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SETTLING AND FEEDING RESPONSES OF BROWN PLANTHOPPER TO FIVE RICE CULTIVARS

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ABSTRACT

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Settling and feeding responses of brown planthopper, *Nilaparvata lugens* (Stål.) to five rice cultivars were studied in terms of nymphal and adult preference, feeding rate, body weight change, ingested and assimilated food during March to September, 2006 in Entomology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh. Both nymphs and adults showed distinct non-preference reactions to resistant cultivars Swarnalata and T27A for settling. Swarnalata had the lowest percentage (10.4) of nymphs at 72 hours after release which was at par with T27A while the highest percentage (34.0) of nymphs settled on TN1. On the contrary, the lowest percentage (7.2) of adults settled on T27A which was identical with Swarnalata whereas TN1 was highly preferred by *N. lugens* female. Adult female feeding on susceptible TN1 excreted the highest amount of 19.8 mg honeydew and gained body weight by 42.0 per cent while they gained the lowest body weight by 8.3 per cent and excreted only 2.1mg of honeydew during 24 hours feeding on resistant T27A. The quantity of food ingested and assimilated by female brown planthopper was also significantly much lower on resistant T27A as compared to that on susceptible TN1.

***Key words**: Nilaparvata lugens, preference, ingestion, assimilation*

INTRODUCTION

The brown planthopper, *Nilaparvata lugens* (Stål.) is now-a days a major rice pest in South and South-east Asia. Although it was formerly a minor pest in most tropical countries of Asia. Widespread adoption of high-yielding cultivars susceptible to *N. lugens*, application of high levels of nitrogen fertilizers, continuous cropping, and injudicious use of insecticides in the 1960's have been reported as causes for increased brown planthopper population and outbreak (Chelliah and Heinrichs, 1984). It causes substantial damage to the rice crop by direct physical damage due to phloem sap removal (Sogawa 1982) and blocking the xylem and phloem by laying egg masses in the midrib of the leaf sheath and leaf blade. Heavy infestations make the plants to dry up rapidly known as 'Hopperburn'. Brown planthopper also acts as a vector for the economically important ragged stunt, grassy stunt and wilted stunt viruses (Ou 1985). Moreover, the feeding and ovipositional marks predispose plants to fungal and bacterial infection, and the honeydew secreted by nymphs and adults encourage sooty molds (Pathak and Khan, 1994).

Host plant resistance, which is relatively stable, inexpensive, causes no environmental pollution, and is generally compatible with other control methods, has been considered as a major control strategy against *N. lugens* (Oka 1983). Natural resistance to brown planthopper exists in several rice varieties and wild rice (Heinrichs *et al*. 1985; Saxena 1989). Susceptibility or resistance of plants is the result of a series of interaction between plants and insects which influence the ultimate degree of establishment of insect population on plants (Saxena and Pathak, 1979). The factors which determine insect establishment on plants can be categorized into two groups such as insect responses to plants, and plant characters influencing insect responses. The insect responses included orientation, feeding, growth of nymphs to adult stage, adult longevity, egg production, oviposition and hatching of eggs. Unfavorable biophysical or biochemical plant characters may interrupt one or more of these insect responses, inhibit the establishment of an insect population on a plant and render it resistant to infestation and injury. It has been shown that resistant plants interrupt the behavior of *N. lugens* leading to the failure of establishment of the insect on its host rice. However, available information on the behavioral and physiological responses of *N. lugens* (biotype 4) in rice is limited. In consideration of the above facts, the present study was undertaken to investigate the settling and feeding responses of brown planthopper to five rice cultivars.

MATERIALS AND METHODS

The settling and feeding responses of brown planthopper, *Nilaparvata lugen*s Stål. to five selected rice cultivars were studied on a series of experiments at the growth room under controlled environmental condition (27 ± 2^{o}C temperature, 60-70% relative humidity with 12h photoperiod) in Entomology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The rice cultivars were IR64 with bph1, ARC10550 with bph5, Swarnalata with bph6, T27A with unknown dominant single gene and TN1 having no resistant gene to brown planthopper. The response tests included settling of brown planthopper, feeding rates, food ingestion and assimilation on different cultivars of rice. To obtain a regular supply of the insect of different stages, brown planthopper was mass-reared in the controlled growth room on susceptible rice variety TN1 following standard culture technique (Heinrichs *et al*. 1985).

To study the settling response, a 20cm diameter plastic pot containing five hills of five cultivars with 30 day-old 2 seedlings per hill that had been randomly but equidistantly planted at 8cm distance from the centre was used. The pot was covered with a cylindrical mylar film cage (50cm x 20cm) having a fine-mesh nylon net at the top. Fifty second instar nymphs obtained from mass culture were released into each cage and the number of nymphs settled on different rice cultivars was recorded at 2, 4, 8, 24, 48, 72 hours after alighting without any disturbances. The experiment was set up in a completely randomized design with five replications, each pot represented a replicate and the percentages of nymphs settling at different time intervals on rice cultivars were calculated. For settling of adults, methodology and experimental design were the same as in the case of nymphs. Four day old fifty brachypterous gravid females were introduced into the centre of each pot. The number of females that alighted on plants of each tested cultivars were recorded at 1, 2, 4, 8, 12, 24, 48, 72h and the percentages of adults settling at different time intervals on rice cultivars were calculated.

Feeding response of adult female hoppers was ascertained on their excretion of honeydew (Heinrichs *et al.* 1985). Newly emerged brachypterous females were starved for 4 hours at 28^0C in an incubator with moist filter paper. Then each of the females was weighed and enclosed singly in an air tight parafilm sachet, which was attached to the base of the plant representing one replicate. After 24 hours feeding, the hopper was removed from the sachet and kept separately in a small glass vial. The hoppers were then anesthetized keeping the vials on ice and weighed separately. The sachets were weighed with honeydew. The honeydew was then blotted out and the sachet was reweighed after blotting. There were five replications for each cultivar. Each replicate comprised of five females caged individually on five plants placed in a plastic trays containing water over a period of 5 consecutive days.

A separate experiment was conducted to determine the quantity of food ingested and assimilated by *N. lugens*. Newly emerged starved for 2 hours but water satiated brachypterous females were weighed individually on a balance (0.001 mg sensitivity) and enclosed singly in air tight parafilm sachets, through each of which passed the leaf sheath of test plants. After 24 hour, the weight of each female and its excreta was recorded separately. For assessing the loss of insect body weight due to catabolism, a control was similarly established in which the female was given access to a moist cotton swab to prevent desiccation. The amount of food ingested and assimilated by the female was calculated using the method described by Smith *et al*. (1994).

$$\text{Food assimilated} = W_1 \times \frac{(C_1\text{-}C_2)}{C_1} + (W_2\text{-}W_1)$$

Where,

W_1 = Initial weight of insect

W_2 = Final weight of insect

C_1 = Initial weight of control insect

C_2 = Final weight of control insect

Food ingested = Food assimilated + weight of excreta.

There were five replications for each cultivar including control. Each replicate comprised of five females caged individually in an air tight parafilm sachets on five different rice plants of a variety. Data obtained from the experiments were analyzed using computer package program, MTAT-C and means were ranked by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Orientation and settling of brown planthopper nymphs and adults

Significant differences in the settling response of *N. lugens* nymphs on different rice cultivars were evident at different hours after release when allowed for a free choice (Table 1). Starting from 2 hours after release, the percentage of nymphs alighted on different rice cultivars ranged from 14.8 to 24.0%. In the subsequent observations, the percentage of nymphs settled on the susceptible TN1 further increased and decreased on

Table 1. Orientational and settling responses of *N. lugens* nymphs on five rice cultivars after different hours of release in a free choice test

Cultivars	Nymphs (%) settled at different hours of release					
	2	4	8	24	48	72
IR64	24.0 a	22.8 a	27.2 ab	22.8 bc	23.2 b	23.2 b
ARC10550	20.8 abc	20.8 ab	20.8 b	19.6 c	20.0 c	19.2 b
Swarnalata	14.8 c	14.8 c	15.6 c	17.2 d	13.2 d	10.4 c
T27A	16.8 bc	16.0 bc	15.2 c	14.2 d	14.4 d	13.2 c
TN1	23.2 ab	25.2 a	25.6 a	26.4 a	29.6 a	34.0 a

Nymph per cent having same letter(s) in a column did not differ significantly at 5% level of probability resistant cultivars. Swarnalata had the lowest percentage of nymphs at 72 hours after release, indicating the non-preference trait of the cultivar but the highest percentage was on susceptible TN1 (34.0). Swarnalata and T27A had identical percentage of nymphs from 2-72 hours after release. Slower rate of settling of brown planthopper nymphs on resistant rice varieties than that on susceptible ones was reported by Sogawa (1982) while Nanda *et al*. (1999) and Reddy *et al*. (2002) observed greater preference for settling on susceptible cultivars.

Significant differences in the pattern of adults settling on different cultivars were evident after 1 hour of infestation (Table 2). At 1 hour after release, resistant cultivar T27A had 9.2% of adults which was statistically identical with Swarnalata while susceptible TN1 had 36.0% of adults. Starting from 1 hour to 72 hours after infestation, the adults had a tendency to move away from resistant plants indicating the non-preference trait of the cultivar. In subsequent observations (up to 72 hours), there was a reduction in the percentage of adult population on all the resistant cultivars, while there was an increase in case of susceptible TN1. Finally, at 72 hours after release, the lowest percentage of adults settled on T27A while the highest percentage of adults settled on TN1. Similar results of non-preference of *N. lugens* adults on resistant varieties were observed by Nanda *et al*. (1999), Reddy *et al*. (2002) and Zhu *et al*. (2002). Host finding and selection by insects depend on an array of morphological and physio-chemical factors. It also varies between stages of insect and plant growth stages.

Tale 2. Orientational and settling responses of *N. lugens* adults on five rice cultivars after different hours of release in a free choice test

Cultivars	Adult (%) settled at different hours of release							
	1	2	4	8	12	24	48	72
IR64	22.8 b	21.6 b	20.0 b	19.6 b	20.8 b	18.4 b	20.0 b	19.2 b
ARC10550	20.4 b	17.2 c	14.8 c	15.6 b	14.0 c	15.2 bc	14.8 c	14.8 bc
Swarnalata	11.6 c	12.0 d	10.4 d	10.4 c	11.6 c	13.2 cd	10.4 c	9.6 cd
T27A	9.2 c	9.6 d	9.6 d	9.2 c	10.0 c	10.0 d	9.4 d	7.2 d
TN1	36.0 a	40.0 a	45.2 a	45.2 a	44.0 a	43.0 a	45.2 a	49.2 a

Adult per cent having same letter(s) in a column did not differ significantly at 5% level of probability

Feeding responses of N. lugens

The amount of feeding by adult female for 24 hours on different rice cultivars, as measured by excreted honeydew differed significantly (Table 3). The lowest amount of excreted honeydew was on resistant cultivar T27A (2.1mg), followed by IR64 (7.2mg), ARC10550 (8.9mg) and Swarnalata (12.6 mg) and the highest was on susceptible TN1 (19.8mg). This study indicated that the female fed less and excreted less honeydew on resistant rice cultivars. Adiroubane and Letchoumanane (2000) showed the similar results in *N. lugens* with the rice cultivars. Lesser feeding of brown planthopper on resistant varieties was also reported by Zeng *et al*. (2000) and Zhu *et al*. (2002). As a result of feeding, the insects gained more weight on susceptible cultivar TN1 (42.0%) than that on the resistant cultivar T27A (8.3%). However, weight gain on Swarnalata (29.2%), ARC10550 (39.6%), IR64 (28.9%) and TN1 (42.0%) was comparable (Table 3). Similar finding was reported by Xiao *et al*. (2002), who observed that the female adult gained less weight on the resistant rice cultivars compared to susceptible TN1.

Table 3. Honeydew excretion, change in body weight, ingestion and assimilation of food by brown planthopper female adults from feeding on different rice cultivars

Cultivars	Honeydew excreted (mg)	% weight gain	Food ingested (mg)	Food assimilated (mg)/female/day
IR64	7.2 c	28.9 a	7.9 c	0.8 b
ARC10550	8.9 c	39.6 a	9.9 bc	1.0 b
Swarnalata	12.6 b	29.2 a	13.3 b	0.7 b
T27A	2.1 d	8.3 b	2.4 d	0.3 c
TN1	19.8 a	42.0 a	21.2 a	1.4 a

Weight having same letter(s) in a column did not differ significantly at 5% level of probability

The quantity of food ingested by brown planthopper female adult was found to be significantly lowest on T27A (2.4mg) followed by IR64 (7.9mg) and ARC10550 (9.9mg) whereas the highest was on susceptible TN1 (21.2mg). Ingestion of food by the female was also significantly reduced on all the rice cultivars compared with TN1 (Table 3). Khan and Saxena (1988) reported reduced quantities of food ingestion from resistant variety than on susceptible ones. It is evident from the present study that food intake by *N. lugens* was significantly less on resistant cultivars than on susceptible TN1.

The amount of food assimilated by *N. lugens* was found to be significantly highest on susceptible TN1 (1.4mg) and lowest on resistant T27A (0.3mg). The female assimilated comparable less food on all the resistant rice cultivars IR64 (0.8mg), ARC10550 (1.0mg), Swarnalata (0.7mg) than the susceptible TN1 (Table 3). The results were in agreement with the report of Adiroubane and Letchoumanane (2000) who found comparatively low ingestion and assimilation of food by the insects in the resistant cultivars than the susceptible TN1. Ingestion and assimilation of food are the most important behavioral and physiological responses of insects.

CONCLUSION

Brown planthopper was found to show non preference reaction to resistant rice cultivars for orientation and settling. Ingestion as well as assimilation of food by female hopper was much lower on resistant T27A as compared to those on susceptible TN1.

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