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STUDIES ON SOME CLIMATIC FACTORS LEADING TO THE SEVERITY OF *DRECHSLERA MAYDIS* NISIKADO RACE 'O' CAUSING LEAF BLIGHT OF MAIZE IN INDIA

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Effects of some climatic factors such as atmospheric temperature, relative humidity and rainfall leading to the severity of *Drechslera maydis* race 'O' causing leaf blight of maize have been studied during the year 1983 to 1985 under field condition. The incidence of the disease was recorded to be highest in 1984 and lowest in 1983 in respect of disease index, intensity of infection and time taken for maximum development. This variation in the incidence of the disease has been explained on the basis of weather data recorded during the susceptible growth phase of the host during these years of study. The present study indicates that the incidence of *D. maydis* is highly favoured by high temperature (33.2° to 33.8°C), high relative humidity (70% and above) and moderate amount of rainfall (188.2 to 368.8 mm). *In vitro* study showed that the maximum growth and conidial germination of the pathogen occurred at 34°C and 70 to 100% of relative humidity. It is further noted that the disease may thrive over a wide range of temperature (22.4° to 33.8°C), relative humidity (49.4 to 91.2%) and rainfall (34.6 to 368.8 mm).

INRODUCTION

Maydis leaf blight of maize (*Zea mays* L.), also known as Southern leaf blight (because of its being more widespread in the Southern United States), is incited by *Drechslera maydis* Nisikado (Drechslera state of *Cochliobolus heterostrophus*). It is one of the major diseases of maize in India as it causes appreciable damage to the standing crop resulting high loss in yield and crop value under favourable conditions. Payak and Sharma (1978) have accounted loss in yield upto 30.3% due to this disease. The annual grain loss in India due to this disease along with some other foliar diseases (Turcicum leaf blight, *Phaeosphaeria* leaf spot, brown stripe downy mildew and common rust) has been estimated to be 396,180 tonnes with the estimated loss in crop value upto 42.9 million US dollars (Payak and Sharma, 1985). The disease is widely prevalent over different states of this country. In West Bengal, the disease is present both in the plains and in the hills during the *kharif* season (summer/monsoon). But it is more severe in the plains.

The disease appears at various stages of plant growth being more serious from mid whorl to silking stage.

Two races of this pathogen, namely race 'O' and race 'T' are found to occur in nature. The race 'T' was reported by Hooker *et al.* (1970) following its extreme pathogenicity on maize cultivars carrying cytoplasmic male sterility (Texas male sterility, Tms) in USA (Ullustrup, 1970 ; 1972). Storbel (1975) accounted this an epidemic which was most severe and caused greatest economic loss so far know due to a plant disease. The main differences of these two races according to Hooker *et al* (1970) are (i) race 'T' is highly virulent on Tms and some other sources of male sterility and generally mildly virulent on maize having normal cytoplasm. Race 'O' shows no differential pathogenicity for these two kinds of cytoplasm, (ii) race 'T' produces a pathotoxin in high amounts *in vitro* and *in vivo* specific to certain cytoplasm. Race 'O' produces only limited amounts of pathotoxin which is non-specific, (iii) rate 'T' attacks leaves, sheaths, husk leaves, shank, ear and stalk tissues producing tan coloured, spindle shaped or elliptical lesions with yellow green or chlorotic halos. Race 'O' infects leaves primarily, producing smaller lesions with paral'el sides and buff to brown borders and little chlorosis.

In India, race 'O' is widely prevalent over different states including West Bengal although presence of race 'T' has been reported by Khera *et al.* (1976) and Sharma *et al.* (1978) on maize experimental hybrids 2310 and 2420 from Ludhiana. Sharma (1982) has pointed out that the disease is currently world wide being important in the regions of warm and damp climate. Reports from outside India indicate that high temperature and high relative humidity favour incidence of this disease (Ullstrup, 1955 ; Nelson, 1957). Although this leaf blight disease due to *D. maydis* race 'O' on maize occurs every year in West Bengal and other maize growing states of India, little information is available on the factors that enhance the disease severity, and hence this study was conducted.

MATERIALS AND METHODS

The study was undertaken at the Maize Research Station, BCKV, Kalyani, West Bengal during the *Kharif* season of 1983, 1984 and 1985. A susceptible variety, hybrid VL-54 was included in the present study. The seed material was obtained from the Project Coordinator, All India Coordinated Maize Improvement Project (AICMIP), IARI, New Delhi-12. The seeds were planted during the last week of June in 2 rows plots. Each row was 5 meters in length and contained 20 plants with 4 replication. Normal agronomic practices were followed and no plant protection measure was undertaken.

The standard whorl inoculation method by using fungal suspension as practiced in the AICMIP was followed to inoculate plants of about 45 cms high (Sharma,

1982). The inoculum was prepared by using a virulent isolate of this pathogen from the same susceptible hybrid VL-54. For field inoculation purposes, the inoculum from the stock culture was multiplied in 10 cm diameter sterilized petriplates on PDA medium at 29±1°C. The inoculation was repeated 3 times at weekly interval. Adequate controls were kept by keeping uninoculated plants in separate plots. Data on the incidence of the disease were recorded about 2 weeks after the final inoculation. The disease was rated visually on the basis of 1 to 5 scale as described by Payak and Sharma (1982). The scale consisted of five broad categories designated by different disease index from 1 (very slight to slight infection) to 5 (heavy to very heavy infection). The measurement was based on the number of lesions present on a leaf and their subsequent spread. Thus all the plants in a replication were affixed with a particular disease index and the average per plant was calculated.

For studying the effect of temperature on the linear growth of the mycelium, the pathogen was grown on sterilized PDA medium in 10-cm diameter sterilized petriplates. The petriplates were inoculated at the centres with 6 mm bits of the fungal inocula cut from a 10 days old culture of the fungus by means of a sterilized cork borer. The inoculated petriplates replicated 3 times were then incubated at different temperature (22° to 38°C) and the data on the linear growth were recorded on 10th day.

For studying the effect of temperature on conidial germination, a drop of conidial suspension on sterile distilled water was placed in each of the grooves of double-grooved cavity slides. The slides were rested on two glass rods within humidity chambers prepared by placing moistened filter papers at the bottom of the petriplates. The cavity slides were incubated for 16 hours at different temperatures after which they were observed under the low powers of a microscope for the percentage of germination of conidia.

The effect of different humidities on the linear growth of the mycelium was studied by maintaining different humidities within 20-cm-diameter sterilized petriplates at a constant temperature of 32°C by adding 20 ml solutions of different concentration of sulphuric acid (McLean and Cook, 1965). Ten-cm-diameter sterilized petriplates containing sterilized PDA medium were inoculated with the fungal culture similarly as described before. The inoculated petriplates were then aseptically placed by removing their upper lids in different humidity chambers prepared in 20-cm-petriplates. The humidity chambers replicating 3 times containing the inocula were then incubated at 32°C and the data on the linear growth were recorded on 10th day. On the same pattern following McLean and Cook (1965) various levels of relative humidities were generated to observe conidial germination in double grooved cavity slides.

In order to find out the relationships between different climatic factors and the incidence of this disease the daily mean maximum and minimum temperature (°C), relative humidity (%) and total monthly rainfall (mm) of 1983, 1984 and 1985 were recorded for two months (August and September) (Table 1).

Table 1. *Daily mean temperature, mean relative humidity and total monthly rainfall at the susceptible stage (mid whorl stage to cob development stage) of maize plants in different years*

Months		1983			1984			1985		
		Tempe-rature (°C)	Relative humidity (%)	Rain-fall (mm)	Tempe-rature (°C)	Relative humidity (%)	Rain-fall (mm)	Tempe-rature (°C)	Relative humidity (%)	Rain-fall (mm)
August	Max	31.4	89.4	141.4	33.2	91.2	368.8	34.2	73 3	214.0
	Min	25.8	57.6		26.5	69.2		26.5	58.4	
September	Max	32.0	90.7	34.6	33.8	83.9	188.2	32.0	70.0	141.0
	Min	26.2	64.3		25.6	49.4		22 4	53.2	

Statistical analysis of the experimental data was done to find out the critical difference at 5% level (P=0.05) by Duncan's multiple range test. However, analysis of the data on conidial germination (%) was carried out with the transformed values . On the basis of this analysis the data were affixed with different letters (a, b, c, ...). The data which did not share the common letters were significantly different.

RESULTS

Incidence of D. maydis in different years

The data on incidence of *D. maydis* in different years are presented in Table 1. The table shows that the maximum incidence of this disease was recorded during 1984 crop season as evidenced by the highest average disease index (4.5) which was significantly different from that of the other two years. The incidence of the disease was, however, higher in 1 85 (the average disease index being 3.8) as compared to that of 1983 (the average disease index being 3.2) and the difference in the disease index of these two years was also significant. It is also evident that the intensity of infection was greatest in 1984, which was heavy to very heavy resulting premature death of plants in the isolated cases. The intensity of infection was, however, mostly heavy in 1985 while it was mostly moderate (heavy in a few cases) in 1983. The time taken for maximum infection on the host surface after the final inoculation was shortest (7 days) in 1984 and longest (12 days) in 1983. The time takcn for maximum infection was, however, 10 days in 1985. It was also observed that the cent percent of the inoculated plants developed

infection in all the years of study. The results indicate that the incidence of *D. maydis* was highly favoured during the 1984 crop season.

Table 2. *Incidence of* Drechslera maydis *on maize hybrid VL 54 in different years*

Year	Intensity of infection	% plant infected	Time taken for maximum infection after final inoculation	Average disease index
1983	*Mostly moderate infection, heavy in a few cases,* abundant lesions on lower leaves, moderate number of lesions on middle leaves extending to upper leaves.	100.00	12 days	3.2 a
1984	*Heavy to very heavy infection,* lesions abundant on lower and middle leaves, extending to upper leaves, plants prematurely dry or killed in the isolated cases.	100.00	7 days	4.5 b
1985	*Mostly heavy Infection,* lesions abundant on lower and middle leaves, extending to upper leaves.	100.00	10 days	3.8 c
Critical difference (at P = 0.05)				0.5

Effect of temperature and relative humidity on the linear growth and conidial germination of D. maydis

The effects of different temperature and relative humidities on the liner growth and conidial germination of *D. maydis* have been presented in Table 3. It is evident that the maximum growth of the pathogen occurred at 34°C, which was significantly different from that at other levels of temperature. There was little growth at 22°C and from 25° to 34°C there was a gradual increase in the extent of growth. However, from 35°C there was a gradual decrease in the extent of growth. The result indicates that the optimum temperature for growth of the pathogen is 34°C. Although for conidial germination the optimum temperature was 34°C there was no significant difference in the germination percentage within the range of 32° to 34°C. The optimum relative humidity for the growth of the pathogen was recorded to be 70 to 100% as within this range no significant difference in the linear growth was observed. At 20% and 30% of relative humidities no growth took place. For conidial germination also, the optimum relative humidity was 70 to 100%.

DISCUSSION

Maydis leaf blight caused by *Drechsdera maydis* race 'O' is one of the major diseases of maize in India rssulting high loss in yield and crop value under favour-

Table 3. *Effect of temperature and relative humidity on the linear growth and conidial germination of* Drechslera maydis

Tempe-rature (°C)	Linear growth (mm)	% conidial germination Original value	Transformed value	%Relative humidity (at 32°C)	Linear growth (mm)	% condial germination Original value	Transformed value
22	46.00 a	35.40	36.51 a	20	No growth	No germination	
25	64.30 b	54.60	47.64 b	30	No growth	No germination	
28	72.06 c	62.50	52.24 c	40	26.14 a	22.20	28.11 a
31	79.20 d	76.20	0.80 d	50	33.07 a	33.80	33.55 b
32	85.08 e	86.50	68.44 e	60	55.00 b	52.50	46.43 c
33	92.01 f	88.00	69.73 e	70	84.23 c	76 70	61.14 d
34	99.00 g	91.60	73 51 e	80	86.10 c	78 £0	62.38 d
35	81.05 d	78.40	62.31 d	90	90.02 c	80.60	63.87 d
38	33.08 h	31.20	33 96 a	100	92.00 c	81.50	64.53 d
Critical difference (at P=0.05)	6.01		5.65		9.25		6.73

able conditions (Payak and Sharma, 1978 ; 1985). In the present study it was observed that the incidence of *D. maydis* varried from one year to another. The incidence was highest in 1984 and lowest in 1983, and the time for maximum infection was shortest in 1984 and longesr in 1983. This variation in the disease incidence may be explained on the basis of weather data recorded during the-susceptible stage of the host during the months of August and September. During 1984, the year of highest disease incidence, the daily mean maximum temperature was 33.2°C in August and 33.8°C in September the daily mean maximum relative humidity was 91.2% in August and 83.9% in September and the total amount of rainfall was 368.8 mm in August and 188.2 mm in September. Within these three years during August and September the highest mean maximum iemperature and relative humidity and the highest amount of rainfall were also recorded in 1984. Therefore, from the results of the field study as well as from the weather data it may be understood that the incidence of *D. maydis* in I984 was highly influenced due to prevalence of comparatively higher temperature (33.2° to 33.8°C), high relative humidity (93.9 to 91.2%) and frequent rainfall (188.2 to 368.8 mm) resulting a damp climatic condition. *In vitro* effect of temperature also showed that the growth and conidial germination of *D. maydis* were highest at 34°C. However, the growth and conidial germination of the pathogen were recorded to be optimum within the range of 70 to 100% of relative humidity. Therefore, from the field study as well as from the laboratory study it may be concluded that the severity of this disease is related to high temperature (33.2° to 33.8°C), high relative humidity (70% and above) and a moderate amount of rainfall (188.2 to 368.8 mm) at the susceptible stage of the host. It was also noted that the disease could thrive over a wide range of temperature (22.4° to 33.8°C), relative humidity

(49.4 to 91.2%) and rainfall (34.6 to 368.8 mm). Ullstrup (1955) observed that the disease was able to thrive better at high temperature and high relative humidity. Nelson (1957) was of the opinion that the disease sometimes became more destructive in the Southern States of USA where high temperature and high humidity prevailed. Sharma (1982) has expressed his views that the disease is world wide important in the regions of warm (20° to 32°C) and damp climate. But in the present study the disease was found to thrive still at a higher temperature (33.2° to 33.8°C) the maximum incidence of which occurred at this level. Das and Chattopadhyay (1984) during their survey of maize disease at Kalimpong hills of West Bengal observed a low and sporadic incidence of this disease even in the susceptible varieties in the later phase of growth of the host plants during the later part of July and August when the mean maximum temperature was 25.8° to 26.2°C. But the observation was inconclusive because none of the varieties showed susceptible reaction probably due to prevalence of cool and humid weather which did not favour high incidence of this disease.

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