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Original Research Article

Role of Critical Environmental Parameters Favouring for Infection and Development of Pearl Millet Blast

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Keywords

Date of sowing, Blast disease, Pearl millet, Weather parameters

A B S T R A C T

Blast incited by Pyricularia grisea (Cooke) Sacc. has become wide spread and destructive disease of pearl millet particularly in the crop cultivated for fodder purpose. Crop was sowing in 5 different dates at weekly interval starting from the last week of June during 2015-16 and 2016-17 to observed severity of blast of pearl millet. The infection and development of blast positively and significantly influenced by maximum relative humidity (r = 0.724**), minimum relative humidity (r = 0.650**), rainfall (r = 0.884**) while it was negatively and significantly influenced by maximum temperature (r = -0.463*) and minimum temperature (r = -0.638**). The evaporation and duration of sunshine hrs did not influence it significantly. The average maximum and minimum relative humidity should be more than 65 and 30 percent respectively whereas the maximum temperature should be less than 34.5 c. In assessing the percentile contribution rainfall (62.201) had contributed the highest proportion followed by maximum relative humidity (43.138), minimum temperature (18.593) and maximum temperature (13.465), whereas evaporation and sunshine hours did not influenced the disease significantly.

Introduction

Pearl millet [*Pennisetum glaucum* (L.)R. Br.] belongs to family Poaceae (section Paniceae) is the world's hardiest warm-season cereal crop with the annual rainfall of 150 mm to 1000 mm. It is cultivated in over 30 countries of Asia, Africa and America where dry land system is possible. India and Africa are together occupying approximately 90% area of total pearl millet in the world (Yadav *et al.*, 2012). It is staple food of majority of the poor and small land holders, as well as feed and fodder for livestock in the rainfed regions of the country. The important pearl millet growing states in the country are Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka and Madhya Pradesh. It is being grown in Madhya Pradesh as sole crop and Rajasthan ranks first in the area and annual production. The crop has a great potential to grow on soils that are too sandy, light-textured, acidic, dry and too infertile for other cereals. The major area of pearl millet cultivation in the state is confined to its northern region compressing Morena, Bhind, Gwalior, Datia, Sheopur, Shivpuri, Alirajpur, Jhabua districts. These districts jointly contribute more than 75% share of the state in its area and production.

In India, it is popularly known as bajra grown for grain and fodder purpose and cultivated over an area of 6.98 million ha with the production of 8.06 million tones and the productivity is 1154 kg/ha (Anon, 2016). Madhya Pradesh occupies 0.27 million ha with an annual production 0.59 million tones and productivity is 2203 kg/ha (Anon. 2016).

The role of meteorological parameters on the infection and development of blast was studied. Through field experiment in two consecutive years that is Kharif 2015 & 2016. The results of correlation study between blast severity and meteorological parameters reveals that maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall significantly influenced the development of blast whereas evaporation and sunshine hours did not influenced the disease significantly.

Materials and Methods

An experiment was laid out at experimental farm of College of Agriculture, Gwalior on five different dates of moderately blast susceptible cultivar JBV-2 was planted in five different dates at weekly interval starting from the last week of June during 2015-16 and 2016-17. The experiment was conducted in RBD design with four replications. Spacing was maintained as 30 cm row to row and 10 cm plant to plant. Fertilizers @ N 80 kg, P 40 kg and K 40 kg /ha were applied as basal dose before sowing. Forty plants from each date will be randomly selected after thinning (approximately 15 days after sowing) at pre tillering. Those plants will be inoculated with spore suspension of *P. grisea.* The progressive blast infection on the tagged plants will be recorded at weekly interval simultaneously. The meteorological parameters data on temperature, relative humidity (RH), rainfall and number of sunshine hrs were also recorded separately weekly interval during crop season in year 2015-16 and 2016-17 from the Meteorological Department of College of Agriculture Gwalior. Symptoms appeared after inoculation on plant. .Progressively development of symptoms on plant was recorded at weekly interval. There after correlation and regression studies will be carried out in between the leaf blast severity and individual metrological parameters. Further Disease incidence (%) for leaf blast was calculated.

Disease incidence (%) =

$$\frac{\text{Total Infected plants}}{\text{Total number of plants Observed}} \times 100$$

Results and Discussions

The role of meteorological parameters on the infection and development of blast was studied. The correlation coefficient between maximum temperature and disease severity R= -0.463* reveals that the maximum temperature negatively and significantly influenced the disease. Similarly the correlation coefficient between minimum temperature and blast severity R =-0.638** reveals that the minimum temperature negatively and highly significantly influenced the disease. The maximum (R = 0.724^{**}) and minimum (R = 0.650^{**}) relative humidity showed a highly significant and positive correlation with blast severity. Similar to relative humidity, rainfall also showed a highly significant positive correlation (R = 0.884**) with the blast severity.

Further the quantitative assessment of the meteorological parameters was worked out through regression study. The regression equation Y1= 34.19- 0.889X reveals that the average maximum temperature should be less than 34.45ºc for disease development thereafter the decrease of 1 c in maximum temperature the severity would increase by

0.88%. The regression study between maximum relative humidity & blast severity Y3 = -12.90+0.198X reveals that the maximum relative humidity should be more than 65% for the initiation of the disease and thereafter with 1% increase in average maximum relative humidity the blast severity would increase by 0.19%. The regression equation (Y4=-3.390+0.115X) reveals that the minimum relative humidity should not be less than 29.5% and thereafter with 1% increase in minimum relative humidity the blast severity would increase by 0.115% (Table 1 and 2).

Table.1 Role of weekly meteorological parameters on the progressive development of Blast severity

Date of observation	Temperature °C		Relative humidity %		Rain fall	Evaporation	Sunshine hrs	Blast severity
	Max.	Mini.	Max.	Mini.				
23/7/15	33.4	26.4	88.2	71.8	47.6	4	7.6	4.5
30/7/15	32.8	24.7	90.4	68.1	39.4	3.6	7.6	5.05
6/8/2015	33.4	25.6	81.8	56.7	13.6	5	5.6	3.23
13/8/2015	33.8	27.7	87.7	67.8	44.8	3.8	7.4	6.27
20/8/15	33.2	29.9	94.1	81.5	85.4	2.3	6	12.04
27/8/15	33.8	25.5	78	59	0	6.5	3	2.3
3/9/2015	35.3	26.6	73.7	57.7	0	5.2	7.7	1
10/9/2015	36.9	24.4	57.1	34.7	0	8.1	8.8	0.5
17/9/15	37.1	25	81	41.5	46	5.8	6.8	4.2
24/9/15	35.1	26.6	84.2	54.7	51.2	3.8	7.6	5.16
31/9/15	35.1	24	65.4	34.8	0	5.9	5.6	0.45
8/10/2015	37.7	19.7	77.1	26	0	5.4	7.6	1.45
20/7/16	31.8	26.2	86.3	76.8	29.2	3.0	2.3	2.2
27/7/16	35.6	27.2	81.2	61.4	44.0	1.0	6.4	1.5
3/8/2016	33.1	27.3	96.6	77.1	76.7	5.0	1.2	8.7
10/8/2016	33.1	25.9	90.9	74.5	57.0	4.0	2.9	5.7
17/8/16	32.1	25.7	90.1	72.9	65.2	3.0	2.1	4.2
24/8/16	30.9	24.5	90.3	74.1	56.0	3.0	3.2	6.1
31/8/16	33.1	25.6	90.1	67.4	17.0	3.0	3.2	2.6
7/9/2016	33.7	25.8	82.3	65.9	10.0	3.0	4.7	1.7
14/9/16	34.3	23.3	70.4	52.0	0.0	0.0	6.2	0.6
21/9/16	34.6	24.0	89.6	62.3	9.2	1.0	3.9	2.1
28/9/16	34.9	24.2	86.6	54.3	0.0	0.0	4.8	1.8
5/10/2016	35.6	21	65.5	29.8	0	5	7.4	0.7

Table.2 Relationship between individual meteorological parameters and blast severity

S.No.	Metrological parameter	Correlation coefficient	Regression equation
1	Maximum Tem.(°c), x_1	-0.463*	Y=34.19- 0.889X
2	Minimum Tem. (°c), x_2	-0.638**	Y=-19.81+0.921X
3	Maximum R.H., (%) x_3	0.724**	Y= -12.90+0.198X
4	Minimum R.H. (%)x_4	0.650**	Y= -3.390+ 0.115X
5	Total Rainfall (mm) x_5	0.884**	Y= 0.895+ 0.089X
6	Evaporation (mm) x_6	-0.078^{NS}	Y=3.824-0.096X
7	Sunshine hrs X_7	-0.223^{NS}	Y=6.433-0.602X

* Significant at 5%, ** highly significant at 5%, NS-Non significant at 5%

Table.3 Regression coefficient of blast severity on meteorological parameter

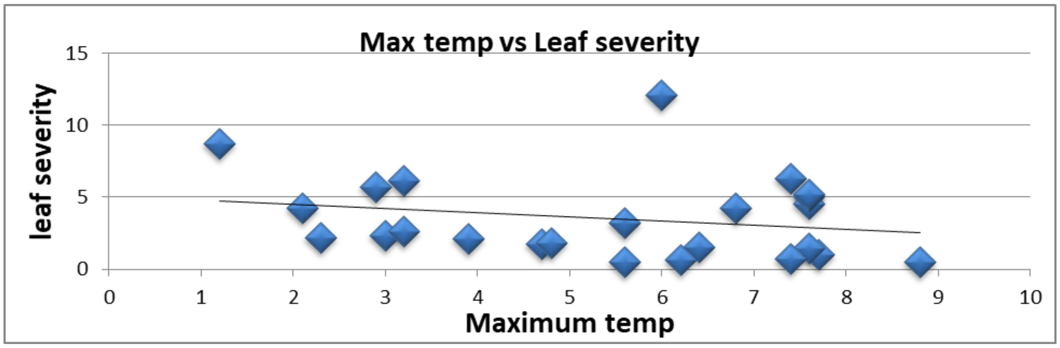
S.No.	Characteristics	BETA	BETA x R	REG. COEF.-B
1	Maximum temperature (X1)	-0.245	13.465	-0.416
2	Minimum temperature (X2)	0.245	18.593	0.334
3	Maximum relative humidity (X3)	0.502	43.138	0.144
4	Minimum relative humidity (X4)	-0.416	-32.101	-0.075
5	Total Rainfall (X5)	0.593	62.201	0.061**
6	Evaporation (X_6)	0.135	-1.247	0.191
7	Sunshine hrs (X_7)	0.153	-4.049	0.198
Multiple R^2= 0.8423				

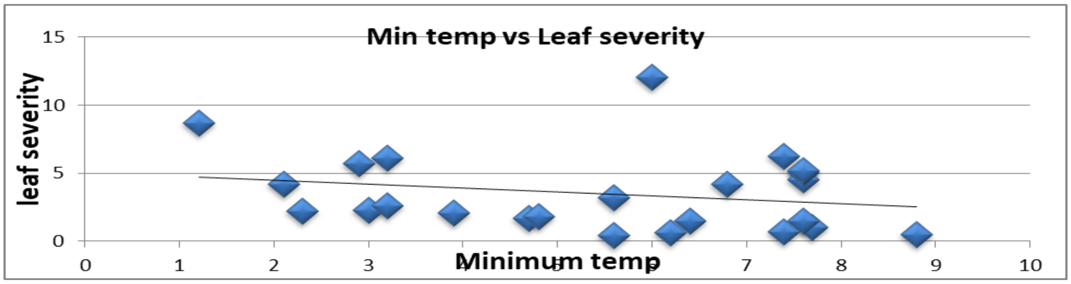
BETA = Partial contribution towards blast severity.
BETA x R =Percent contribution towards R^2 Values of different metrological parameters
Regression coefficient B= Regression coefficient of blast severity on metrological parameters
*=Significant at p= 0.05
**=Significant at p=0.01

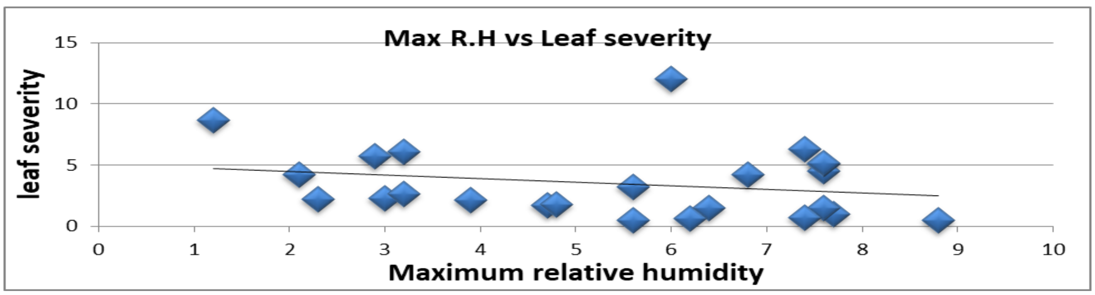
Table.4 Step down regression analysis: The 7th step showing regression coefficient of blast severity on the total rainfall

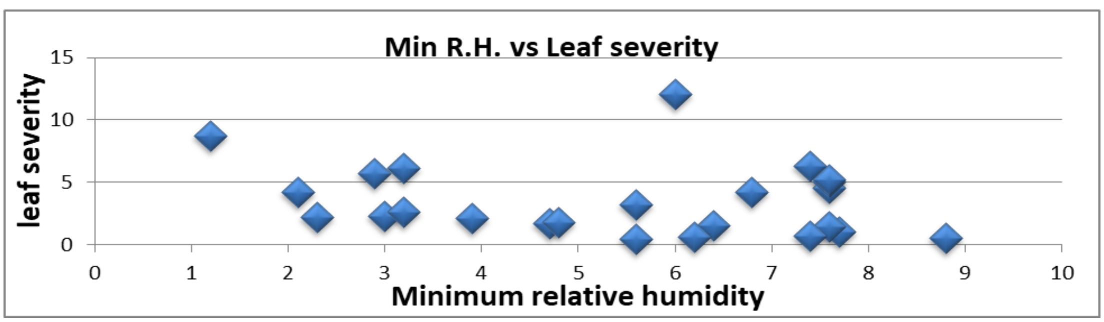
S.No.	Characteristics	BETA	BETAXR	REG. COEF.-B
1	Total rainfall (X5)	0.884	100.000	0.091**
Multiple R^2 = 0.7817				

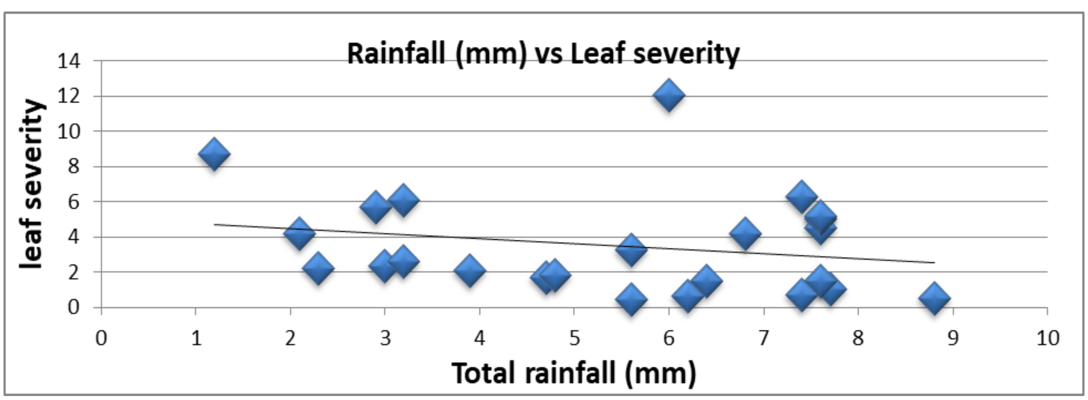
BETA = Partial contribution towards blast severity.
BETA x R = Percent contribution towards R^2 Values of total rainfall
Regression coefficient B= Regression coefficient of blast severity on total rainfall
*=Significant at p= 0.05
**=Significant at p=0.01


Max temp vs Leaf severity
leaf severity
Maximum temp


Min temp vs Leaf severity
leaf severity
Minimum temp


Max R.H vs Leaf severity
leaf severity
Maximum relative humidity


Min R.H. vs Leaf severity
leaf severity
Minimum relative humidity


Rainfall (mm) vs Leaf severity
leaf severity
Total rainfall (mm)

The regression equation between rainfall and blast severity (Y5=0.895+0.089X) accelerate infection and development of blast. The evaporation and sunshine hours did not showed their significant effect on the development of blast severity. In multiple regression study the partial contribution of meteorological parameters, towards blast severity, the regression coefficients (standard as well as partial) of metrological parameters on blast severity were worked out taking blast severity as dependent variable and meteorological parameters as independent variables. The results are presented in table 3 clearly indicate that rainfall had recorded a significant "t" value for its respective partial regression coefficient to employ that this had got substantial effect in quantifying the blast severity.

In assessing the percentile contribution rainfall (62.201) had contributed the highest proportion followed by maximum relative humidity (43.138), minimum temperature (18.593) and maximum temperature (13.465). The multiple R2 (coefficient of determination) value had been found 84.23 percent to employ that all independent variables put together 84.23 percent of total variation had been rendered explicable. The step down regression analysis depicted that rainfall had been retained at the seventh step (Table 4). This, however, elucidated their stupendous contribution (R2 = 78.17 percent) towards the total variation 84.23 percent. In other words it can be stated that only 6.06 percent variation in blast severity was unexplained by this one variable.

The present finding of the result is similar to Yadav *et al.* (2016) who concluded that the various weather variables such as temperature (T), relative humidity (RH) and rainfall influence different parameters of infection process and disease development. Correlation studies showed significant and negative correlation with average maximum temperature (r= 0.647*). In contrast to temperature, the maximum relative humidity and minimum relative humidity showed a significant positive relationship with the disease. The total rainfall showed a significant positive relationship with the disease (r = 0.668*) indicate that the blast severity increases with the increase in total rainfall. Development of pearl millet blast is favored by temperature 30-35 c, relative humidity 50-75 % with intermittent rains (190-100mm) proved most effective for disease development.

Netam *et al*. (2014) also observed incidence and severity of blast on different dates of sowing of finger millet. Minimum leaf blast severity and neck and finger blast incidence as well as highest grain yields were recorded from 1st June sown crop during both the years. The weather parameters recorded and correlated with disease development, in two years indicated that the average minimum and maximum temperatures of 21 C and 29 C respectively at 70-81% relative humidity were most important factors favoring blast disease development. Present study indicated that decrease in temperature and increase in humidity may favor the disease development and may cause epidemic of leaf blast or neck blast or finger blast. Patro *et al.* (2014) concluded the under favorable environmental conditions the losses caused by *Pyricularia grisea* are severe due to leaf, neck and finger blast in finger millet. The highest incidence of neck blast of 72.67 and 67.00 per cent was noticed in the susceptible genotypes VR-708 and KM-252 respectively in June 16th sown crop, where minimum temperature of 26.1 C, maximum temperature of 32.36 C, relative humidity of 89.9 percent and a very high amount of rainfall prevailed. Similarly highest incidence of leaf blast was recorded in June

16th sown VR-708. The investigations revealed that increased leaf, neck and finger blast was due to increased temperature, significantly high amount of rainfall and high relative humidity and vice versa for low blast disease development.

The present finding is also supported by Shafaullah *et al.* (2011) who observed a negative correlation between temperature and incidence of the disease. This indicated that the disease incidence increased with decrease in temperature. However, humidity was positively correlated with paddy blast that indicated increased in disease as the humidity increased. Rainfall was also positively correlated with incidence of disease.

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