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Effect of agronomic practices on Maydis leaf blight disease of maize

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The kharif (summer/monsoon) maize (*Zea mays* Linn.) which is popular in the eastern part of the country may be predisposed to Maydis leaf blight (*Drechslera maydis* Nisikado Race 'O') if proper agronomic practices are not followed. Field experiments under the artificial epiphytotic conditions showed that the disease incidence was favoured by planting in July, while early planting in May or June, or late planting in August reduced the incidence. Disease incidence gradually increased with the increase in plant density and it was maximum at a population of 70,000 ha^{-1}, while it was minimum at 40,000 ha^{-1}. Nitrogen alone or in combination with phosphorus and potassium, or with both phosphorus and potassium, reduced it. There was a gradual increase in the disease severity with the increase in the dose of nitrogen and the maximum infection occurred at the highest dose of nitrogen @ 160 kg ha^{-1}. *In vitro* study, however, showed that nitrogen significantly increased the linear growth of the pathogen, while both phosphorus and potassium individually or in combination with nitrogen reduced it. Nitrogen also significantly increased the percentage of conidial germination, while both phosphorus and potassium individually or in combination with nitrogen reduced it.

Key words : Agronomic practices, *Drechslera maydis*, leaf blight, maize

INTRODUCTION

Maydis leaf blight of maize (*Zea mays* Linn.) caused by race 'O' of *Drechslera maydis* Nisikado (synonym of *Helminthosporium maydis* Nisikado & Miyake) is one of the major foliar diseases of this crop in India as it is widely prevalent over different states including West Bengal and it may cause appreciable damage to the standing crop in terms of both yield and crop value under favourable climatic conditions (Payak and Sharma, 1978; 1985). The disease occurs during July to October in kharif season (summer/monsoon) and it appears at various stages of plant growth, being more serious from midwhorl to silking stage. Charateristic symptoms are produced on leaves in the form of small lesions with parallel sides and buff to brown border with little chlorosis. In case of severe infection the lesions may coalesce exhibiting a blighted appearance.

Although this disease appears every year in different parts of the country, yet the influence of agronomic practices on disease severity is not well established.

MATERIALS AND METHODS

The study was undertaken in the Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Kalyani (22.5 N, 89.0 E), located on the Gangetic plains of West Bengal, during June to October (kharif season) of 1995, 1996 and 1997. The soil of the experimental field was alluvial with pH 6.7. The field had been covered with maize only for the previous years with normal agronomic practices. The different experiments in relation to the disease incidence were : (1) effect of time of planting, (2) effect of plant density, (3) effect of nitrogen (N), phosphorus (P) and potassium (K) fertilizers and (4) effect of different levels of N. The other experiments in relation to the *in vitro* effects of N, P and K fertilizers were on the (5) linear growth of the pathogen and (6) germination of conidia of the pathogen. A susceptible maize variety North Eastern Himalayan (NEH) composite was planted during the second week of June (except in the case of experiment on time of planting) in five row plot with three replications. Each row was 5 m long and it approximately contained 25 plants. The row to row distance was kept at 75 cm. Before planting of seeds 3 cm thick layer of compost was thoroughly added to the soil by ploughing.

The recommended fertilizer doses were 160 kg of N as 400 kg of ammonium sulphate (AS), 40 kg of P as 250 kg of superphosphate (SP) and 60 kg of K as 120 kg of muriate of potash (MOP) ha^{-1} in two equal doses. The first dose was applied at the time of planting, while the second dose was applied at the knee high stage of plant growth. Normal irrigation was provided when it was necessary and no other plant protection measure was undertaken during the entire crop season.

Methods of inoculation and recording of disease incidence

The whorl inoculation method (Sharma, 1982) by using inoculum of the pathogen grown on sterilized wheat grain (50 g of washed wheat grain + requisite quantity of water in 250 ml Erlemeyer flask) was followed to inoculate the growing plants of about 45 to 50 cm high. All plants in the middle three rows were inoculated, while the two side rows remained uninoculated as checks. The inoculation was repeated twice at weekly interval to ensure infection. Symptoms appeared in about 7 to 10 days in the inoculated plants and the disease incidence was visually recorded after 21 days following the 1 (very slight to slight infection showing one or two few scattered lesions on lower leaves) to 5 (very heavy infection showing abundant lesions on almost all leaves ultimately causing premature drying or death of the affected plants) that has been described elsewhere in detail (Payak and Sharma, 1982).

Effect of time of planting on disease incidence was studied by planting maize on seven different dates from May 30 to August 30 at 15 days interval in a randomized block design (RBD). The time of inoculation in relation to the time of planting was adjusted and fell on different dates from July 15 to October 15 at 15 days interval (Table 1). In a RBD design, the effect of plant density on disease severity was studied by maintaining plant population at 40,000 ha^{-1}, 50,000 ha^{-1}, 60,000 ha^{-1} and 70,000 ha^{-1} keeping plant to plant distance approximately at 25 cm, 20 cm, 15 cm and 10 cm respectively, while row to row distance was kept at 75 cm.

The role of major plant nutrients N, P and K on disease developement was studied following the split plot technique. The recommended dose of each nutrient mentioned earlier was applied singly and in comibnation as follows : N, P, K, NP, NK, PK and NPK. Controls were kept without applying any fertiliser dose except compost. Similar experimental design was followed to study the effect of different levels of N alone without P or K on disease development. The different doses of N applied were 40 kg, 80 kg, 120 kg and 160 kg ha^{-1}. For comparison, controls were kept without any dose of N except compost.

Effect of N, P and K fertilizers on linear growth of the pathogen was studied at 60 ppm, 37.5 ppm and 18 ppm of the respective nutrient prepared by adding 60 mg of AS, 37.5 mg of SP and 18 mg of MOP respectively l^{-1} of potato dextrose agar (PDA) following the ration of recommended doses of 400 kg of AS, 250 kg of SP and 120 kg of MOP ha^{-1} (10,000 m^2). The above fertilizer doses were added singly and in combination. The fertilizer supplemented medium was sterilized at 121°Cfor 20 minutes. After cooling to 45°C, 20 ml of this medium was aseptically poured in each of the 10 cm petriplates and was allowed to solidify. Such petriplates replicated five times were then seeded at the centre with 6 mm mycelial discs of the fungal culture and were incubated at 28 ± 1°C, and the linear growth was recorded after 7 days.

Conidia of the pathogen were harvested from the mycelial mat grown on potato dextrose broth (PDB) at 28 ± 1°C for 10 days following the method described elsewhere (Pal, 1998). The conidial suspension was so diluted that approximately 50 conidia in a drop of suspension were observed under the field of a low power microscope. Germination of conidia was studied at 60 ppm of N, 37.5 ppm of P and 18 ppm of K (prepared by adding 60 mg of AS, 37.5 mg of SP and 18 mg of MOP respectively l^{-1} of sterile glass distilled water) in grove slides inside a moist chamber at 28 ± 1°C.

The slides were observed at different time intervals and percentage of germination was recorded after 24 hs.

RESULTS AND DISCUSSION

Disease incidence in relation to different dates of planting

Disease incidence (Table 1) was significantly higher in July planting than in all other planting dates. However, no significant variation in disease incidence was recorded between the planting dates in June and middle of August where moderate intensity of infection was recorded. Disease incidence was much less when planting was done during the end of May and August. Kaiser *et al.* (1987) concluded that the incidence of race 'O' of *D. maydis* was highly favoured by high temperature (33.2 to 33.8°C), high relative humidity (RH) (70 per cent and above) and moderate amount of rainfall (188.2 to 368 mm) that prevailed from August to September. Since the outbreak of the disease is also linked with the stage (mid whorl to grain development) of the crop, the early and late planted crop in the present case attend this stage when lack of optimum temperature and comparatively less amount of rainfall and RH were the main contributing factors for low disease incidence. Oyekan (1977) observed that the incidence of *D. maydis* considerably varied with the time of planting and it was lowest in early planting (March to early April) and highest in late planting (after middle of April onwards). Studying with different planting dates, Gowda *et al.* (1989) observed that the incidence of *Exserohilum turcicum* causing leaf blight of maize was increased by early planting dates, while it was considerably decreased by the late planting dates probably due to prevalence of very low RH.

Table 1. Effect of time of planting in relation to the incidence of *D. maydis* on maize

Time of planting	Time of inoculation	Disease index		
		Maximum	Minimum	Average
May 30	July 15	2.5	2.0	2.3
June 15	July 30	3.5	3.0	3.2
June 30	August 15	4.0	3.0	3.5
July 15	August 30	4.5	4.0	4.1
July 30	September 15	4.5	4.0	4.4
August 15	September 30	4.0	3.0	3.4
August 30	October 15	3.0	2.0	2.5
SE (mean)				± 0.20
CD (P = 0.05)				0.41

Disease incidence in response to different levels of plant population

Effect of plant population on disease incidence is presented in Table 2. From the regession values of data it appears that the disease severity significantly increased almost in a linear fashion (r = 0.94; P > 0.001) with the increase in plant density. The incidence was maximum at a population of 70,000 ha^{-1}, while it was minimum at 40,000 ha^{-1}. A good disease development also occurred at a plant population of 50,000 to 60,000 ha^{-1}. The experiment shows that the agronomic recommendation of high plant population at 50,000 to 60,000 ha^{-1} is conducive for high disease development. Information on the positive and significant correlation between plant population and disease intensity in respect of this disease is lacking. Payak (1975), however, described the role of plant population in respect of some other foliar diseases of maize but data on brown stripe downy mildew (*Sclerophthora rayssiae var. zeae*) were only conclusive where high plant population increased the disease severity.

Table 2. Effect of different plant population on the incidence of *D. mydis* on maize

Plant population (x 1000 ha^{-1}) (X)	Disease index			
	Maximum	Minimum	Average	
			Observed value (y)	Expected value (Y)
40	3.4	3.2	3.3	3.1
50	4.1	3.9	4.0	3.8
60	4.3	4.1	4.2	4.1
70	4.5	4.3	4.4	4.5

Regression equation (n = 4) :
Average disease index : Y = 2.045 + 0.35X (r = 0.94 **)

Effects of N, P and K fertilizers and different levels of N on disease development

Data on the application of N, P and K fertilizers on the incidence of race 'O' of *D. maydis* (Table 3) showed that maximum incidence of the disease occurred when N was applied alone. But P and K alone resulted in a high significant reduction in the disease incidence over N. N in combination with P or K, or with both, in general, significantly enhanced the disease severity over P or K individually. Among the different fertilizer treatments the disease incidence was minimum with

P and K combination. The results indicate that N increased the disease severity, while both P and K reduced it.

Table 3. Effect of N, P and K fertilizers (singly and in combination) on the incidence of *D. maydis* on maize

Fertilizer	Dose (Kg ha^{-1})	Disease index Maximum	Minimum	Average
N	160	4.5	4.0	4.3
P	40	3.5	3.0	3.3
K	60	3.5	3.0	3.1
NP	160 + 40	4.5	3.5	4.0
NK	160 + 60	4.0	3.5	3.7
PK	40 + 60	3.0	2.5	2.9
NPK	160 + 40 + 60	4.0	3.0	3.5
Control	No fertilizer (expect compost)	2.5	2.0	2.2
SE (mean)				± 0.18
CD (P = 0.05)				0.38

Table 4. Effect of different levels of N on the incidence of *D. maydis* on maize

Dose of N (kg ha^{-1}) (X)	Disease index Maximum	Minimum	Average Observed Value (y)	Expected Value (Y)
0.0	2.5	2.0	2.2	2.5
40.0	4.0	3.5	3.6	3.0
80.0	4.0	3.5	3.9	3.5
120.0	4.5	3.5	4.1	4.0
160.0	4.5	4.0	4.3	4.6

Regression equation (n = 5) :
Average disease index : Y = 2.56 + 0.01275 X (r = 0.87**)

The results on the influence of different levels of N on disease development (Table 4) showed that there was a gradual increase in the disease severity in a linear fashion (r = o.87; P>0.001) with the increase in the doses of N. Maximum infection occurred at the highest dose of N @ 160 kg ha^{-1}, while it was minimum without any dose. There was also a good disease development when N was applied @ 120 kg ha^{-1}. The results indicate that the agronomic practice of high doses of N @ 120 kg to 160 kg ha^{-1} is also conducive for high disease development.

Several workers have reported the role of N, P and K fertilizers in soil on the incidence of foliar disease of cereals incited by different species of *Helminthosporium*. Majority of those workers agreed that the leaf infection was more severe when N was in excess in relation to other fertilizers. According to those workers N tended to increase the disease severity (Chattopadhyay and Dickson, 1960, Roy and Mishra, 1966), while both P and K reduced it (Hooker *et al.,* 1963; Dasgupta and Chattopadhyay, 1977). Dasgupta and Chattopadhyay (1977) also recorded similar effects of N and P fertilizers in respect of *H. oryzae* (*Drechslera oryzae*) of rice, while Hooker *et al.* (1963) recorded a similar reducing effect of K fertilizer against *E. turcicum* of maize. Motacha and Smith (1980) also reported a similar effect of P or K applied individually or in combination in reducing the incidence of *D. oryzae* in rice seedlings as it was observed in case of race 'O' of *D. maydis* in the present study.

There are, however, disagreements among different workers over the role of N fertilizer on foliar infection in cereals caused by different species of *Helminthosporium*, who reported that the increase in the doses of N either increased or decreased the disease severity. Increasing effect was recorded, for example, in case of Turcicum leaf blight (*E. turcicum*) of maize (Roy and Mishra, 1966), brown spot (*D. oryzae*) of rice Dasgupta and Chattopadhyay, 1977), while the decreasing effect was recorded, for example, in case of brown spot (*D. oryzae*) of rice (Ismunadji *et al.,* 1977). The observation done by Sharma *et al.* (1982) could not be confirmed here who reported that the incidence of *D. maydis* of maize was reduced by the application of N fertilizer. Although the results of the present study and the works done by several other workers suggest that there is a general trend of N fertilizer towards the increase of leaf blight infection but the role of increased levels of N is rather complicated which has been best explained by Dasgupta and Chattopadhyay (1977) who reported that the susceptibility of *D. oryzae* of rice increased under both high and low levels of N, more so under the former, under low level of N the increase was due to more infection, whereas under high level it was due to increased number of large spots i.e., due to greater lesion expansion. The effect of unfavourable N level combined with low N, could reduce both number and expansion of lesions.

In vitro effect of N, P and K fertilizers on linear growth and conidial germination of the pathogen

The data in Table 5 showed that the linear growth of the pathogen was maximum when N was applied alone but the application of P and K alone resulted in a high significant reduction in the mycelial growth over N. But instead of its increasing effect on the disease incidence *in vivo*. N in combination with P or K, or with both failed to enhance the linear growth of the pathogen over P or K *in vitro*. The results indicate that N alone increased the linear growth of the pathogen, while both P and K alone or in combination with N reduced it. *In vitro* study further revealed that the conidial germination of the pathogen also followed a similar pattern as in the case of linear growth in response to different fertilizer treatment (Table 6). Hence from the study *in vivo* as well as *in vitro* it may be understood that the growth and germination of the pathogen race 'O' of *D. maydis* in response to N, P and K fertilizers in the culture medium has no direct relation with the disease incidence in response to these elements.

Table 5. Effect of N, P and K fertilizers (singly and in combination) on linear growth of *D. maydis* in PDA medium.

Fertilizer	Dose (mg l^{-1})	Linear growth (mm) Maximum	Minimum	Average
N	60 As	85.0	78.5	82.2
P	37.5 SP	78.0	69.5	72.7
K	18 MOP	72.5	69.5	71.5
NP	60 AS + 37.5 SP	72.5	68.5	70.1
NK	60 AS + 18 MOP	71.5	68.0	69.1
PK	37.5 SP + 18 MOP	71.0	66.0	67.5
NPK	60 AS + 37.5 SP + 18 MOP	71.0	63.0	66.8
Control	No fertilizer	82.5	76.0	78.7
SE (mean)				± 1.63
CD (P = 0.05)				3.37

Table 6. Effect of N, P and K fertilizers (singly and in combination) on the germination of conidia of *D. maydis*

Fertilizer	Dose (mg l^{-1})	Germination (%) Original value	Transformed value[a]
N	60 As	84.0	64.4
P	37.5 SP	64.0	53.1
K	18 MOP	51.5	45.8
NP	60 AS + 37.5 SP	66.5	54.6
NK	60 AS + 18 MOP	58.5	49.8
PK	37.5 SP + 18 MOP	55.0	47.8
NPK	60 AS + 37.5 SP + 18 MOP	57.0	49.0
Control	(Sterile Distilled water)	81.0	64.1
SE (mean)			± 0.73
CD (P = 0.05)			1.50

a Angular transformed value

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