

INFLUENCES OF MAJOR PESTS OF RICE ON YIELD IN BANGLADESH

M. SHAHJAHAN AND F.A. TALUKDER

Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

(Received January 3, 1994 ; revised September 25, 1994)

Field experiments were conducted during aman season of 1990 with two rice varieties namely, Nizersail and IR20, to determine the influences of pests on rice yield and interrelationship among the attacking pests. Abundance of rice pests showed negative correlations with rice yield. Path coefficient analysis reveals that abundance of *Scirpophaga incertulas* and *Sesamia inferens* (rice stem borers) had the maximum negative direct effect on rice yield. Step-wise regression equations showed the highest relative importance of rice stem borers for their damaging capabilities on rice yield followed by *Dicladispa armigera* (rice hispa).

Key words: Stem borers, Green leafhopper, Rice swarming caterpillar, Rice hispa, Influence of pests, Rice yield.

Introduction

In Bangladesh, rice crop occupies more than 78% of the cropped area and grown round the year [1]. Alam *et al.* [2] reported that more than 100 species of insect-pests infest rice plant and among them 20 species are of major significance.

Determination of correlation matrix, regression equations and path coefficient analysis among rice yield and rice pests is absent in Bangladesh. Such types of approaches are practiced in a large scale by the agronomists and plant breeders [3,4]. This experiment was, therefore, undertaken to find out the interrelationship between rice yield and rice pests.

Materials and Methods

Field trials were laid out in randomized block design with thirty six replications during Jul.-Nov. (aman season), 1990 at the Bangladesh Agricultural University Farm with two rice varieties namely, Nizersail and IR20. The experimental unit plots were 5 × 4m. The populations of four major insect-pests of rice namely, rice stem borers (*Scirpophaga incertulas* and *Sesamia inferens*), rice green leafhoppers (*Nephotettix* spp.), rice swarming caterpillar (*Spodoptera litura*) and rice hispa (*Dicladispa armigera*) were counted after 30 and 50 days of transplantation. Stem borer damage percentages were assessed by counting dead hearts by taking 10 random samples with a wooden plant counter of 0.61 × 0.61 m in size. For rice green leafhopper (nymph and adult), rice swarming caterpillar (larva) and rice hispa (adult), populations were counted by taking 10 random sweeps diagonally from each plot with a sweeping net having a diameter of 30 cm. All average data of two counting days including those of yield of rice varieties tested were analyzed statistically and mean differences were adjudged with Duncan's Multiple Range Test [5]. To determine the extent of interrelationship among the rice yield and rice pests, correlation matrix for all possible data combina-

tions was worked out by the method described by Hayes *et al.* [6]. Correlation coefficients were further partitioned into components of direct and indirect effects by path coefficient analysis originally developed by Wright [7] and later described by Dewey and Lu [8] taking all the characters into consideration. Rice yield was considered as resultant variable. Following the step-wise regression programme, yield of rice was regressed separately with infestation of each insect. Selection of the first independent variable was then accomplished by employing the criterion of coefficient of determination (R^2). The relative importance of each independent variable generated by the step-wise regression programme and the test of significance of this incremental contribution of each variable were accomplished by employing the "F-test" [9].

Results and Discussion

Abundance of pests in rice field. With the increase of plant ages, all the pest populations increase in a significant way (Table 1). The lowest pests abundance were recorded at 30 days of seedling transplantation (30 DAT) and with the advancement of days, population abundance were significantly higher at 50 DAT. Among attacking the pests, green leafhopper population was highest in the present experiment. Between the two rice varieties, higher rate of pest populations, except rice stem borer, were observed on IR20 in both days. Higher yield was recorded in IR20 (15.047 quintal/ha).

Quantitative relationships. Simple correlation coefficients among different insects and yeild of rice have been given in Table 2. The high negative association of rice stem borer with the yield of rice suggested that rice stem borers were the most consistent pest of rice in Bangladesh [10]. The only another negatively significant correlation was found between rice green leafhopper and yield of rice which also showed the major pest status of hoppers in rice field and these results are

also in agreement with the findings of Alam and Islam [11] in which they ranked them in second position in importance to rice stem borer. On the other hand, rice swarming caterpillars showed a negative but lowest correlation which proved them as minor pests of rice crop. Significant and positive correlation among the pests were observed, but, because of the differences in food habits of the four above pests, they are not interpretable.

The estimated correlation coefficient among rice yield and pests tested were partitioned into direct and indirect effects and have been presented by path-coefficient analysis in Table 3. The direct effect of rice green leafhoppers on yield of rice were positive and of relatively lowest magnitude (0.0476). Its indirect effects via rice hispa and rice swarming caterpillar were positive but via rice stem borers it was negative. The rice hispa showed the positive highest direct effect (0.3152) on yield. Its indirect effects via rice green leafhoppers and rice swarming caterpillar were positive but via rice stem borers was negative. Rice swarming caterpillar also showed a positive direct effect (0.2137) and indirect positive effects via rice green leafhopper and rice hispa but negative effect via rice stem borer. Rice stem borer had exerted the maximum negative direct influence (-0.7429) on rice yield whereas its indirect effects via all other tested insects were positive. The result of path-coefficient analysis indicated the maximum direct effect

of rice stem borer on rice yield followed by rice hispa. This findings support the view of Alam *et al.* [10] and Alam [12], where they ranked the stem borer as the most damaging pests of rice. The high residual factor (0.8994) suggests that many parameters such as variety, seed quality, fertilizer, irrigation, intercultural operations which influence the yield of rice, were not included in this study.

Relative contribution of pests. Following the step-wise programme, yield of rice was regressed separately with each pest. Selection of the first pest was then accomplished by employing the criteria of coefficient of determination (R²) and F-test (Table 4). The relative importance of influencing pest were rice stem borers (X1) as per step I. Their relative contribution towards rice yield was 10.48%. Different scientist reported that stem borer causes 5-20% damage to the rice crop with about 60-70% damage in case of severe outbreaks [13-15]. According to step II, rice hispa (X2) was the next

TABLE 1. INFESTATION RATE OF DIFFERENT RICE PESTS ON TWO RICE VARIETIES.

Variety and date of data collection	Rice green leaf hopper	Rice hispa	Rice swarming caterpillar	Rice stem borer (percent dead heart)	Yield of rice (Qnt/ha)
NAIZERSAIL					
30 DAT	52.778 a	2.083 a	8.583 a	1.506 a	
50 DAT	99.111 b	6.750 b	19.306 b	3.782 b	12.121
Sx value	6.252	0.566	1.241	0.350	
IR20					
30 DAT	32.917 a	1.639 a	8.389 a	0.918 a	
50 DAT	101.310 b	7.250 b	26.556 b	2.766 b	15.047
Sx value	6.574	0.569	1.218	0.281	

DAT = Days after transplantation; NB= Data in a column represented by different alphabet are statistically significant at 1% level.

TABLE 2. CORRELATION MATRIX BETWEEN RICE YIELD AND INFESTATION OF DIFFERENT PESTS.

Variable	Rice green leafhopper	Rice hispa	Rice swarming caterpillar	Rice stem borer (dead heart %)	Yield of rice
Green leafhopper	1.0000	0.7395**	0.5600**	0.8845**	-0.2567*
Rice hispa		1.0000	0.6028**	0.7992**	-0.1145
Rice swarming caterpillar			1.0000	0.5858**	-0.0048
Rice stem borer				1.0000	-0.3237*
Yield of rice					1.0000

*, ** Significant at 5% and 1% level of probability, respectively.

TABLE 3. PATH COEFFICIENT ANALYSIS OF VARIOUS PESTS INFLUENCING YIELD OF RICE.

Characters	Indirect effect through				Correlation with yield of rice
	Rice green leafhopper	Rice hispa	Rice swarming caterpillar	Rice stem borer (dead heart %)	
Rice green leafhopper	<u>0.0476</u>	0.2330	0.1198	-0.6571	-0.2567*
Rice hispa	0.0352	<u>0.3152</u>	0.1288	-0.5937	-0.1145
Rice swarming caterpillar	0.0267	0.1899	<u>0.2137</u>	-0.4351	-0.0048
Rice stem borer (dead heart)	0.0421	0.2519	0.1252	<u>-0.7429</u>	-0.3237*

Residual effect = 0.8994. N.B. Underlined figures denote the direct effect of the characters on the yield of rice. * = Significant at 5% level.

TABLE 4. STEP-WISE REGRESSION EQUATIONS FROM EACH STEP FOR FINDING OUT RELATIVE IMPORTANCE OF INFESTATION OF PESTS OF RICE YIELD.

Step/Regression equation	R ²	F value computed
STEP I Y = 14.217 - 0.282** X1 (0.097)	0.1048	8.193**
STEP II Y = 13.949 - 0.560** X1 + 0.201 X2 (0.160 (0.092))	0.1623	6.684**
STEP III Y = 13.478 - 0.615** X1 + 0.161 X2 + 0.049 X3 (0.162) (0.095) (0.032)	0.1906	5.338**
STEP IV Y = 13.292 - 0.648** X1 + 0.160 X2 + 0.049 X3 + 0.003 X4 (0.233) (0.096) (0.032) (0.012)	0.1911	3.957**

Figures in parentheses below the regression coefficient show the standard errors of the estimated value; **, Significant at 1% level; Y = Yield of rice. X1 = Rice stem borer. X2 = Rice hispa; X3 = Rice swarming caterpillar. X4 = Rice green leafhopper.

important pest having influence on the yield of rice in the presence of rice stem borers. According to step III, rice swarming caterpillar (X3) was entered as third important pest of rice among the tested pests in the presence of stem borer and rice hispa. Rice green leafhoppers (X4) were the last in order of importance, as revealed by step IV. F-test showed that the contributions of rice stem borers, rice hispa, rice swarming caterpillar and rice green leafhopper were found significant at 1% level. Results revealed that the maximum damage capabilities on rice yield was made by rice stem borers (10.48%) followed by rice hispa (5.75%), rice swarming caterpillar (2.83%) and rice green leafhoppers.

From these results, it appeared that rice stem borers were the most important pests of rice which made highly negative correlation association (-0.3237, $P < 0.05$) with rice yield, maximum negative direct effect (-0.7429) and maximum influences (10.48%) on rice yield which was followed by rice hispa, rice swarming caterpillar and rice green leafhopper. It is interesting to note that though rice green leafhoppers showed a significant negative correlation (-0.2567, $P < 0.05$) with rice yield and placed second in descending magnitude, but it failed to prove its supremacy in path coefficient analysis or in stepwise-regression. It may be due to its lower infestation in present experimental rice area. Hence, rice green leafhoppers proved as a minor pest of rice for this experimental year only.

References

1. M. K. Hussain, Workshop on Rice Cultivation in Bangladesh (BRRI, Gazipur, 1981), pp.21-40.
2. S. Alam, H. D. Catling, A. N. M. R. Karim, M. S. Alam and N. Quraishi, *Bangladesh J. Zool.*, **2** (2), 91 (1981).
3. M. A. Khaleque, O. I. Joarder and M. A. Eunos, *Cereal Res. Comm.*, **6** (2), 205 (1978).
4. E. A. Amin, *Intern. Rice Comm. Newsl.*, **28** (1), 19(1979).
5. D. B. Duncan, *Virginia J. Sci.*, **2**, 171 (1951).
6. H. K. Hayes, F. R. Immer and D.C. Smith, *Methods of Plant Breeding* (McGraw Hill Book Co. Inc., New York, 1955), pp.551.
7. S. Wright, *Genetics*, **8**, 239 (1923).
8. D. R. Dewey and K. H. Lu, *Agron. J.*, **51**, 515 (1959).
9. G.W. Snedecor and W. G. Cochran, *Statistical Methods* (Oxford and IBH Publishing Co., Calcutta, India, 1968).
10. M. Z. Alam, M. S. Alam and M. Abbas, *Int. Rice Comm. Newsl.*, **21**(2), 15 (1972).
11. Z. Alam and A. Islam, *Pak. j. sci. res.*, **2**, 20 (1959).
12. S. Alam, *Literature Review of Insect Pests and Diseases of Rice in Bangladesh* (Rice Research Institute, Gazipur, 1977).
13. H. D. Catling and S. Alam, *Literature Review of Insect Pests and Diseases of Rice in Bangladesh* (Rice Research Institute, Gazipur, 1977).
14. H. D. Catling and Z. Islam, *The Problem of Yellow Borer in Asian Deep-water Rice*, Paper Presented at Workshop, Bangkok, 2-6 November (1981).
15. W. P. Jepson, *A Critical Review of the World Literature on the Lepidopterous Stalk Borers of Tropical Graminaceous Crops* (Commonwealth Institute of Entomology, London, 1954), pp.127.