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Survey and Effects of Weather Parameters on Powdery Mildew of Black Gram Caused by *Erysiphe Polygoni* DC

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Abstract— *Surveys were conducted during kharif 2018 in ten villages viz., Gandholi, Noorda, Joonawas, Odwariya, Banora, Malpur, Panarwa, Oda, Khandiovri and Sundara of four tehsil's (Mavli, Salumbar, Jhadol and Kherwara) of Udaipur district. The maximum (54.67%) disease incidence was recorded in Joonawas village (Mavli tehsil) with 43.22% disease severity while, minimum incidence 25.40% with 19.54% severity from Malpur village (Salumber tehsil). Study of weather parameters in relation to powdery mildew development revealed that, the maximum disease severity (8.67-58%) was found during July 30- Sept 2, 2018. During this period the maximum temperature (29.1-30.5˚c), minimum temperature (22-22.9˚c), maximum relative humidity (82.6-85.1%), minimum relative humidity (58.6-78.3%), sunshine (1.2-3.6 hours) and rainfall (17.4-67.6 mm) was favoured for powdery mildew development.*

Keywords— ***Survey, Weather, Powdery Mildew, Black Gram, Erysiphe Polygoni.***

I. INTRODUCTION

Black gram [*Vigna mungo* (L.) Hepper] is the most important grain legumes. It is from *Fabaceae* family with 2n=22 Chromosomes and it is believed to have originated in India (Chatterjee and Bhattacharya, 1986). Black gram cultivation is suitable for hot and moist weather condition. Black gram is well known protein rich *kharif* pulse crop in India, which is approximately three times richer than cereals (Kanade, 2006). It is the most important pulse crop in India as it is produced about 2.83 million tonnes annually from about 44.78 lakh hectares of area and an average productivity is 632 kg per hectare (Anon., 2017a).

Black gram is attacked by several diseases like- Anthracnose- *Colletotrichum lindemuthianum* (Sacc. and Magnus) Briosi and Cavara, Bacterial leaf blight- *Xanthomonas phaseoli* (Dowson), *Cercospora* leaf spot- *Cercospora canescens* (Ellis and Martin), Powdery mildew- *Erysiphe polygoni* (De Candolle), Root rot- *Rhizoctonia solani* (Kuhn), Rust- *Uromyces phaseoli* (Winter), *Macrophomina* blight- *Macrophomina phaseolina* (Tassi) Goid., Yellow mosaic disease- *Mungbean yellow mosaic virus* and Leaf crinkle disease - *Leaf crinkle virus* (Anon., 2014). Powdery mildew of black gram incited by *Erysiphe polygoni* (De Candolle) is the major problem in black gram production, it causes both quantitative and qualitative losses of grains. This disease has been observed severe mainly in late sown *kharif* crop and remains active throughout the year. The powdery mildew disease interferes in photosynthetic activity and causes significant physiological changes in plants, which causes reduction in yield (20-40 per cent) depending on the stage and time at which the disease appears (Legapsi *et al*., 1978; Singh, 1995).

II. MATERIALS AND METHODS

The investigations on "Epidemiology of Powdery Mildew of Black Gram Caused by *Erysiphe polygoni* DC" was conducted during *Kharif* 2018. The laboratory studies were carried out in the Plant Pathology Department and the field experiments were conducted at agronomy farm of RCA, MPUAT, Udaipur. The detailed information of experimental techniques and materials used for these studies are described below.

Surveys were carried out to know the occurrence and incidence of powdery mildew of black gram disease at farmers' fields of Udaipur district during *kharif* season

2018. In Udaipur district randomly ten black gram growing villages *viz*., Gandholi, Noorda, Joonawas, Odwariya, Banora, Malpur, Panarwa, Oda, Khandiovri and Sundara from four tehsils (Mavli, Salumber, Jadhol and Kherwara) were surveyed to record the incidence and severity of powdery mildew disease. In each field, four plots of 1 m×1 m area were randomly selected and the powdery mildew incidence was recorded by counting the total number of plants and the infected plants in the selected area. The per cent disease incidence was calculated by the following formula:

$$\text{Per cent disease incidence} = \frac{\text{Total number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

Powdery mildew severity was recorded by observing leaf area covered by the pathogen on the plants in selected areas. Powdery mildew disease severity was recorded by 0 to 5 rating scale of Gawande and Patil (2003). Where, 0 = No infection; 1= 0.1-10.0 % leaf area infection, 2 = 10.1-25 % leaf area infection, 3 = 25.1-50 % leaf area infection, 4 = 50.1-75 % leaf area infection, 5 = >75.1-100 % leaf area infection.

The recorded values were transformed into per cent disease index (PDI) by following formula given by wheeler (1969).

$$\text{Percent disease index} = \frac{\text{Sum of the individual disease ratings}}{\text{No. of leaves observed x Maximum disease grade}} \times 100$$

Identification of the pathogen

Black gram leaves infected with powdery mildew showing the fresh white powdery patches symptoms were collected from field and brought in laboratory to identify the pathogen. With the help of Camel brush, the powdery mass was mounted in the lactophenol on the glass slide. For the identification of the pathogen these mounted slides were examined under low and high-power objective lens of a compound microscope and the pathogen was identified by morphological characters of conidia and mycelium described by (Hans and Boeswinkel, 1980; Basu *et al*., 2006 and Patil *et al*., 2017a).

Effect of environment factors on black gram powdery mildew disease development under field conditions.

Field experiment was conducted in *kharif* 2018 during July to Sept 2018 at Agronomy Farm, Rajasthan college of Agriculture, MPUAT, Udaipur. The experiment was conducted in Randomized block design (RBD) in three replications. The moderately susceptible black gram cultivar "PU 31" was sown at 30 cm × 10 cm distance in four rows of 1.2 m × 3 m (3.6 m^2) size plots. All the agriculture activities were followed as per package and practices. After the initiation of powdery mildew disease symptoms, the observations were started to recorded at seven days interval and continued until disease severity reached maximum up to physiological maturity of the crop on 0-5 rating grade in terms of per cent disease severity (Gawande and Patil, 2003).

The observations for powdery mildew development in relation to effect of weather elements was recorded up to eleven weeks after sowing. Minimum ten plants were randomly selected and tagged in each replication. For observations these tagged plants were assessed for disease progress in each replication. In each plant two upper, two middle and two lower leaves were assessed for powdery mildew development. The weather data *viz.,* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine and rainfall were collected from Meteorological observatory unit of Agronomy department, RCA, Udaipur. The statistical analysis [multiple linear regression (Panse and Sukhatme, 1985)] was done based on average weekly data of per cent disease index and average weekly meteorological data using MS Excel Software.

$(R^2)\ Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6$

Where: -

R^2 = multiple correlation coefficients

Y = per cent disease index (dependent variable)

a = constant (intercept)

b_1, b_2, b_3, b_4, b_5 and b_6 = partial regression coefficients

X_1 = maximum temperature

X_2 = minimum temperature

X_3 = maximum relative humidity

X_4 = minimum relative humidity

X_5 = Sunshine

X_6 = Rainfall

Statistical Analysis

The data from all the experiment were statistically analyzed. For laboratory experiment Completely randomized design (CRD) was followed, while for field experiment the Randomized block design (RBD) was followed. For the epidemiological studies the correlation and regression analysis were calculated between weather parameters and PDI (Per cent disease index).

III. RESULT & DISCUSSION

1. Survey for powdery mildew (*Erysiphe polygoni*) incidence in different black gram growing areas of udaipur district

Surveys were conducted to know the occurrence and incidence of black gram powdery mildew at farmers's fields of Udaipur district during *kharif* season 2018. Ten black gram growing villages (Gandholi, Noorda, Joonawas, Odwariya, Banora, Malpur, Panarwa, Oda, Khandi ovri and Sundara) belongs to four different tehsils (Mavli, Salumber, Jadhol and Kherwara) of Udaipur were selected randemly to record the incidence and severity of powdery mildew disease. In these villages farmers were mostly growing local land race and hybrid varieties *i.e*., PU 31, PU 1 and Azad-3 of black gram (Table-1). In the surveyed villages average per cent disease severity and incidence ranged from 19.54% to 43.22% and 25.40% to 54.67%, respectively. The highest (54.67%) disease incidence was observed in Joonawas village of Mavli tehsil with 43.22 per cent disease severity on "local variety" of black gram followed by Odwariya village (Mavli tehsil) had 50.89% disease incidence with 38.56 per cent disease severity on black gram variety "Pratap urd 1", Sundara village (Kherwara tehsil) (49.23% disease incidence) with 41.90 per cent disease severity on local variety of black gram and Khandi ovri village (Kherwara tehsil) (47.20 % disease incidence) with 39.84 per cent disease severity on local variety, Gandholi village (Mavli tehsil) (45.20% disease incidence) with 39.73 per cent disease severity on black gram variety "Pratap urd 1", Noorda village (Mavli tehsil) (43.40% disease incidence) with 35.91 per cent disease severity on black gram variety "PU 1", Banora village (Salumbar tehsil) (38.45% disease incidence) with 30.25 per cent disease severity on black gram variety "PU 31", Panarwa village (Jadhol tehsil) (34.30% disease incidence) with 27.82 per cent disease severity on black gram variety "PU 31", Oda village (Jadhol tehsil) (33.16% disease incidence) with 25.98 per cent disease severity on black gram variety "PU 31" and lowest disease incidence (25.40%) is recorded in Malpur village of Salumber tehsil with 19.54 per cent disease severity on black gram variety "Azad 3" (Table-2).

Table- 1. Effect of environmental factors on black gram powdery Mildew (Erysiphe polygoni) development under field condition

Week No.	*SMW	Period	Temperature (°C)		R. H. (%)		Sunshine (Hrs)	Rainfall (mm)	PDI** (%)
			Max.	Min.	Max.	Min.			
1	29	July 16-22 ,2018	30.1	23	90.9	81	1.2	98.2	0
2	30	July 23-29, 2018	28.2	22.9	82.1	74.6	0.9	2.4	0
3	31	July 30-Aug 5 , 2018	30.5	22.7	75.6	58.6	3.6	0	8.67
4	32	Aug 6-12, 2018	29.6	22.4	85.1	73.9	1.6	27.2	20.67
5	33	Aug 13-19, 2018	30.8	22.9	82.7	72.1	2.8	67.6	36.67
6	34	Aug 20-26, 2018	28.6	22.5	82.6	78.3	1.2	33.6	42.67
7	35	Aug 27-Sept 2, 2018	29.1	22	83.7	74.1	1.7	17.4	58.00
8	36	Sept 3-9, 2018	28.3	21	81.7	69.1	4.1	11	64.00
9	37	Sept 10-16, 2018	27.9	21	83.7	64.7	3.3	8.8	68.00
10	38	Sept 17-23, 2018	32.3	19.6	81.3	52.4	6.5	28.8	81.34

*Standard meteorological week **Per cent disease index; Mean of three replications

Table–2. Survey for powdery mildew (Erysiphe polygoni) incidence in different black gram growing area of Udaipur district

S. No.	Name of Tehsils	Name of village	Black gram cultivar	*Mean Incidence (%)	*Severity (%)
1.	Mavli	Gandholi	Pratap urd 1	45.20 (44.23)	39.73 (39.06)
		Noorda	Pratap urd 1	43.40 (41.19)	35.91 (36.80)

		Joonawas	Local variety	54.67 (47.66)	43.22 (41.09)
		Odwariya	Pratap urd 1	50.89 (45.49)	38.56 (38.37)
2.	Salumbar	Banora	PU 31	38.45 (38.31)	30.25 (33.35)
		Malpur	Azad 3	25.40 (30.25)	19.54 (26.22)
3.	Jhadol	Panarwa	PU 31	34.30 (35.84)	27.82 (31.82)
		Oda	PU 31	33.16 (35.15)	25.98 (30.63)
4.	Kherwara	Khandi ovri	Local variety	47.20 (43.38)	39.84 (39.12)
		Sundara	Local variety	49.23 (44.54)	41.90 (40.32)
SEm±				0.02	0.03
CD *(P=0.05)*				0.06	0.09

*Mean of three replications: Figures given in Parentheses are arcsine √ Per cent angular transformed values

Disease symptoms on black gram plant

The powdery mildew (*E. polygoni*) symptoms on black gram were first appeared as small, white powdery colonies on upper surface of infected leaves. When the disease progressed, these white powdery patches enlarge and joined together and covers both the surface of infected leaves. This white powdery mass consists of mycelium, conidiophores, and conidia. The lower leaves of infected plants turn yellow, later yellow-brown, and finally cover all parts of the plant. In the later stages the white patches turn in dirty grayish and dry.

characteristics of *Erysiphe polygoni*

Morphological characters of black gram powdery mildew pathogen *E. polygoni* were examined in the laboratory. The leaves showing white powdery mass of fungus was scraped with the help of brush and the slide was prepared in lacto phenol and cotton blue than examined under the compound microscope at 40X. The external mycelium was white in colour, hyphae was hyaline, branched and septate. The conidiophores were simple, erect, hyaline in colour and cylindrical at base, bearing conidia singly or in chain at apex. The conidia were unicellular, oval to roundish or barrel shaped and hyaline in colour.

2. Effect of weather elements on black gram powdery mildew (*e. Polygoni*) development under field condition-

To study the relationship between weather parameters (maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine, rainfall) and powdery mildew development a field experiment was laid out at the agronomy farm of Rajasthan College of Agriculture, Udaipur during *kharif* season July to Sept. 2018. The black gram variety PU 31 was sown in 1.2 m × 3 m size plots at 30 cm × 10 cm in three replications. The relationship between the black gram powdery mildew disease progress and six weather parameters was studied for ten standard meteorological weeks. The data of weather parameters and disease development revealed that the disease was first appeared in first week of august. The observation was recorded after the initiation of disease at seven days interval up to third week of September. The observations of average weekly data of six weather parameters *i.e.* maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine, rainfall, and average Per cent disease index (PDI) were recorded and then correlated.

Data depicted from (Table-1) revealed that for the development of powdery mildew, the favorable weather

elements *viz;* maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine, and rainfall have in ranged from 27.9 to 32.3˚C, 19.6 to 22.9˚C, 75.6 to 85.1 per cent, 52.4 to 78.3 per cent, 1.2 to 6.5 hrs and 8.8 to 67.6 mm respectively. The disease severity in these data ranged from 8.67 to 81.34 per cent. The maximum disease development in increasing order was observed during standard week 31 to 33 with mean PDI 8.67 to 36.67 per cent. In 34th week the PDI (42.67) was increased with slowly increased rate and again in 35th week, the trend got fluctuated and the PDI (58.0) again increased with increasing rate and after that in 36th week the PDI was 64.0% and in 37th it was 68.0%, again the PDI increased but slowly and in the 38th week PDI was 81.34 with increasing trend.

The results revealed that the correlation between powdery mildew disease severity and maximum temperature (r = +0.064) was found non-significant and positive, Minimum temperature (r = -0.865) was found significant and negative, where as the sunshine (r = +0.664) was found significant and positive correlated with powdery mildew disease severity and the maximum relative humidity (r = -0.158), minimum relative humidity (r = -0.484) and the rainfall (r = -0.250) were found negative and non-significantly correlated with powdery mildew disease severity (Table-1).

The multiple linear regression analysis was done to find out the relationship between six independent variables (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine, rainfall) and dependent variable (per cent disease index- PDI). By fitting this equation, the contribution of independent variables in the powdery mildew development was observed.

R^2 $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6$

$R^2 = 0.8733$ $a = 1859.24$

$b_1 = - 5.13$ $b_2 = - 48.33$

$b_3 = - 7.85$ $b_4 = + 0.80$

$b_5 = - 13.10$ $b_6 = + 0.82$

$(0.87) = 1859.24 – 5.13\ X_1 - 48.33\ X_2 – 7.85\ X_3 + 0.80\ X_4 – 13.10\ X_5 + 0.82\ X_6$

The equation showed that the effect on PDI, if maximum temperature, minimum temperature, morning relative humidity and sunshine increased 1 unit the PDI decreased by 5.13, 48.33, 7.85 and 13.10, respectively. In case of evening relative humidity and rainfall increase in 1 unit the PDI will be increased by 0.80 and 0.82.

The coefficients of determination (R^2) were 0.8733. It indicated that there was 87.33% effect of these six weather elements on powdery mildew of black gram and the remaining 12.67% variations were unexplained. The results revealed that the higher temperature and low humidity favours the disease development.

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