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EFFECT OF NITROGEN AND ZINC ON RICE GREEN LEAFHOPPERS, *NEPHOTETTIX* SPP. AND PREY-PREDATOR RELATIONSHIP BETWEEN LEAFHOPPERS AND THEIR PREDATORS

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A significant reduction in rice green leafhopper *(Nephotettix* spp.) population was observed with higher doses of zinc; however increase of pest populations was not significant with higher doses of nitrogen. Abundance of green leafhoppers showed negative correlations with their predator population, namely, spiders, damsel flies and ladybird beetles. Path coefficient analysis revealed that abundance of spiders had the maximum negative effect on green leafhopper abundance, followed by damsel flies. Step-wise regression equations showed the highest relative importance of spiders for their predatory efficiency on rice green leafhoppers, followed by damsel flies.

Key words: Nitrogen and Zinc, *Nephotettix* spp., Correlation matrix, Path analysis.

Introduction

Rice green leafhopper (*Nephotettix* spp.) are the most devastating pests of rice throughout the rice growing areas of Asia [1]. Alam and Islam [2] reported rice crop losses to the tune of 50 – 80% in Bangladesh, by these hoppers.

Rice green leafhopper populations can be kept below economic injury levels by using different cultural practices, chemical insecticides and also with the help of natural enemies prevailing in the rice field.

Ananthakrishnan and Raman [2] reported that plants defended themselves through lower levels of nitrogen. Velusamy *et al.* [4] recorded increased populations of green leafhoppers with increased levels of nitrogen. At present considerable amount of zinc fertilizers are regularly being used by the rice farmers. However, literature dealing with the effect of zinc on rice green leafhopper or other insect pests of rice are lacking in Bangladesh.

Predators are often the most important biological control agents of rice green leafhoppers and among them spiders, ladybird beetles and damsel flies are more important than others [5-8]. According to Shepard *et al.* [8], spiders colonize in rice fields and prey on green leafhoppers at the rate of 2-15 per day, depending on spider species. It was also reported that both the adult and larvae of ladybird beetles fed on eggs, nymphs and adults of leafhoppers. Reissig *et al* . [6] reported that both nymphs and adults of damsel flies were predaceous and feed on leafhoppers. However, correlations and regression equations among prey and its predators and path coefficient analysis on rice pests and their natural enemies have not been done in Bangladesh.

This experiment was undertaken to find out the effect of nitrogen and zinc on rice leafhopper population abundance and interrelationship between leafhoppers and their predators.

Materials and Methods

A field experiment was conducted on farm land of the Bangladesh Agricultural University, Mymensingh, during aman season of 1989 with rice variety BR11. The factorial experiment was laid out in a randomized block design with three replications. Each unit plot was 4.0 x2.5 m in size. Six levels of nitrogen *viz.* 0.50, 100, 150, 200 and 250 kg/ha (N_0, N_{50}, N_{100}, N_{150}, N_{200}, respectively), and four levels of zinc, *viz.* 0, 5, 10 and 20 kg/ha (Zn_0 , Zn_5 , Zn_{10} , and Zn_{20} respectively), were included as treatments. Nitrogen was applied in the form of urea in split, 1/2 before transplantation, 1/4 at 25 days, and 1/4 at 50 days after transplantation, whereas total zinc was applied in the form of zinc sulphate before transplantation. At a spacing of 25 x 15 cm, 50 day old rice seedling were transplanted using 2 seedlings per hill.

Sampling of green leafhoppers and their predators was done by taking 10 sweeps from each plot with a sweeping net (30 cm. dia.) . The sweeps were taken 35 and 60 days after transplanting. The grain yield (sun dry weight), average number of hoppers and predators of two sampling days were analyzed statistically and mean differences were adjudged with DMRT. To determine the extent of interrelationship among the leafhoppers and their predators, correlations matrix for all possible data combinations was worked out by the method described by Hayes *et al.* [9] . Correlation coefficients were further partitioned into components of direct and indirect effects by path coefficient analysis following Dewey and Lu [10] taking all the characters into consideration. Rice green leafhoppers were considered as resultant variable.

Results and Discussion

The data on the abundance of rice green leafhoppers as influenced by their predators and different doses of nitrogen and zinc are presented in Table 1. Interrelationships among

green leafhoppers and their predators are shown in Tables 2, 3 and 4.

Effect of nitrogen and zinc. Application of nitrogen increased the green leafhopper population in a non-significant way (Table 1). The hoppers were least abundant (6.250/plot) in plot having no nitrogen; however, with the increase of nitrogen doses, population abundance increased. These results are in agreement with the findings of Ananthakrishnan and Raman [3] and Saroja and Raju [11]. However, predator population did not show any statistical difference as there was no relationship with nitrogen fertilizer.

The different doses of zinc showed significant effect on the abundance of green leafhoppers as well as of several predators (Table 1). The highest population of leafhoppers (11.065/plot) was observed in control plots (0 kg zn/ha) and abundance of pest population gradually decreased with increasing levels of zinc. Population of ladybird beetless and spiders showed significant response with variation of the doses of zinc. It might be possible due to the variation of leafhooper population in the rice field.

Prey-predator relationships. Abundance of green leafhoppers showed negative correlations with all the predators and the differences were found to be statistically significant (Table 2). It was revealed that abundance of predators suppressed their prey populations. This corresponds with the views of Shepard *et al.* [8] and Reissing *et al.* [6]. Among the predators' relationship, positive correlations were noticed in damsel fly-spider combination (0.4304), spider-ladybird beetle combination (0.6784), and ladybird beetler -damsel fly combination (0.4546).

TABLE 1. EFFECT OF NITROGEN AND ZINC ON THE ABUNDANCE OF GREEN LEAFHOPPERS AND THEIR PREDATORS.

Fertilizer and dose	Average No. of insects of two different days			
	Green leafhoppers	Damsel flies	Spiders	Ladybird beetles
Nitrogen				
N_0	6.250	2.000	2.333	1.750
N_{50}	8.333	1.167	1.667	0.833
N_{100}	8.083	1.583	1.583	1.250
N_{150}	6.583	2.083	2.083	1.583
N_{200}	8.583	1.583	2.083	1.167
N_{250}	9.083	1.250	1.583	0.833
F test	NS	NS	NS	NS
Zinc				
Zn_0	11.056 a	1.056	1.167 b	0.556 b
Zn_5	8.722 ab	1.778	1.944 ab	1.167 ab
Zn_{10}	5.556 b	2.222	2.444 a	2.000 a
Zn_{20}	5.944 b	1.389	2.000 ab	1.222 ab
F test	*	NS	*	*

* = Significant at 5% level, NS = Not significant. In a column, for Zinc treatment, the figures having common letter(s) do not differ significantly at 5% level of probability.

TABLE 2. CORRELATION MATRIX BETWEEN GREEN LEAFHOPPERS AND THEIR PREDATORS.

Characters	Damsel flies	Spiders	Ladybird beetles	Green leafhoppers
Damsel flies	1.0000	0.4304**	0.4546**	-0.5319**
Spiders		1.0000	0.6784**	-0.7112**
Ladybird beetles			1.0000	-0.6155**
Green leafhoppers				1.0000

** = Significant at 1% level of probability.

TABLE 3. PATH COEFFICIENT ANALYSIS OF VARIOUS PREDATORS CONTROLLING GREEN LEAFHOPPERS.

Characters	Indirect effects through			Correlation with green leafhoppers abundance
	Damsel flies	Spiders	Ladybird beetles	
Damsel flies	-0.2425	-0.2106	-0.0788	-0.5319**
Spiders	-0.1044	-0.4893	-0.1175	-0.7112**
Ladybird beetles	-0.1102	-0.3320	-0.1733	-0.6155**

Residual effect = 0.6453

N.B. Underlined figure denotes the direct effect of the characters on the abundance of rice green leafhoppers.

** = Significant at 1% level.

TABLE 4. STEP-WISE REGRESSION EQUATIONS FOR FINDING OUT RELATIVE IMPORTANCE OF PREDATORS TO GREEN LEAFHOPPER ABUNDANCE.

Step/Regression equation			R2	F Value computed
Step I:				
Y = 12.590	-2.518** (0.298)	XI	0.5058	71.649**
Step II:				
Y=13.443	-2.096** (0.310)	XI-1.006** X2 (0.318)	0.5684	45.430**
StepIII:				
Y=13.518	-1.923** (0.357)	XI -0.672** X2 (0.311)	0.6284	38.330**
-	0.796*X3 (0.380)			

Figures in parentheses below the regression coefficient show the standard errors of the estimated value.

*, Significant at 5% level, **, Significant at 1% level, Y= Green leafhoppers, XI = Spiders, X2 = Damsel flies, X3 = Ladybird beetles.

TABLE 5. EFFECT OF NITROGEN AND ZINC ON THE GRAIN YIELD (Kg/ha) OF BR11 RICE.

Doses of nitrogen	Graind yeield kg/ha	Doses of zinc	Grain yield kg/ha
N_0	2861.67	Z_0	3031.67
N_{50}	3173.33	Z_5	3286.67
Z_{100}	3173.33	Z_{10}	3768.33
Z_{150}	3258.33	Z_{20}	3513.33
Z_{200}	3428.33	–	–
Z_{250}	3343.33	–	–
F -test	NS	–	NS

Path coefficient analysis (Table 3) revealed that spiders had the maximum negative effect (- 0.4893) on the abundance of green leafhoppers, followed by damsel flies (-0.2425). The indirect effect of spiders on leafhoppers through ladybird beetles (-0.1175) and damsel flies (-0.1044), damsel flies through spiders (-0.2106) and ladybird beetles (-0.0788), ladybird beetles through spiders (-0.3320) and damsel flies (-0.1102) were found to be negative. These findings also established spiders as the main predators of rice green leafhoppers. Sasab *et al.* [7] had reported similar results.

Relative contribution of predators. Following the stepwise regression programme, abundance of leafhoppers was regressed separately with each predator. Selection of the first predator was then accomplished by employing the criteria of coefficient of determination (R2) and F-test (Table 4). The relative importance of influencing predators was spider (XI) as per step I. According to step II, damsel flies (X2) were the next important predator in the presence of spiders (XI). According to step III, ladybird beetles were the least important in the presence of spiders and damsel flies. From the F-test, after every step-up procedure, the contribution of spiders and damsel flies were found to be significant at 1% level and that of ladybird beetles at 5% level. Results indicated that the contribution of spiders (50.58%) was the highest (significant) in controlling leafhoppers, followed by damsel flies (6.26%), and ladybird beetles (6.00%) showed the lowest influence on leafhoppers.

The results obtained from the present experiment indicated that the nitrogenous fertilizer showed no significant influence, whereas zinc fertilizer played a significant role in controlling rice green leafhoppers. Moreover, spiders, damsel flies and ladybird beetles showed negative correlation with the abundance of green leafhoppers. Thus, it may be concluded that the use of zinc fertilizers in higher doses in rice field and encouragement of natural enemies such as spiders, damsel flies and ladybird beetles can play a remarkable role in the control of rice green leafhoppers.

Grain yield. The results obtained from the present experiment showed that nitrogenous and zinc fertilizer increased grain yield in a insignificant way (Table 5). These results are in agreement with the findings of Haque and Khan [12] and Jahiruddin *et al.* [13].

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