tested.

Brachypterous form: The difference in per cent

brachypterous forms among the tested rice cultures were significant (Table 2). The per cent Among the rice cultures, lowest per cent of brachypterous adults were observed in MTU IJ 206-7-4-1 (16.05) and on par with WGL II 218-5-1 (20.05), MTU 1075 (28.05) and NLR 3093 (28.05) which were 32.0 to 36.0 and 6.0 to 12.0 per cent lower than the susceptible check, TN1 (52.05) and resistant check, Ptb 33 (32.05) respectively. These were followed by other rice cultures.

Sex: The sex of emerged adults from the nymphs developed on tested rice cultures along with the resistant and susceptible checks was presented in table 2. The per cent female and male emergence ranged from 20.0 to 64.0 and 12.0 to 52.0 respectively. Significantly lowest female population of 20.0 per cent was observed in MTU IJ 206-7-4-1 which was 24.0 and 44.0 per cent lower than the resistant check, Ptb 33 (44.0) and susceptible check, TN1 (64.0) respectively. It was on par with RGL 7001 (32.0 per cent) and WGL II 218-5-1 (32.0 per cent). These were followed by other rice cultures.

Similarly, among the tested rice cultures, significantly lowest per cent of male emergence was recorded in resistant check, Ptb 33 (12.0) and was followed by MTU IJ 206-7-4-1 (32.0) and highest in RGL 7002 (52.0) and NLR 3093 (48.0). From the results it was evident that in some cultures like MTU PLA 99-1-3-1-2, BPT 2404, RDR 34, RGL 7001 the per cent female and males were almost equal. In some cultures like NLR 3093, MTU 1075, WGL II 218-5-1, RGL 7002, MTU IJ 206-7-4-1 the per cent females were lower than males. In cultures *viz.,* NLR 3090, WGL 401, NLR 20131, Ptb 33 and TN1 the per cent females emerged were more than males. So, in most of the rice cultures disproportionate sex ratio was observed. These results were in contrary to the findings of Alagar and Suresh (2007) who reported that per cent male emergence was higher on the resistance genotypes than on susceptible genotypes.

Emergence of first generation nymphs: The number of first generation nymphs emerged on the tested rice cultures were presented in table 2. The number of first generation nymphs varied from 32.40 to 450.80. Significantly lowest numbers of first generation nymphs was observed on WGL II 218-5-1 (32.40) and was on par with WGL 401 (40.80), MTU IJ 206-7-4-1 (41.60), resistant check, Ptb 33 (46.00). These were followed by RGL 7001 (60.40), RGL 7002 (72.20) and MTU PLA 99-1-3-1-2 (73.40). The cultures *viz*., NLR 20131 (142.00), NLR 3090 (174.20), RDR 34 (186.80), and NLR 3093 (319.80) recorded moderate population of first generation nymphs. Significantly highest population of first generation nymphs was observed on BPT 2404 (438.00) and was on par with susceptible check, TN1 (450.80).

In the present investigation, except BPT 2404, the other rice cultures tested recorded lowest number of first generation nymphs than the susceptible check, TN1. These results are in agreement with the observations of Kalode *et al*. (1978) who reported that population build up was adversely affected to varying degrees on Ptb 33, Ptb 21, ARC 6650 and CR-57-MR-1523.

Days to wilt: During the development of first generation nymphs, the days taken for wilting of each tested rice culture were recorded and presented in table 2. The number of days taken to wilt ranged from 20.60 to 40.00 days. The data from the table revealed that all the tested rice cultures significantly took longer period to wilt compared to susceptible check TN1 (20.60 days). Among the rice cultures, MTU IJ 206-7-4-1 took 40 days to wilt and was on par with resistant check Ptb 33 (39.20 days). These were followed by NLR 3093 (34.80 days), RGL 7001 (34.20 days), WGL 401 (34.20 days), MTU 1075 (33.60 days) and RGL 7002 (32.60 days).

The susceptible check, TN1 showed an early wilting mainly because of higher population buildup. Whereas, the cultures *viz*., MTU IJ 206-7-4-1, WGL 401, WGL II 218-5-1, MTU PLA 99-1-3-1-2, RGL 7001, RGL 7002 and the resistant check, Ptb 33 etc., withstood longer period because of low population pressure. The rice cultures like NLR 3093, MTU 1075, NLR 3090, RDR 34 took more days to wilt even though they harbour high population of first generation nymphs. Similarly, the culture BPT 2404 supported the higher population of first generation nymphs and withstood up to 26.80 days which was 6.0 days more compared to TN1. Similar findings were also reported against BPH in rice by Boopathi and Bharathi (2008).

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Table 1. Honeydew excreted area (mm^2) by female adults of BPH

Rice culture No.	Cross combination	Reaction	Mean amount of
NLR 3090	RNR 19994/ MTU 7014	MR	218.40
NLR 3093	MTU 1001/ RNR 19994	MR	65.60
MTU 1075	MTU 2716/MTU 1010	R	160.80
WGL 401	BPT 5204/ Badrakali	MR	260.80
WGL II 218-5-1	MTU 1061/ MTU 1071	MR	168.20
MTU PLA 99-1-3-1-2	PLA 1100/ NLR 145	MR	200.80
NLR 20131	BPT 5204/ NLR 33359	MR	164.00
BPT 2404	BPT 5204/ IR 64/	MR	340.60
RDR 34	---	MR	184.80
RGL 7001	RGL 4107/ MTU 7029	R	133.20
RGL 7002	RGL 2232/ RGL 3250	R	87.80
MTU IJ 206-7-4-1	(Vajram/W40//Vajram)/	HR	25.60
Ptb 33	Resistant check	HR	58.80
TN 1	Susceptible check	S	456.40
SEm			0.76
CD (0.05)			2.15
CV (%)			13.45

*Mean of five replications; Figures in parenthesis were square root transformed values; Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 2. Population buildup of BPH on selected rice cultures

Rice culture No.	Alate forms (%)***		Sex (%)*		1st generation nymphs**	No. of days taken to wilt**
	Macroptery	Brachyptery	Female	Male		
NLR 3090	44.05 (6.53) [ab]	44.05 (6.61) [ab]	48.00 (43.85) [ab]	40.00 (39.01) [ab]	174.20 (13.14) [cd]	32.00 (5.65) [c]
NLR 3093	56.05 (7.42) [a]	28.05 (5.22) [ab]	36.00 (36.70) [ab]	48.00 (43.85) [ab]	319.80 (17.77) [f]	34.80 (5.90) [b]
MTU 1075	48.05 (6.64) [ab]	28.05 (4.74) [a]	36.00 (36.70) [ab]	40.00 (39.01) [ab]	285.60 (16.82) [e]	33.60 (5.80) [bc]
WGL 401	48.14 (6.64) [ab]	44.05 (6.27) [ab]	52.00 (43.85) [ab]	44.00 (41.31) [ab]	40.80 (6.21) [ab]	34.20 (5.85) [bc]
WGL II 218-5-1	60.04 (7.50) [a]	20.05 (3.52) [a]	32.00 (34.16) [abc]	48.00 (43.85) [ab]	32.40 (5.66) [a]	32.00 (5.65) [c]
MTU PLA 99-1-3-1-2	56.14 (7.30) [a]	32.05 (5.59) [ab]	44.00 (41.54) [ab]	44.00 (41.31) [ab]	73.40 (8.39) [b]	31.80 (5.64) [c]
NLR 20131	40.05 (6.33) [ab]	48.05 (6.90) [ab]	48.00 [ab] (43.85)	40.00 (39.23) [ab]	142.00 (11.82) [c]	26.00 (5.10) [e]
BPT 2404	44.14 (6.62) [ab]	44.05 (6.53) [ab]	44.00 (41.31) [ab]	44.00 (41.54) [ab]	438.00 (20.86) [g]	26.80 (5.17) [de]
RDR 34	52.05 (7.18) [ab]	40.05 (6.33) [ab]	44.00 (41.54) [ab]	44.00 (41.09) [ab]	186.80 (13.55) [d]	28.40 (5.33) [d]
RGL 7001	36.05 (5.87) [abc]	28.05 (5.22) [ab]	32.00 (33.94) [bc]	32.00 (33.94) [ab]	60.40 (7.75) [b]	34.20 (5.84) [bc]
RGL 7002	64.05 (7.81) [a]	28.05 (5.22) [ab]	40.00 (39.23) [ab]	52.00 (45.93) [a]	72.20 (8.45) [b]	32.60 (5.71) [bc]
MTU IJ 206-7-4-1	36.05 (5.26) [bc]	16.05 (3.63) [a]	20.00 (26.56) [c]	32.00 (31.16) [b]	41.60 (6.13) [ab]	40.00 (6.32) [a]
Ptb 33	24.05 (4.37) [c]	32.05 (5.59) [ab]	44.00 (41.54) [ab]	12.00 (15.94) [c]	46.00 (6.67) [ab]	39.20 (6.26) [a]
TN 1	44.05 (6.53) [ab]	52.05 (7.18) [b]	64.00 (53.30) [a]	32.00 (34.16) [ab]	450.80 (21.20) [g]	20.60 (4.54) [f]
SEm	0.69	0.69	3.56	5.04	0.59	0.079
CD (0.05)	1.95	1.96	10.08	14.25	1.67	0.22
CV (%)	23.54	27.64	19.99	29.68	11.24	3.14

Mean of five replications; *Figures in parenthesis are arcsine transformed values; **Figures in parenthesis are square root transformed values; ***Figures in parenthesis are square root (X+0.05) transformed values, Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

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