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Effect of host age and nitrogen fertilization on Bakanae disease of rice

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Resistance of rice plants to inoculation with *Fusarium moniliforme* Sheld., the incitant of Bakanae disease of rice, increased significantly with the increasing age of the plant. Percentage increase of height of seedlings over control was maximum in 25 day old seedlings and was minimum in 55 day ones. Similarly inoculation efficiency (%) was also maximum in 25 day old seedlings and minimum in 55 day. Percentage infection index, however, showed maximum in 15 day old seedlings and minimum in 55 day. Disease incidence and percentage of tiller infection in affected hills increased with increase in number of split applications of nitrogen in comparison with the treatments where the same amount of nitrogen was applied in single dose as basal application. Disease incidence and % of tiller infection in affected hills, however, reduced significantly when split application of nitrogen was given in comparison with the treatment, where the whole amount of urea was applied in single dose as basal application. Further, disease decreased when split application of N was given thrice, instead of twice, the total amount of nitrogen remaining the same. Disease incidence and % of tiller infection were lowest at 50 kg N/ha when applied in 3 split doses and highest at 150 kg N/ha when applied as basal. Panicle length, panicle weight and yield, however, increased with the increased amount and number of split application of urea.

Key words : Bakanae disease, *Fusarium moniliforme*, rice, effect of host age, nitrogen fertilization

INTRODUCTION

'Bakanae' disease, caused by *Fusarium moniliforme* Sheld. [Teleomorph: *Gibberella fujikuroi* (Sawada) Ito], is one of the important diseases of rice throughout the paddy growing countries of the world (Ou, 1985). The disease is prevalent in many rice growing states of India and known to cause around 15% loss in Uttar Pradesh and Assam (Pavgi and Singh, 1964; Rathaiah *et al.*, 1991). Now-a-days, the disease is more or less common during boro season in West Bengal.

Disease symptoms consisted mainly of lanky elongated growth and change in leaf colour. The present study was undertaken to ascertain the effect of host age on severity of the disease. Also the effect of nitrogen fertilization, essential of high yields, particularly of high yielding varieties, has been investigated to study its effect on disease development.

MATERIALS AND METHODS

An isolate of *F. moniliforme* (RDI) causing bakanae disease of rice plant was used in this study.

To study the effect of host age on disease severity, the experiment was conducted in earthen pots (dia 20 cm, height 30 cm). Seeds were sown at 10 day interval. When the first lot of seedlings attained the age of 55 day, all the seedlings of different ages were inoculated with soil containing 5% inoculum (prepared in sand-maize meal medium for 20 day at 28 ± 1° C and mixed thoroughly with soil in pots). Soil without inoculum served as control.

For each treatment (age), 3 replications (pots) were taken and from each pot three plants were randomly selected for collecting data. Average height of both healthy seedlings (C) and infected seedlings (T), % increase of height of seedlings over control (T-C/C × 100), inoculation efficiency % (T-C/T × 100) and % infection index were recorded at 20 day after inoculation.

Disease assessment

In-vitro disease screening of the seedlings grown in inoculated soil was done using the following 0-9 scale:

Grade	Disease reaction
0	Healthy (no discolouration of leaves)
1	Very mild discolouration of leaves
3	Mild discolouration of leaves
5	Medium discolouration of leaves
7	Severe discoluration of leaves
9	Very severe discolouration of leaves

Individual leaves were assessed and the % infection index was calculated using the following formula:

$$\% \text{ Infection Index} = \frac{\text{Sum of disease ratings}}{\text{Total rating} \times \text{Max. disease grade}} \times 100$$

Field experiments for the study of the effect of the nitrogen fertilization on disease development were conducted during the boro season of 1997 and 1998 at University Experimental Farm, Kalyani in randomized block design (RDB) with three replications of each of the ten treatments consisting of different nitrogen levels (50 kg N/ha, 100 kg N/ha and 150 kg N/ha) applied through urea (46% N) at basal and topdressing along with control (no nitrogen). For each dose, nitrogen was applied in three ways: i) total amount as basal (during last ploughing); ii) in two equal split doses, one at basal and another at active tillering stage (15 days after transplanting); iii) in three split doses, ¼ at basal, ½ at active tillering stage, ¼ at panicle initiation stage (40 days after transplanting).

A highly susceptible rice variety Rasi (IET 1444) was used as test variety. Thirty-five day old seedlings, raised from infected seeds (collected from heavily infested rice field) were transplanted in the puddle field, which had a history of severe disease incidence of bakanae infestation. Plant spacing of 20 × 15 cm was given and 3 seedlings per hill were transplanted. Standard recommended dose of phosphorus and potash in the form of single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were applied respectively as basal dose. Recommended irrigation and other agronomic practices were followed in raising the crop.

Disease incidence was recorded from 1.5 × 1.5 m selected area within each plot 15 day after last top dressing . Percentage of tiller infection was also recorded from nine affected hills per plot, at the same time. At maturity, panicle weight and panicle lengths were recorded from randomly selected five plants. Total yield per plot was also recorded.

RESULTS AND DISCUSSIONS

In the study on the effect of host age on disease severity, it was observed that the inoculated seedlings of all ages showed significant increase in height, but the resistance of the plants to inoculation with the pathogen increased significantly with increasing age of seedlings (Table 1).

Maximum effect of the disease on the plant was observed on 25 day old seedlings when % increase of the height of seedlings over control and inoculation efficiency (%) were taken as parameters. But, when % infection index (based on the colour of the seedlings) was taken as the parameter, highest effect of disease infection was recorded on 15 day old seedlings. However, no death of the seedlings was observed in the inoculated pots. It thus appears that, the initial impact of the disease as manifested by severe chlrosis of the seedlings in the very early stages is somewhat overcome with increasing age of the plant and thus the degree of chlorosis does not appear to be a very important parameter for disease assessment, particularly at a later stage of plant growth.

Table 1. Effect of host age on severity of rice Bakanae disease

Average height of seedlings (cm)	Days of inoculation				
	15	25	35	45	55
Healthy (non-inoculated/ control)	24.67 ±1.50	27.89 ±1.27	36.22 ±1.72	43.22 ±1.20	45.11 ±2.09
Inoculated	34.78 ±2.11	48.22 ±2.44	59.78 ±2.95	69.22 ±1.39	52.44 ±2.74
't' value$_{(0.05)}$	11.72*	22.19*	20.71*	42.37*	6.38*
% Increase of height of seedlings over control	40.99	72.95	65.01	60.15	16.24
Inoculation Efficiency (%)	29.07	42.18	39.40	37.56	13.97
%Infection Index	82.71	56.79	50.61	20.98	13.58

Table 't' (0.05) d.f. 16= 2.12
*Significant

Host age may affect disease severity in several ways. Firstly, with increase in host age, the host tissues become mature and hardened due to lignification and thus may provide some sort of barrier to pathogenic invasion and reducing disease severity. This factor may explain the severe chlorosis of the inoculated young seedlings, a symptom, which is not common in older plants. Secondly, the physiological and nutritional changes, that occur within the host tissues with increase in age, may also influence in some way, the severity of the disease. The relation between nutritional status of the host at different ages and

gibberellins production by the pathogen, which in fact is the cause of the elongation of the host, the most prominent symptom of the disease, may also be involved in the process. However, no information in this regard is available in the literature. It will, no doubt, be an important aspect of study in future and may provide some valuable information.

Different levels and mode of nitrogen fertilization in the disease development revealed that, the disease incidence and % of tiller infection in affected hills increased significantly with the increase in total amount of nitrogen applied in the form of urea. Disease incidence and % of tiller infection in affected hills, however, reduced significantly when split application of nitrogen was given in comparison with the treatment, where the whole amount of urea was applied in single basal dose. Further, disease decreased when split application of N was given thrice, instead of twice, the total amount of nitrogen remaining the same.

Table 2. Effect of different levels and modes of application of nitrogen (N) on the disease incidence, tiller infection, panicle length, panicle weight and yield of rice

Levels of N (kg/ha)	Disease incidence (%)	% of tiller infection*1	Panicle length (cm)	Panicle weight (gm)	Yield (q/ha)
0	10.78 (19.09)* G	15.99 (23.56) F	17.60 G	1.27 F	25.90 I
50 S1	22.72 (28.45) D	24.36 (29.55) D	18.38 G	1.33 F	31.45 H
50 S2	17.48 (24.65) E	22.77 (28.48) D	18.65 FG	1.63 E	32.90 G
50 S3	14.47 (22.24) F	19.20 (25.95) E	19.65 EF	1.69 E	34.80 F
100 S1	34.31 (35.83) B	31.53 (34.15) A	19.75 F	1.65 E	34.60 F
100 S2	27.71 (31.75) C	29.03 (32.59) B	21.00 CD	1.91 CD	36.95 E
100 S3	20.03 (26.52) DE	24.87 (29.90) CD	22.75 B	2.01 C	40.90 C
150 S1	39.09 (38.68) A	33.42 (35.29) A	20.45 DE	1.85 D	39.45 D
150 S2	31.56 (35.98) B	31.56 (34.16) A	21.85 BC	2.27 B	42.75 B
150 S3	26.12	26.73	24.00 A	2.46 A	46.75 A

* Figures in parenthesis are angular transformed values
*1 In infected hills
Means followed by common letter are not significantly different

0 = Control (without N) 50 = 50 kg N/ha S1 = N applied in single application (Basal)
100 = 100 kg N/ha S2 = N applied in two splits
150 = 150 kg N/ha S3 = N applied in three splits

Disease incidence and % of tiller infection were lowest at 50 kg N/ha when applied in 3 split doses and highest at 150 kg N/ha when applied at basal. Panicle length, panicle weight and yield, however, increased with the increased amount and number of split application of urea (Table 2).

In earlier studies also, Thomas (1973) in India showed that, the application of nitrogen to soil stimulated the development of disease and the effect was not modified by the addition of phosphorus or potassium. Grewal and Kang (1990) also reported that the application of increased amount of nitrogen, either as urea alone or as urea + FYM (1:1) increased the intensity of *Fusarium* sheath rot of rice, caused by *F. moniliforme* and produced more grain chaffiness than in treatments without nitrogen. Kruger *et al.*, (1965) found that, stalk rot of Maize, caused by *F. moniliforme* increased with high nitrogen levels. They further observed that, fertilizers affect resistance or susceptibility by affecting the chemical composition of plants or inoculum potential of the pathogen. In his studies with blast of rice, Otani (1952) have shown that, there was a marked increase in soluble nitrogen, particularly amino acids, in plants, receiving higher amount of nitrogen. The soluble nitrogen, which accumulates in the plants, may serve as a suitable nutrient for increasing the growth and activities of the pathogen within the host causing higher disease incidence. However, panicle length, panicle weight and total yield increased with the application of the increased amount of nitrogen, either in a single dose or in split applications. The result of the present studies, thus indicate that, the adverse effect of increased amount of nitrogen on the host as indicated by increase in disease incidence and % tiller infection is greatly neutralized by the beneficial effect of nitrogen nutrition on the growth and development of the plant resulting in higher yield with the application of increased amount of nitrogen.

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REFERENCES

Grewal, S.K. and Kang, M.S. (1990). Influence of nitrogen fertilization on *Fusarium* sheath rot and yield of rice. *Plant Disease Research*, 5 : 47 - 52.

Kruger, W.; Grobler, J.H. and Du-Plooy, J. (1965). The influence of fertilizers and plant population on the incidence of stalk rot of maize. *South African Journal of Agricultural Science.* **8 :** 703 – 715.

Otani, Y. (1952). Growth factors and nitrogen sources of *Pyricularia oryzae* Cavara. *Annals of the Phytopathological Soceity of Japan* **17 :** 9 – 15.

Ou, S.H. (1985). *Rice Diseases.* CMI, Kew, Surrey, U.K.

Pavgi, M.S. and Singh, J. (1964). Bakanae and foot rot of rice in Uttar Pradesh , India. *Plant Disease Reporter,* **48 :** 340 – 342.

Rathaiah, Y.; Das, G.R. and Singh, K.H.U. (1991) : estimation of yield loss and chemical control of bakanae disease of rice. *Oryza.* **28 :** 509 512.

Thomas, K.M. (1937). Administrative report of the Government Mycologist for the year 1936 – 1937. *In administrative reports: Agriculture, Chemistry, Entomology and Mycology, Madras, 1936 – 37,* 35 – 51.

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