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Studies on Epidemiology and Disease Development of Cucumber Powdery Mildew

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ABSTRACT

Powdery mildew is very important foliar disease of cucumber among major cucurbits growing areas of Karnataka which results in huge economic loss. Disease first appear on the leaves thirty days after sowing and continue to produce white mycelial growth on various aerial plant parts up to the harvest. To establish relationship between environment factors and disease development present study has been conducted. Results reveals that among different dates of sowing, second fortnight of August recorded maximum disease severity and first fortnight of July resulted in least severity and all the dates of sowing are significantly correlated negatively with weather parameters. Relative humidity and temperature were positively correlated whereas rainfall and number of rainy days are negatively correlations. In lab conditions Maximum per cent conidial germination of 48.52 per cent was observed at 25 ^{0}C, and at 30 ^{0}C observed 46.12 per cent which are on par with each other from temperature levels tested. Among the relative humidity levels tested maximum conidial germination of 46.72 per cent was observed at 85 per cent relative humidity, which was significantly superior to other treatments. Relative humidity of 90 percent was the next best treatment with 41.86 per cent conidial germination.

Key words: *Cucumber, Epidemiology, Powdery mildew, Karnataka, India.*

INTRODUCTION

Cucumber (*Cucumis sativa* L.) is a popular fresh market vegetable preferred for several food stuffs and is cultivated throughout India. The total area under cucumber cultivation in India is 71000 hectare with a production of 1202000 tonnes with an average productivity of 16.92 tonnes[1]. Powdery mildew is a serious disease and causes considerable yield loss to the number of cucurbitaceous crops grown in India. Its distribution and relative occurrence varies throughout the world. Most of the cucurbits are found susceptible to powdery mildew disease but few cucurbits are not much infected due to resistant cultivars. This disease reduces the yield by interfering with photosynthetic activity and biochemical imbalance. Till date across the world more than eight genera have been reported from order Erysiphales. Among them *Erysiphe cichoracearum*, *Sphaerotheca fuliginea* and *Levilulla taurica* are the major pathogens.

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Cucumber powdery mildew caused by *Erysiphe cichoracearum and Sphaerotheca fuliginea* has worldwide importance and it is considered to be one of the most devastating disease as its occurrence and incidence assumes greater significance resulting in reduction of fruit yield. Powdery mildew and downy mildew together causes up to 50-70 per cent a loss[10,2]. Epidemiological studies which gives an idea about the outbreak and disease development, in order to study role of weather parameters in relation to disease development both *in vitro* and *in vivo* experiments was conducted,

MATERIAL AND METHODS

Effect of time of planting on powdery mildew development on cucumber

A field experiment was conducted during *kharif*, 2016 at Main Agricultural Research Station (MARS), College of Agriculture Dharwad, to assess the progress of powdery mildew at different dates of sowing. The cultural practices like inter cultivation and weeding were attended regularly. General sprays of insecticides were given whenever it was necessary to avoid severe damage from insect pests.

The first date of sowing treatment was imposed by sowing seeds of locally cultivated genotype Dharwad green on 1st Fortnight of July and subsequent sowings were done at an interval of 15 days till the last sowing was carried on 1st Fortnight of October. Individual plot size was 5 m × 4 m. Cucumber seeds were sown at 90 cm spacing between rows and 60 cm between plants. Totally seven different dates of sowings were carried out in the experiment. Observations on the age of the crop at which disease appeared and intensity of disease was recorded on five plants in each plot for all the dates of sowing using a disease scoring scale 0-9 and compared to find out the best sowing date. The weather data of MARS, UAS Dharwad was collected from meteorological unit and used for correlating with the disease severity.

Disease scoring scale used for grading

Score	Description
0	No symptom of powdery mildew on leaves.
1	Small scattered powdery mildew specks covering 1 % or less leaf area.
3	Small powdery lesions covering 1-10 % of leaf area.
5	Powdery lesions enlarged covering 11-25 % of leaf area.
7	Powdery lesions coalesce to form big patches covering 26-50 % leaf area.
9	Big powdery patches covering 51 % or more of leaf area and defoliation occur

Per cent disease index (PDI) was calculated by using formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of the all individual disease ratings}}{\text{Total number of plants observed x Maximum grade}} \times 100$$

Effect of different temperature on conidial germination

The temperature required for conidial germination was studied by cavity slide technique. Two drops of conidial suspension was mixed with two drops of two per cent glucose solution in cavities to achieve the required concentrations of 1.5 per cent. The cavity slides were placed in moist chambers and incubated at 24 hours at different temperature levels *viz.*, 5, 10, 15, 20, 25, 30, 35 and 40^0 C in thermostatically controlled incubators for 24 hours. Three replications were maintained for each treatment. The per cent germination was calculated by counting the number of conidia germinated to the total number of conidia.

Effect of relative humidity on conidial germination

Effect of different levels of relative humidity on conidial germination was studied. Different levels of relative humidity were maintained in

desiccators containing various proportion of concentrated sulphuric acid with distilled water. The cavity slides containing conidia were placed in desiccators containing sulphuric acid and distilled water to maintain different levels of relative humidity and presented. in *viz.*, 65, 70, 75, 80, 85, 90, 95 and 100 per cent. The desiccators were incubated at room temperatures of (25 ± 1 ^{0}C) for 24 hours. In each treatment, three replications were maintained. The per cent germination was calculated by counting number of conidia germinated among the total number of conidia observed under microscopic field and expressed in percentage.

RESULTS AND DISCUSSION

Effect of temperature on conidial germination of *E. cichoracearum*

The effect of different temperature levels on spore germination of *E. cichoracearum* was studied as explained in "Material and Methods" and the data are presented in Table 1a. The effect of different temperature regimes on the conidial germination of fungus was significant. Maximum per cent conidial germination of 48.52 per cent was observed at 25^0 C, and at 30^0 C, 46.12 per cent which are on par with each. This was followed by 35^0 C and 20^0 C at which the conidial germination was 29.30 per cent and 21.15 per cent, respectively.

Effect of different relative humidity levels on conidial germination of *E. cichoracearum*

The effect of different relative humidity levels on spore germination of *E. cichoracearum* was studied as explained in "Material and Methods" and data presented in Table 1a. The effect of different relative humidity regimes on the conidial germination of fungus was significant. Maximum conidial germination 46.72 per cent was observed at 85 per cent relative humidity, which was significantly superior to other treatments. Relative humidity of 90 percent was the next best treatment with 41.86 per cent conidial germination. The conidial germination of 41.61 per cent and 31.62 per cent was observed at 80 per cent and 95 per cent relative humidity, respectively which varied significantly among the treatments. However conidial germination was least 16.31 per cent was at 65 per cent relative humidity.

2.1.3 Effect of time of planting on powdery mildew development on cucumber

The results on the different dates of sowing of cucumber powdery mildew severity are presented in Table 1b and Fig 1a. Results of the experiment revealed that sowing of crop in the I fortnight (FN) of July recorded the minimum mean disease severity (7.96 %) followed by crop sown in II FN of July (13.19 %) as against the crop sown in II FN of August (41.44 %) and I FN of September (33.78 %) and the I fortnight of October (33.77 %).

Effect of time of planting on powdery mildew development on cucumber

A field experiment was conducted during *kharif*, 2016 at Main Agricultural Research Station (MARS), College of Agriculture and Dharwad to assess the progress of powdery mildew at different dates of sowing. The cultural practices like inter cultivation and weeding were attended regularly. General sprays of insecticides were given whenever it was necessary to avoid severe damage from insect pests. In first date of sowing infection started at 45 DAS and progressed till 73 DAS and it was up to 14.66 Per cent and in second date of sowing disease progressed up to 22.66 per cent and in third date of sowing it was upto 59.35 per cent. Afterwards, disease started earlier and progressed up to 66.15 per cent and in sixth and seventh date of sowing disease progressed up to 43.15 per cent and 59.85 per cent respectively.

Disease progress is very fast after 45 days after sowing and highest disease incidence was noticed at 73 DAS irrespective of dates of sowing. From the results of present study it is very clear that disease development will be very high if crop sown in between 1st fortnight of august and 1st fortnight of September.

Correlation of weather parameter with disease severity

The PDI obtained at different stages of crop growth and different dates of sowing were correlated with weather parameters prevailed

during the respective dates of sowing. The correlation coefficients are presented in Table 1c. The results in Table 1c reveals that during 2016, maximum temperature (0.606) was positively correlated with PDI, Minimum temperature (-0.471), Morning relative humidity (-0.531) and evening relative humidity (-0.531) negatively correlated with PDI. While, rainfall (-0.421*) and number of rainy days were (-0.422*) was significantly negatively correlated with PDI at one per cent.

The first date of sowing treatment was imposed by sowing seeds of locally cultivated genotype Dharwad green on 1st Fortnight of July and subsequent sowings were done at an interval of 15 days till the last sowing was carried on 1st Fortnight of October. Individual plot size was 5 m × 4 m. Cucumber seeds were sown at 90 cm spacing between rows and 60 cm between plants. Totally seven different dates of sowings were carried out in the experiment. Observations on the age of the crop at which disease appeared and intensity of disease was recorded on five plants in each plot for all the dates of sowing using a disease scoring scale 0-9 and compared to find out the best sowing date. The weather data of MARS, UAS Dharwad was collected from meteorological unit and used for correlating with the disease severity.

DISCUSSION

Effect of temperature on inhibition of conidial germination of *E. cichoracearum*.

Conidia of *Erysiphe cichoracearum* germinated at all the temperatures tested ranging from 5 to 40 ^{0} C but the maximum germination was observed at temperature ranging from 25 ^{0}C -30 ^{0}C and conidial germinated was maximum at 25^0 C at a wide range of relative humidity. Similarly, Cheah *et al.*[4], Gupta *et al.*[6], Singh[9]. also reported maximum germination of conidia at 25^0 C while working with pea, cucumber and pea powdery mildew.

Effect of relative humidity on conidial germination of *E. cichoracearum.*

Conidial germination was maximum when the relative humidity was adjusted to 85 per cent however, conidia germinated even from 65 per cent and 100 per cent humidity, indicating the ability of the fungus to infect both under dry and humid conditions in presence of higher water content. This indicates that if the temperature and humidity are optimal then conidia germinate within 24hr. and these results are in conformity with Gupta, *et al.*[6], Cheah *et al.*[4], Singh[9]. working with cucumber and pea powdery mildew respectively.

Effect of time of planting on powdery mildew development on cucumber.

Environmental factors decide the epidemic of powdery mildew of various crops. The environmental factors like temperature, relative humidity, rainfall and wind speed are important for disease development and these environmental factors are being used to forecast the disease severity. Further, the knowledge of weather conditions for the development and spread of disease are important to organize agro advisory services to the farmers to take up timely management practices.

The role of temperature, relative humidity (RH) and rainfall on powdery mildew development in cucumber was studied under field conditions during late *kharif* and *rabi* 2016. The rate of disease development was positively correlated with Maximum temperature (0.606) and Minimum temperature was found to be negatively correlated (-0.471), morning relative humidity was found to be negatively correlated (-0.531) Evening relative humidity (-0.608) is negatively correlated at one per cent significant and rainfall was also negatively correlated (-0.421) significantly. Number of rainy days were (-0.422) negatively correlated. Similar studies were conducted by Guzman Plazola *et al.*[7], and their observations revealed that temperature 32^0 C and above coupled with very low RH reduces the spore germination of *L. taurica* and progress of powdery mildew in tomato. Ashtaputre[3] while working with chilli powdery mildew observed maximum temperature had positive correlation and minimum temperature, maximum and minimum relative humidity and rainfall were

negatively correlated with disease development. In general, if low relative humidity is associated with warm weather, then the powdery mildew development is most rapid. The ability of the powdery mildew to spread under dry climatic conditions is largely due to the capacity of their conidia to dissemination of these spores and their germination at lower humidity than moist condition. The findings are in conformation with the reports of Reuveni and Rotem[8]. and Clerk and Ayesu–Offei while working with sunflower powdery mildew reported that the incidence decreases as the rainfall increases and vice-versa.

Table 1a: Effect of temperature and relative humidity on conidial germination of *E. cichoracearum*

Temperature (^{0}C)	**Conidial germination (%)**
5	7.22 (15.58)*
10	18.11 (24.01)
15	19.55 (27.39)
20	21.15 (29.62)
25	48.52 (45.07)
30	46.12 (43.75)
35	29.30 (34.07)
40	13.19 (21.29)
S.Em. ±	0.68
C.D. (P = 0.01)	2.81
Relative humidity (%)	**Conidial germination (%)**
65	16.31 (23.81)*
70	26.52 (30.99)
75	30.04 (33.22)
80	41.61 (40.15)
85	46.72 (43.10)
90	41.86 (40.30)
95	31.62 (34.20)
100	26.87 (31.21)
S.Em. ±	0.65
C.D. (P = 0.01)	2.69

* Figures in the parenthesis are arc sine transformed value

Table 1b: Effect of dates of sowing in relation to cucumber powdery mildew severity

Treatments (Date of sowing)	**Per cent disease index (PDI)**					**Mean**
	45 DAS	**52 DAS**	**59 DAS**	**66 DAS**	**73 DAS**	
I Fortnight of July	3.22 (10.33)*	5.28 (13.28)	7.48 (15.87)	9.15 (17.60)	14.66 (22.50)	**7.96 (16.38)***
II Fortnight of July	5.22 (13.20)	7.55 (15.94)	14.97 (22.75)	15.55 (23.22)	22.66 (28.41)	**13.19 (21.29)**
I Fortnight of August	4.15 (11.75)	22.66 (28.41)	36.79 (37.33)	53.26 (46.85)	59.35 (50.37)	**35.24 (36.40)**
II Fortnight of August	16.79 (24.18)	32.77 (34.91)	39.35 (38.84)	52.12 (46.20)	66.15 (54.40)	**41.44 (40.06)**
I Fortnight of September	11.45 (19.77)	28.12 (32.01)	31.11 (33.89)	38.35 (38.25)	59.86 (50.66)	**33.78 (35.52)**
II Fortnight of September	10.79 (19.17)	22.77 (28.49)	36.35 (37.66)	38.12 (38.11)	43.15 (41.05)	**30.24 (33.35)**
I Fortnight of October	11.25 (19.77)	26.66 (32.01)	30.54 (33.89)	38.55 (38.25)	56.45 (50.66)	**32.69 (35.52)**
S.Em. ±						1.87
C.D. (P = 0.05)						5.47

* Figures in the parenthesis are arc sine transformed value

Table1c. Correlation coefficient between weather parameters and per cent disease index (PDI) of Powdery mildew of cucumber caused by *Erysiphe cichoracearum*

Sl. No	Weather parameter	Correlation coefficient
1	Max. temperature	0.606
2	Min. temperature	-0.471
3	Max. relative humidity	-0.531
4	Min. relative humidity	-0.608
5	Rainfall	-0.421*
6	No. of rainy days	-0.422*

Significant at 5% level of probabilities

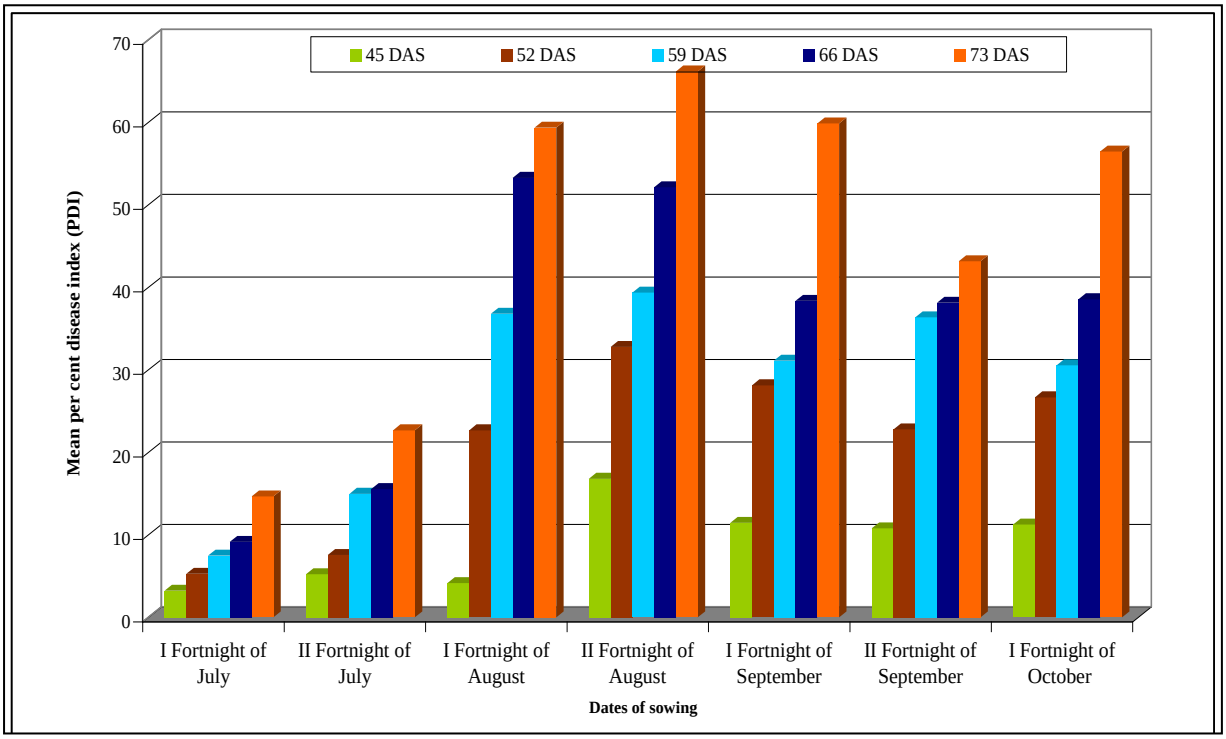

Fig. 1a: Effect of different dates of sowing on powdery mildew severity of cucumber

CONCLUSIONS

Highest germination of conidia (48.52 %) was found at 25^0 C temperature and 85 per cent relative humidity. However, the optimum temperature range of 25 to 30^0 C and 80 to 90 per cent of RH was good for conidial germination of *E. cichoracearum.*

Among different dates of sowing, second fortnight of August recorded maximum disease severity and first fortnight of July resulted in least severity and all the dates of sowing are significantly correlated negatively with weather. Relative humidity and temperature were positively correlated whereas rainfall and number of rainy days are negatively correlations.

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