Proc. Indian natn. Sci. Acad. B **44**, pp. 43-48 (1978)

Entomology

STUDIES ON THE PATTERN OF RESISTANCE TO BROWN PLANTHOPPER *(NILAPARVATA LUGENS)* IN SOME RICE VARIETIES

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(Communicated by DR N. C. PANT, F.N.A.)

(Revised 4 *September* 1976 *; after revision* 17 *October* 1977)

Studies on the pattern of resistance in some resistant/tolerant varieties, viz. P.b 33, Ptb 21, Leb Muey Nahng, ARC 6650 and CR 57-MR 1523 indicated that less number of brown planthopper nymphs had settled on resistant/tolerant varieties than on susceptible variety $T(N)_1$. The nymphal survival and population build up was also adversely affected to varying degrees on these varieties. Ptb 33 was least preferred and also showed a high degree of antibiosis. Six to seven days old nymphs had greater feeding capacity compared to insects of other ages. The tolerant varieties at all stages of growth studied showed high degree of tolerance even under a high insect population pressure.

INTRODUCTION

The brown planthopper *Nilaparvata lugens* (stal.) is one of the major pests of rice in South and South-East Asia, China, Japan, Korea and Australia. Recently damage caused by this pest in several parts of India has aroused considerable alarm. Kalode (1976) and Krishna *et al.* (1977) had indicated significant varietal differences in their resistant reaction to *N. lugens*. The evolving of high-yielding lines, combined with resistance, is likely to keep its population low.

Mudgo was observed (Pathak *et al.* 1969) to be resistant in Philippines and, also reported to exhibit antibiotic effects like higher nymphal mortality, delayed nymphal development, emergence of small-size adults and lower rate of reproduction on brown planthopper. No detailed information of this nature is available on the mechanism of resistance to brown planthopper in India. Studies were undertaken to understand the nature of resistance in some of the varieties identified at the All-India Coordinated Rice Improvement Project, Hyderabad, to brown planthopper. Additional experiments were also conducted to study the resistance mechanism using insects in their different stages of development as well as rice varieties at various stages of plant growth.

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MATERIALS AND METHODS

Preference

Ptb 33, Ptb 21, ARC 6650, Leb Muey Nahng and CR 57-MR 1523 possessing varying degrees of resistance and a susceptible check, Taichung (Native)$_1$ were grown in rows (35 cm long and 6 cm apart arranged randomly) in four wooden trays (50 × 40 × 8 cm) containing puddled soil. Each tray represented one replication. Apart from the test varieties, additional row of T(N)$_1$ was also grown on either side of the tray. One to three days old nymphs of *N. lugens* were released per seedling on an average, on one week old seedlings. After 24 hr of release, the number of nymphs on each of the seedlings was counted to know whether the insects had any preference for the varieties under test.

Antibiosis

To study antibiosis reaction, 10 plants each of the five resistant and tolerant varieties and a susceptible T(N)$_1$ were grown separately in clay pots. When the seedlings were 30 days old, each seedling was caged with a clear propionate tube (5 × 45 cm) which was provided with fine mesh screen windows. The plants were later infested with 10 freshly hatched nymphs. Mortality of nymphs was noted daily till they became adults. The adults were then transferred to the fresh plants (45 days old) of the respective variety for egg laying. The nymphs, hatching out from such plants, were counted and removed every alternate day.

Effects of different ages of the insects on the reaction of rice varieties

Insects of three ages, viz. 1-2 days, 6-7 days and 14-15 days (adults) and five susceptible varieties (T(N)$_1$, RPW, 6-13, RP 31-49-2, RP 9-4, RP 9-6) and a tolerant variety CR 57-MR 1523 were taken. The varieties were grown in wooden trays and the treatments were replicated 5 times. When the seedlings were 14 days old, individual seedlings were caged with 15 insects. Individual seedling was scored daily for damage reaction until the susceptible test varieties were completely killed.

Effects of different levels of nymphal population on different ages of the varieties

Two rice varieties, CR 57-MR 1523 (tolerant) and T(N)$_1$ (susceptible) were grown in wooden trays. The varieties in different ages were infested with different numbers of 1 to 3 days old nymphs per seedling under suitable cages as indicated in Table III. Observations on the extent of damage were taken when T(N)$_1$ plants were killed and also 15 days later to know the effects of continued infestation on the tolerant variety. Ten replications were maintained per treatment.

In another experiment, six resistant/tolerant varieties (Ptb 33, ARC 6650, Umsum, Ptb 21, CR 57-MR 1523 and Leb Muey Nahng) were grown in four replications for each age group separately in wooden trays. The T(N)$_1$ seedlings were also grown in the middle as well as on both the borders. When the seedlings were

10, 30, 45 and 60 days of age, large population of nymphs was released in wooden trays so that each plant had insect population approximately the same corresponding to its age (10, 30, 40 and 60 insects respectively). Observations on damage reaction were taken when all plants of $T(N)_1$ were killed.

Results and Discussion

Mechanism of insect resistance in crop plants has been broadly grouped into (i) preference or non-preference, (ii) antibiosis, and (iii) tolerance (Painter, 1951).

Preference and non-preference

Twenty-four hours after infestation significant differences were observed in the number of nymphs recorded on different varieties (Fig. 1). The variety $T(N)_1$ attracted more number of nymphs than all other varieties indicating varietal preference. Lowest number of insects had settled on Ptb 33 followed by Ptb 21, ARC 6650, CR 57-MR 1523 and Leb Muey Nahng. The presence of more number of insects on $T(N)_1$ and least number on Ptb 33 suggests the possibility of some attractants in the susceptible variety and their absence in the resistant ones, which requires further study.

Antibiosis

(a) *Survival of one-day old nymphs on resistant and susceptible varieties*

The survival of nymphs on the resistant and susceptible varieties varied significantly 10 days after caging (Fig. 2). On 20th day of release the survival

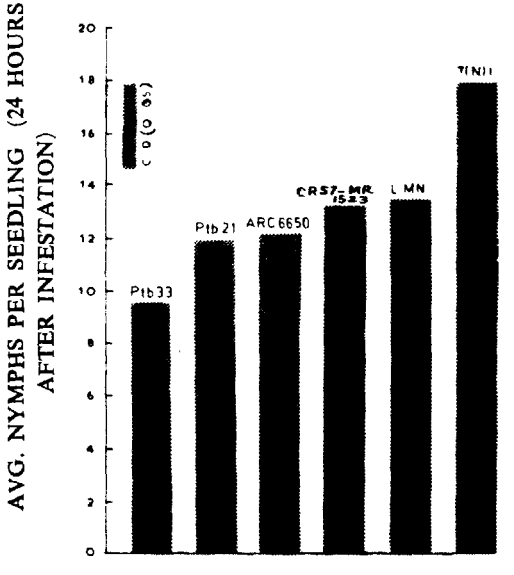

FIG. 1. Relative host reference of Brown Planthopper nymphs on seedlings of selected rice varieties.

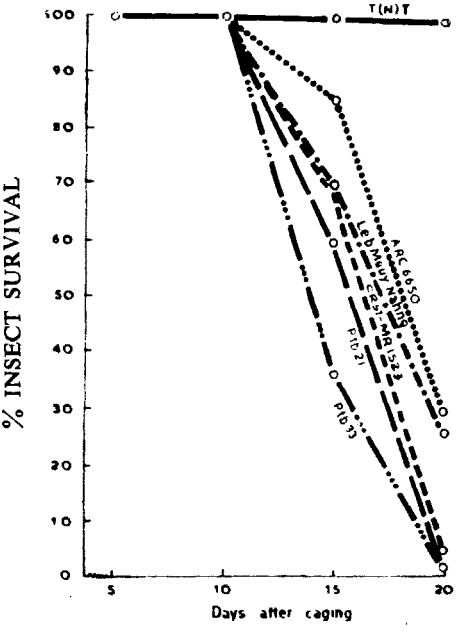

FIG. 2. Survival rate of newly hatched nymphs of BPH on resistant and susceptible varieties.

of nymphs was 97·9% on $T(N)_1$, while it was as low as 2·8, 3·3 and 4·8% on Ptb 33, Ptb 21 and CR 57-MR 1523, respectively. Leb Muey Nahng and ARC 6650 were intermediate (26·1 and 29·2% insects survival respectively).

The insects had no choice but to feed on the plants on which they were caged. The knowledge on the precise factor for resistance as indicated by lower survival of nymphs is still lacking.

(b) *Population development of brown planthopper on tolerant and susceptible varieties*

Significant differences in the population build-up were observed when the insects were allowed to feed continuously for 35 days on resistant and susceptible varieties (Table I). The population increase on tolerant varieties like Ptb 33, Ptb 21 and CR 57-MR 1523 was significantly lower in number ranging from 189 to 200 nymphs compared to 7401 progenies produced on $T(N)_1$. The population developed on $T(N)_1$ was approximately 9·5 times more than that produced on Ptb 33. The rate of nymphal development was also relatively slow on Ptb 21, Ptb 33, CR 57-MR 1523 and Leb Muey Nahng which was evident from the fact that only 15 to 37 per cent nymphs reached the adult stage 14 days after infestation while 61 per cent adults developed on $T(N)_1$. Comparatively more females were recorded on susceptible variety $T(N)_1$. The females were bigger in size. The adverse effects were apparent in case of females and nymphs which were allowed to feed on the tolerant varieties. Similar effects were earlier reported by Kalode (1971) in case of brown planthopper where the population build-up was much less on Mudgo, a relatively resistant variety as compared to $T(N)_1$.

TABLE I

Extent of population build-up from 100 brown planthopper nymphs caged on selected varieties for 35 *days*

Varieties	% adults at 14th day	% females 20 days after release	35 days after infestation		Remarks
			Total number of progenies	Average nymphs/ females	
Ptb 33	18	13	200	15·3	Adults feebly developed.
CR 57-MR 1523	20	9	189	21·0	Females feebly developed, irregular development of nymphs.
Ptb 21	15	9	197	21·8	-do-
Leb Muey Nahng	37	31	1300	41·9	Irregular development of nymphs. Females small in size.
ARC 6650	53	45	3105	69·0	Normal and healthy development of females.
$T(N)_1$	61	52	7401	142·3	-do-
C.D. (0.05)	2·14	3·14	201·91		

Effect of insects of different ages on tolerant and susceptible varieties

It is evident from the data presented in Table II that the extent of damage was higher with 6-7 days old nymphs as compared to other two age groups studied. The maximum average time (10 to 12 days) to cause complete damage in susceptible varieties was taken by 1-2 days old nymphs followed by adults while

TABLE II

Time taken by different test varieties for complete damage with different age group insects

Test variety	Time taken for complete damage (days)		
	1-2-day old nymphs	6-7-day old nymphs	Adults
$T(N)_1$	12·0	4·0	4·4
RP 31-49-2	10·8	4·4	6·2
RP 9-6	10·2	6·2	9·2
RP 9-4	10·2	4·0	5·8
RPW 6-13	10·0	6·0	6·6
CR 57-MR 1523 (Resistant check)	*	*	*

* Complete damage was not observed.

TABLE III

Effect of different levels of brown planthopper nymphal population on tolerant variety, CR 57-MR 1523 at different plant ages

Age of the plant at the time of insect release	No. of insects released per plant	Damage score in CR 57-MR 1523	
		When T $(N)_1$ is killed*	15 days after $T(N)_1$ is killed
10 days	5	0·5	1·6
10 days	10	1·0	2·6
10 days	15	1·2	2·7
15 days	15	0·6	1·2
15 days	20	1·1	2·5
15 days	25	1·2	2·9
20 days	25	0·5	1·2
20 days	30	1·0	1·4
20 days	35	1·3	2·1

* T $(N)_1$ damage score = 5

least time (4 to 6·2 days) was taken by 6-7 days old nymphs indicating greater feeding requirement of the latter group of insects. On tolerant variety, CR 57-MR 1523 also the damage rate recorded was higher with 6-7 days old nymphs. However, CR 57-MR 1523 never suffered from complete damage.

Effect of different levels of nymphal population on different ages of tolerant and susceptible varieties

Variety, CR 57-MR 1523 retained its level of resistance even with increased pressure of insect load on different ages of plant growth (Table III). This variety showed damage score 0.5 to 1.3 when $T(N)_1$ was completely killed (5 damage score). Even with continued infestation for further 15 days, CR 57-MR 1523 never suffered a complete damage. Similarly, Ptb 33, Ptb 21, Leb Muey Nahng, ARC 6650 and Umsum when infested at 10, 30, 45 and 60 days of age did not show any significant damage when susceptible variety $T(N)_1$ of the same age was completely killed. These results confirm the observations made by Krishna *et al.* (1977) with ARC varieties.

ACKNOWLEDGEMENTS

The authors express their sincere thanks to Dr R. Seetharaman, Project Director, for his suggestions and encouragement during the course of investigation.

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