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# Comparative study on varietal resistance to rice green leafhoppers *Nephotettix virescens* (Distant) and *N. nigropictus* (Stål)

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**Abstract.** Employing three different methods, 108 rice varieties were screened for resistance against *N. virescens* and *N. nigropictus*. In mass screening test, 76 varieties suffered significantly less damage by *N. virescens*, while *N. nigropictus* caused less damage to 72 varieties. Ten varieties *viz*. Ptb 2, Ptb 18, Ptb 7, Khama 49/8, Ptb 21, DS 1, ARC 6049, Khama 49/2, ARC 10243 and Jhingasail were greatly detrimental to insect bionomics in the studies using first instar nymphs and newly emerged adults. Adult longevity test could be a good criterion to identify the high degree of resistance in the varieties. From an overall assessment, Ptb 18, Ptb 2 and Ptb 7 were identified as highly resistant to both the species.

**Keywords.** *N. virescens*; *N. nigropictus*; mass screening test; varietal resistance.

## 1. Introduction

Intensification of rice cultivation in the last two decades has greatly altered the magnitude of insect pest problems in tropical Asia. Among the several species of rice leafhoppers, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stål) are the most predominant and widespread. Both are serious pests causing crop damage by direct feeding or indirectly by transmitting some important virus diseases.

Green leafhoppers feed on the leaves or upper parts of the rice plant. Frequently they occur in large number causing significant crop losses, estimated as 50 to 80% in Bangladesh (Alam and Islam 1959) and Vietnam (Tao 1962). Besides this, tungro epidemics have been reported from India (John 1968; Raichaudhuri *et al* 1970), Philippines (Pathak 1972) and Indonesia (Reddy 1973). Tungro outbreaks have been attributed to a heavy build-up of the vector population. The general change in vector population has been attributed to the shift to the growing of short statured, heavy tillering rice varieties and use of greater quantities of nitrogenous fertilizers (Pathak 1973; Kalode 1974).

Crop protection is now based on pest management principles involving a greater understanding and implementation of population regulating factors such as cultural control, growing of resistant varieties etc. Although earlier workers (Pathak *et al* 1969; Shastry *et al* 1971; Misra *et al* 1975; Veronica and Kalode 1983) identified some of the donors against green leafhoppers, recent indications of biotypes (populations) in the gall midge (in India) and brown planthopper (Philippines) in rice suggest need of further intensive testing of known donors to existing populations of green leafhoppers prior to their utilization in breeding programme. Efforts were therefore made to evaluate critically a few selected donors by adopting different parameters with a view to identifying donors with high degree of resistance to both the species. Utilization of such resistant donors in developing superior genotypes of rice would generate material with greater stability of performance in areas endemic to these pests.

## 2. Material and methods

*N. virescens* and *N. nigropictus* adults were collected from the experimental plots at the national headquarters of the All India Coordinated Rice Improvement Project (AICRIP), Hyderabad, India. The species were isolated and pure colonies maintained in the greenhouse on potted plants of the susceptible variety, Taichung Native 1 (TN 1), in separate rearing cages (70 × 62 × 75 cm). Insect cultures were maintained by caging gravid females on plants for a short period which provided age-specific populations for different experiments.

With the objective of identifying varieties resistant to both the species of green leafhoppers 108 varieties which were known to have some degree of resistance either to *N. virescens* or *N. nigropictus* were selected. They included 41 cultivated varieties, 27 cultures of hybrid origin and 30 cultivars from the Assam Rice Collection. The seeds were obtained from AICRIP, Hyderabad, the Central Rice Research Institute (CRRI), Cuttack and the International Rice Research Institute (IRRI), Philippines. Varietal resistance was judged using the following criteria.

### 2.1 *Mass screening test*

Varieties were grown in rows at a distance of 3 × 4 cm in wooden trays (50 × 40 × 8 cm). Each tray had 10 randomly-planted test varieties, including the susceptible check, TN 1. There were three replications for each test. When seedlings were 10 days old, the trays were placed individually in screening cages. Each variety was thinned to 10 seedlings per row. Three day-old 400 adults (sex ratio 1 : 1) were then released on each tray and insects settled on individual seedling were counted at 6, 18, 24 and 42 hr after release. Test varieties were scored for damage reaction when TN 1 (the susceptible check) had scored 6, by adopting a scoring system developed by the authors for critical evaluation. Based on damage symptomatology and insect settling behaviour on different plant parts, the scoring values were given as 1 for first leaf, 2 for second leaf, 3 for third leaf and 2 for stem.

In case of initiation of wilting or yellowing, only half the score of the particular leaf was considered. In a condition where the first leaf was completely wilted and also the second leaf, the total score of the plant was reckoned as $1 + 2 = 3$. If the third leaf was also partially wilted, the score would be $1 + 2 + 1{\cdot}5 = 4{\cdot}5$. If the plant was dead, the score was $1 + 2 + 3 + 2 = 8$. All the seedlings were scored individually for damage reaction, and the average score for the test variety was worked out. For comparison of different test entries damage index was calculated as follows:

$$\text{Damage index} = \frac{\text{Average score of test variety} \times 100}{\text{Average score of TN 1}}$$

As soon as the final damage scoring was completed, the plants were dissected to count the number of eggs laid. Data on damage index were analysed and the following criterion was used for comparison. Entries showing significantly less damage than susceptible check TN 1 were designated as 0, while entries showing no significant difference than TN 1 were rated as 1.

2.2 *Antibiosis*

Cellulose butyrate cages with muslin cloth windows were used for caging nymphs or adults separately on individual 20 day-old test plants.

2.2a *Nymphs*: Five first instar nymphs were caged on individual plants and seven replications were maintained for each test variety. Insect survival was recorded at three-day intervals until nymphs became adults. Growth-index was the criterion used for comparison. The growth-index was calculated by dividing the percentage of the nymphs becoming adults with the average developmental period and entries were scored as follows.

| *Growth-index* | *Score* |
|---|---|
| 0 | 0 |
| 0·1 to 1 | 1 |
| 1·1 to 2 | 2 |
| 2·1 to 3 | 3 |
| 3·1 to 4 | 4 |
| 4·1 to 5 | 5 |

2.2b *Adults*: Ten pairs of males and females (2-day old) were caged on individual plants and observations on their survival, longevity and oviposition were recorded. The entries were classified on the basis of adult longevity by assigning the following scores for comparison.

| *Adult longevity (days)* | *Score* |
|---|---|
| 0 to 5 | 0 |
| 5·1 to 10 | 1 |
| 10·1 to 15 | 2 |
| 15·1 to 20 | 3 |

Final classification of the varieties was based on the cumulative score obtained under the above three criteria for determining the degree of resistance.

| *Score* | *Classification* |
|---|---|
| 0 to 1 | Highly resistant |
| 2 to 3 | Resistant |
| 4 to 5 | Moderately resistant |
| Above 5 | Susceptible |

## 3. Results and discussion

Studies on insect plant relationship were conducted under greenhouse conditions to identify varieties highly resistant to both species of green leafhoppers, *N. virescens* and *N. nigropictus*. One hundred and eight rice varieties were included.

3.1 *Mass screening tests*

Progressive damage symptoms in the susceptible variety, TN 1, at the 3-leaf stage indicated that the damage symptoms caused by green leafhoppers progressed from the first, second and third leaf. Insect settling behaviour was not related to the degree of damage. However, more hoppers settled on the second leaf, followed by third leaf, stem and first leaf. Based on these results, various scores were assigned to different plant parts as described earlier.

Mass screening of 108 entries conducted in 12 separate sets revealed that 76 and 72 varieties were significantly less damaged than TN 1 by *N. virescens* and *N. nigropictus*, respectively. In general, *N. nigropictus* inflicted greater damage than *N. virescens* to the same varieties (table 1). This could be attributed to more feeding punctures made because of the less preference of the host (Viswanathan and Kalode unpublished). By adopting similar mass screening test, Rapusas and Heinrichs (1982) identified IR 24, IR 28, IR 29, IR 30 and IR 34 as resistant to *N. virescens*.

Preferential settling of the insects in relation to damage was not greatly significant. Similarly, egg laying was also not related to the extent of damage caused to the variety. However, the non-preference mechanism observed in some cases appeared to be of a gustatory nature. This was evident from the fact that even highly resistant varieties like Ptb 2, Ptb 18 and Ptb 7 were damaged to some extent (table 1) but while doing so both the species excreted less honey dew when fed on these varieties (Viswanathan and Kalode unpublished).

### 3.2 *Antibiosis*

3.2a *Nymphs*: varieties varied greatly in nutritional suitability and for nymphal development of test insects. On a majority of the test varieties a small percentage of *N.*

**Table 1.** Preferential damage indices, number of adult insects settled and number of eggs laid by *N. virescens* (*N.v.*) and *N. nigropictus* (*N.n.*) under mass screening tests on selected rice varieties*.

| | Preferential damage index | | Insects settled (Average number) | | Eggs laid (Average number) | |
|---|---|---|---|---|---|---|
| Variety | *N.v.* | *N.n.* | *N.v.* | *N.n.* | *N.v.* | *N.n.* |
| Ptb 2 | 37 | 58 | 3 | 3 | 3 | 2 |
| Ptb 18 | 6 | 44 | 2 | 3 | 4 | 3 |
| Ptb 7 | 4 | 49 | 3 | 4 | 5 | 3 |
| Khama 49/8 | 13 | 51 | 3 | 5 | 3 | 2 |
| ARC 10243 | 15 | 61 | 3 | 4 | 5 | 2 |
| Jhingasail | 13 | 61 | 4 | 3 | 3 | 3 |
| Kalimekri 391 | 0 | 29 | 4 | 4 | 4 | 2 |
| Godalki | 20 | 35 | 4 | 4 | 5 | 3 |
| ADT 7 | 20 | 27 | 4 | 3 | 4 | 3 |
| CO 9 | 62 | 51 | 14 | 17 | 7 | 3 |
| Sukali | 68 | 89 | 4 | 4 | 2 | 5 |
| Vijaya | 37 | 46 | 14 | 9 | 7 | 3 |
| Ptb 10 | 45 | 81 | 4 | 3 | 4 | 4 |
| Kataribhog | 84 | 80 | 4 | 4 | 4 | 3 |
| TN 1 (S. check) | 100 | 100 | 4 | 5 | 4 | 2 |

*The data were taken from 12 separate experiments. The statistical analysis was done experimentwise and hence not given here.
(S. check) = susceptible check.

*nigropictus* nymphs reached the adult stage and the growth-index-values were less when fed on susceptible varieties (Ptb 10, Kataribhog and TN 1) as compared to *N. virescens* (tables 2 and 3). Thus *N. nigropictus* is not so well adapted to rice as *N. virescens*. The varieties, Ptb 18, Ptb 2 and Ptb 7, exhibited a high degree of antibiosis with high mortality of first instar nymphs of both *N. nigropictus* and *N. virescens* within 10 days suggesting a common resistance mechanism in these varieties. Studies conducted at IRRI have shown that many varieties possessed high degree of resistance to *N. virescens* comparable to the above varieties (Cheng and Pathak 1972). But in our study there was a greater survival on the same varieties indicating probable differences in pest biotypes (table 4). The present report is perhaps the first one of such type of variations in the case of green leafhopper reaction between two countries. However, the varieties Khama 49/8, DS 1, Khama 49/2 and Jhingasail were resistant both at AICRIP and IRRI. Recent studies conducted by Karim and Pathak (1979) also revealed the susceptibility of Pankhari 203, ASD 7, IR 8 and ASD 8 in Bangladesh to *N. virescens*. Based on these studies it is concluded that the physiological races (biotypes) of *N. virescens* differ in Philippines and Bangladesh. Although similar reports are available, of late, from different countries, repeated investigations with selected common sets of differentials are needed to ascertain biotypic variations, if any, in the pest populations.

3.2b *Adults*: Newly emerged adults survived for only 3 to 6 days on highly resistant varieties and for 8·4 to 13·4 days on resistant varieties as compared to 16 to 20·1 days survival on TN 1. The surviving insects also laid fewer eggs on both resistant and highly resistant varieties than on the susceptible check (table 5). This indicates that adult

**Table 2.** Survival and development of *N. virescens* nymphs on selected rice varieties.

| Variety | Percentage survival of 1st instar nymphs after days | | | Average developmental period (days) | Growth index |
|---|---|---|---|---|---|
| | 3 | 9 | 18 | | |
| Ptb 2 | 9 | — | — | — | 0·0 |
| Ptb 7 | 74 | 0 | — | — | 0·0 |
| Ptb 18 | 34 | — | — | — | 0·0 |
| Khama 49/8 | 51 | 23 | 6 | 19·5 | 0·2 |
| ARC 10243 | 100 | 57 | 11 | 17·2 | 0·6 |
| Jhingasail | 77 | 54 | 14 | 16·2 | 0·9 |
| Kalimekri 391 | 89 | 74 | 11 | 19·4 | 0·6 |
| Godalki | 89 | 69 | 26 | 19·1 | 1·3 |
| ADT 7 | 100 | 77 | 13 | 18·6 | 1·6 |
| CO 9 | 97 | 69 | 31 | 18·0 | 1·7 |
| Sukali | 97 | 66 | 17 | 17·7 | 0·9 |
| Vijaya | 80 | 49 | 31 | 13·7 | 2·2 |
| Ptb 10 | 100 | 74 | 40 | 14·1 | 2·8 |
| Kataribhog | 100 | 97 | 51 | 15·6 | 3·2 |
| TN 1 (S. check) | 100 | 89 | 86 | 16·2 | 5·2 |

— indicates no survival in earlier observation.

**Table 3.** Survival and development of *N. nigropictus* nymphs on selected rice varieties.

| Variety | Percentage survival of 1st instar nymphs after days 3 | 9 | 18 | Average developmental period (days) | Growth index |
|---|---|---|---|---|---|
| Ptb 2 | 6 | — | — | — | 0·0 |
| Ptb 7 | 83 | 0 | — | — | 0·0 |
| Ptb 18 | 89 | — | — | — | 0·0 |
| Khama 49/8 | 89 | 29 | 14 | 20·2 | 0·7 |
| ARC 10243 | 100 | 51 | 20 | 20·2 | 1·0 |
| Jhingasail | 80 | 43 | 20 | 19·2 | 1·0 |
| Kalimekri 391 | 91 | 69 | 23 | 19·3 | 1·1 |
| Godalki | 94 | 60 | 9 | 19·6 | 0·4 |
| ADT 7 | 94 | 66 | 34 | 17·5 | 1·9 |
| CO 9 | 100 | 83 | 29 | 17·8 | 1·6 |
| Sukali | 97 | 80 | 40 | 17·8 | 2·2 |
| Vijaya | 74 | 46 | 26 | 16·5 | 1·5 |
| Ptb 10 | 86 | 54 | 29 | 15·5 | 1·8 |
| Kataribhog | 100 | 80 | 49 | 18·5 | 2·6 |
| TN 1 (S. check) | 91 | 69 | 51 | 16·5 | 3·1 |

— indicates no survival in earlier observation.

**Table 4.** Differential reaction of selected rice varieties to green leafhoppers at IRRI (Philippines) and AICRIP (Hyderabad).

| Variety | IRRI* % Nymphal survival after 22 days of caging: *N. virescens* | AICRIP % Nymphal survival after 22 days of caging: *N. virescens* | AICRIP: *N. nigropictus* |
|---|---|---|---|
| DK 1 | 0 | 37 | 29 |
| UPC 122 | 1 | 29 | 51 |
| DV 139 | 0 | 34 | 23 |
| DNJ 27 | 0 | 26 | 14 |
| IR8 | 0 | 37 | 43 |
| Intan 2400 | 0 | 57 | 23 |
| MAS | 0 | 34 | 14 |
| Pankhari 203 | 7 | 51 | 43 |
| TN 1 (S. check) | 90 | 69 | 54 |

* Data from Cheng and Pathak (1972).

longevity test could be a good parameter for detection of high level of resistance to green leafhopper in rice varieties.

The overall reaction based on the three parameters of the entries used showed that Ptb 2, Ptb 18 and Ptb 7 could be classified as highly resistant, while varieties Khama

**Table 5.** Longevity and oviposition of *N. virescens* and *N. nigropictus* adults on selected rice varieties.

| Variety | *N. virescens* Average longevity (days) Female | Male | Average number of eggs laid |
|---|---|---|---|
| Ptb 2 | 4·4 | 4·6 | 10·5 |
| Ptb 18 | 4·1 | 3·0 | 0·0 |
| Ptb 7 | 5·2 | 4·5 | 6·3 |
| Khama 49/8 | 12·3 | 10·4 | 29·3 |
| ARC 10243 | 13·4 | 12·1 | 53·1 |
| Jhingasail | 12·4 | 10·6 | 44·7 |
| Kalimekri 391 | 9·5 | 8·4 | 27·2 |
| Godalki | 14·3 | 12·8 | 58·1 |
| ADT 7 | 17·0 | 16·1 | 69·3 |
| CO 9 | 15·6 | 16·0 | 65·5 |
| Sukali | 14·3 | 13·3 | 46·4 |
| Vijaya | 15·0 | 15·6 | 61·1 |
| Ptb 10 | 18·4 | 16·8 | 93·8 |
| Kataribhog | 16·3 | 14·2 | 88·1 |
| TN 1 (S. check) | 20·1 | 19·1 | 137·0 |

| Variety | *N. nigropictus* Average longevity (days) Female | Male | Average number of eggs laid |
|---|---|---|---|
| Ptb 2 | 5·0 | 5·0 | 16·2 |
| Ptb 18 | 4·2 | 4·0 | 2·5 |
| Ptb 7 | 6·4 | 5·8 | 10·2 |
| Khama 49/8 | 10·2 | 10·5 | 29·4 |
| ARC 10243 | 9·8 | 8·4 | 59.4 |
| Jhingasail | 11·1 | 9·4 | 27·1 |
| Kalimekri 391 | 12·4 | 11·7 | 32·6 |
| Godalki | 13·4 | 9·9 | 42·5 |
| ADT 7 | 14·2 | 13·8 | 56·1 |
| CO 9 | 15·2 | 16·7 | 53·5 |
| Sukali | 11·7 | 10·2 | 33·6 |
| Vijaya | 15·1 | 14·2 | 53·8 |
| Ptb 10 | 16·7 | 15·8 | 73·3 |
| Kataribhog | 14·2 | 11·6 | 45·2 |
| TN 1 (S. check) | 17·8 | 16·0 | 89·4 |

**Table 6.** Overall performance of selected rice varieties for resistance or susceptibility to *N. virescens* and *N. nigropictus*.

| | *N. virescens* | | | | | *N. nigropictus* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variety | Damage index | Growth index | Adult longevity | Total score | Class | Damage index | Growth index | Adult longevity | Total score | Class |
| Ptb 2 | 0 | 0 | 0 | 0 | HR | 0 | 0 | 0 | 0 | HR |
| Ptb 18 | 0 | 0 | 0 | 0 | HR | 0 | 0 | 0 | 0 | HR |
| Ptb 7 | 0 | 0 | 0 | 0 | HR | 0 | 0 | 1 | 1 | HR |
| Khama 49/8 | 0 | 1 | 1 | 2 | R | 0 | 1 | 2 | 3 | R |
| ARC 10243 | 0 | 1 | 2 | 3 | R | 0 | 1 | 1 | 2 | R |
| Jhingasail | 0 | 1 | 2 | 3 | R | 0 | 1 | 2 | 3 | R |
| Kalimekri 391 | 0 | 1 | 1 | 2 | R | 0 | 2 | 2 | 4 | MR |
| Godalki | 0 | 2 | 2 | 4 | MR | 0 | 1 | 2 | 3 | R |
| ADT 7 | 0 | 2 | 2 | 4 | MR | 0 | 2 | 2 | 4 | MR |
| CO 9 | 0 | 2 | 3 | 5 | MR | 0 | 2 | 3 | 5 | MR |
| Sukali | 1 | 1 | 2 | 4 | MR | 1 | 3 | 2 | 6 | S |
| Vijaya | 0 | 3 | 3 | 6 | S | 0 | 2 | 2 | 4 | MR |
| Ptb 10 | 0 | 3 | 3 | 6 | S | 1 | 2 | 3 | 6 | S |
| Kataribhog | 1 | 4 | 3 | 8 | S | 1 | 3 | 2 | 6 | S |
| TN 1 (S. check) | 1 | 5 | 3 | 9 | S | 1 | 3 | 3 | 7 | S |

HR = Highly resistant; R = resistant; MR = Moderately resistant; S = susceptible.

49/8, Ptb 21, DS 1, ARC 6049, Khama 49/2, ARC 10243 and Jhingasail as resistant to both green leafhoppers. On the other hand, 21 varieties were susceptible, while 77 lines indicated differential reactions (only representative entries are given in table 6). The present studies revealed that varieties highly resistant to one green leafhopper species could also be highly resistant to the other green leafhopper species.

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