Resistance of Brown Plant Hopper, Nilaparvata Lugens (Stal 1854) to Carbofuran in Different Rice Growing Districts of Sri Lanka

— HEMACHANDRA D. LIYANAGE

Abstract

Resistance of Brown Plant Hopper (BPH) *Nilaparvata lugens* to Carbofuran was studied in the laboratory by comparing LC_{50} values observed for B.P.H. from five rice growing districts of Sri Lanka.

Highest LC_{50} value (0.000666 percent a.i. carbofuran) for BPH from Ampara district showed a highly significant development of resistance compared to four other districts.

Highest susceptibility was shown by BPH from Galle, Kandy and Kegalla districts, LC_{50} values being 0.000340, 0.000365, 0.000354 percent a.i. carbofuran respectively. BPH from Kurunegala LC_{50} being 0.000469 percent a.i. carbofuran did not provide any clear-cut indication of development of resistance demanding further investigations.

Introduction

The Brown Plant Hopper (BPH) *Nilaparvata lugens* (Stal 1854) recently increased in numbers and caused severe yield losses of rice in several tropical countries of Asia, including Sri Lanka.

Many regard the BPH as the number one insect-pest of rice in Asia today, primarily because of the unpredictability of the infestation and the dramatically severe damage (hopper burn) it causes by direct feeding.

Manickavasagar (1975), Fernando (1975), and Dick and Thomas (1975) have reported the extensive damages caused by BPH during the past decade in Sri Lanka.

Control of BPH has depended primarily on the application of insecticides. Of the various leaf-hopper and plant-hopper species that attack rice the BPH, *N. lugens* was reported by Choi and Lee (1976) as one of the most difficult to kill.

Shigo Moria (1977) and Heinrichs (1977) reported resistance of BPH to organo-phosphorus insecticides in Japan.

In 1977 Carbofuran failed to control the BPH at I.R.R.I. fields (I.R.R.I 1978).

Teh-Chi-Chung *et al.* (1981) reported the possibility of inducing carbamate resistance in BPH by laboratory experiments.

The BPH can develop resistance to insecticides within a relatively short period of time with the increase in continuous cropping and in use of insecticides in the tropics causing a real threat to the production of staple food, rice.

The present study was undertaken to observe the relative build-up of resistance of BPH to carbofuran in major rice growing regions of Sri Lanka.

Materials and Methods :

Field samples of BPH adults were collected from five districts namely Galle, Kandy, Kegalle, Kurunegala and Ampara of Sri Lanka.

Each sample from a district consisted of a mixture of three subsamples which were collected from different locations of heavy BPH infestation within each district.

BPH's from each respective district were reared in the laboratory in separate glass chambers to get the first generation of insects for bioassay test. The most susceptible paddy variety B.G. 90-2 seedlings in a nutrient solution were continuously supplied throughout the experiment.

About fifty (50) BPH adults from each of the five districts were respectively introduced to paddy seedlings of 3 weeks' age in chambers and allowed to lay eggs up to 5 days.

The new generation of emerged nymphs were fed to adult stage with fresh seedlings and a control chamber was maintained to measure the RH and temperature during their growth period.

Five concentrations of a.i. carbofuran were prepared using water as media and Furadan (3% GR) as the insecticide, viz. 0.0001%, 0.002%, 0.0005%, 0.001% and 0.005%.

Provided only the roots get contact with insecticide solution, paddy seedlings from nutrient solution were kept in small chambers containing different concentrations of carbofuran. Dry sand was used as the media to support plants in chambers and to avoid contact of BPH with chemical.

A batch of twenty plant hopper adults were introduced to each chamber, and each concentration was used in four replicates for each district.

A control was maintained with no insecticide treatment in the same manner.

Twenty four hours after introduction mortality counts were taken for each concentration.

Results and Discussion :

Results are summarized in tables 1, 2, 3, and 4.
The mortality of BPH of different districts, the effect of different concentrations and concentration population interaction being significant at 0.1% level indicate that the effect of concentration and susceptibility of BPH to carbofuran varies significantly in different districts from which BPH were sampled.

The fact that non-significant differences in mortality and lowest values of carbofuran 0.00034, 0.000354, 0.000365% are respectively for Galle, Kandy and Kegalle districts suggests highest susceptibility of BPH to carbofuran.

BPH from Ampara district having highest LC_{50} value (0.00067% a.i.) and significantly low mortality at 0.1% level compared to above 3 districts represents the highest resistance to carbofuran.

The fact that the mortality of BPH from Kurunegala district differed significantly at 1.0% level compared to Ampara, but 5% level compared to Galle and is non-significant when compared to Kandy and Kegalla demands further research in order to find whether there is an actual build-up of resistance by BPH from the Kurunegala district.

The favourable climate, i.e. high temperature and high RH, for BPH in Ampara district brings frequent heavy attacks of BPH resulting in severe economic losses to the production of rice. Haphazard usage of heavy doses of insecticides, particularly of the carbamate group, by farmers of less knowledge about economic threshold levels might probably have accelerated pest resurgence and a build-up of resistance causing a spiral effect. The infrequent or occasional attacks of BPH in Galle, Kandy and Kegalla warrant less use of insecticides, leading to a lower rate of resistance build-up.

The present study emphasizes the need for further investigations on cross resistance and multiple resistance of BPH to insecticides and also on the presence or absence of distinct geographic populations or biotypes with resistance to insecticides.

Table 1 : Percentage mortality[a] of BPH after 24 hours of treatment with different concentrations of carbofuran[b]:

	Percentage mortality				
Concentration	*Galle*	*Kandy*	*Kegalla*	*Kurunegala*	*Ampara*
0.0000	8.75	7.50	7.50	10.00	7.50
0.0001	17.50	16.25	15.00	13.75	10.00
0.0002	53.75	48.75	45.00	27.50	11.25
0.0005	95.00	92.50	91.67	71.25	40.00
0.001	100.00	100.00	100.00	93.75	78.75
0.005	100.00	100.00	100.00	100.00	100.00

a. Mean percentage mortality of four replicates, each with a batch of 20 insects.
b. Percentage active ingredient, carbofuran. Furadan 3% GR was used to treat roots of paddy seedlings, B.G. 90-2.

Table 2 : LC_{50}[a] values of carbofuran[b] for brown plant hopper (*N. lugens*) from different districts :

District	*LC_{50}*
Galle	0.000340
Kandy	0.000354
Kegalle	0.000365
Kurunegala	0.000469
Ampara	0.000666

a. LC_{50} = Lethal concentration to kill 50 percent of the population.
b. Concentrations of carbofuran (a.i. percentages of furadan 3% GR) BPH adults were introduced to rice seedlings of which only roots were treated.
Temperature variation during experiment 24 - 27°C .
Relative humidity ranged from 70 - 85%.

Table 3 : ANOVA for data of Table 1. (A x B) S Model :

Variance component	*Degree of freedom*	*S.S.*	*M.S.*	*F cal*	*F. tab*
Populations	4	294.417	73.604	24.88***	8.25
Concentration	5	6603.267	1320.653	546.854***	4.42
Conc. x population	20	309.983	15.499	6.418***	2.83
Replicate/Environment	15	44.372	2.958		
Error	75	181.132	2.415		
Total	119	7453.171	62.463		

***Significant at 0.1% level.

Table 4 : t value and associated probability computed for different populations compared:

District compared	*t value*
Galle and Kandy	0.4157NS
Galle and Kegalle	0.6624NS
Galle and Kurunegala	2.425*
Galle and Ampara	5.39***
Kandy and Kegalle	0.246NS
Kandy and Kurunegala	1.997NS
Kandy and Ampara	4.952***
Kegalle and Kurunegala	1.75NS
Kegalle and Ampara	4.7***
Kurunegala and Ampara	2.98**

NS — Not significant
* — Significant at 5% level
** — Significant at 1% level
*** — Significant at 0.1% level.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_1^2 + S_2^2}$$

X_1 Mean of sample 1
X_2 Mean of sample 2
$S^2{}_1$ Variance of sample 1
$S^2{}_2$ Variance of sample 2
N Number of items per sample

References:

1. Dyck, V. A. and Thomas, B. (1979): 'The brown plant hopper problem. Brown plant hopper: Threat to rice production in Asia': IRRI, Los Banos, Philippines p. 11
2. Fernando, H. E. (1975): 'The brown plant hopper problem in Sri Lanka': Rice Entomol. Mewsb 2: p. 24-36.
3. Heinrichs, E. A. (1979): 'Chemical control of the brown plant hopper. Brown plant hopper. Threat to rice production in Asia': IRRI Los Banos, Philippines p. 145-164
4. I.R.R.I (International Rice Research Institute) (1976): Annual Report for 1977. Los Banos, Philippines, p. 207
5. Manickawasagar, P. 1975: 'Brown Plant Hopper - Pest of Rice' Plant protection leaflet. Extension Division, Department of Agriculture, Sri Lanka.
6. Teh-Chi Chung, Chi-Nung sun and Hueilian Kao (1981): 'Induction of carbamate resistance in BPH,.' I.R.R.N. 6: 1 (February 1981) p. 16