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University of Calcutta, Kolkata 700 019, India

Role of weather parameters on occurrence of Downy Mildew of Pea

PUJA PANDEY[1], K.P.S. KUSHWAHA[2] AND VINOD UPADHYAY[3]
[1]*Department of Plant Pathology, Anand Agricutural University, Anand, Gujrat*
[2]*Department of Plant Pathology, G.B. Pant University of Agriculture and Technology, Uttarakhand*
[3]*Regional Agricultural Research Station, Assam Agricultural University, Jorhat, Assam*

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The effect of weather factors on the development of downy mildew in pea was conducted at N.E. Borlogue Crop Research (NEBCRC) Station, G.B. Pant University of Agriculture and Technology, Pantnagar. The results of the present investigation revealed that the downy mildew severity has positive relationship with minimum temperature and relative humidity whereas, it has negative relationship with rainfall and maximum temperature. Multiple regression analysis of pooled data (2014-2015) showed that maximum, minimum temperatures, rainfall and relative humidity significantly influenced the development of downy mildew of pea.

Key words: Correlation, downy mildew, pea, weather

INTRODUCTION

In all over the world, India is the largest producer, consumer and importer of pulses. In India area under pulses is around 25.1 million hectares and annual production of pulses is 22.14 million tonnes (Anonymous, 2017). Pulses are one of the most important source of energy that have been extensively used as source of basic protein and energy. The range of protein content in pulses is from 18 to 25 per cent, making them one of the cheapest sources of protein available for human consumption.

Among all pulses more imports of dry peas in recent years due its lower international prices have resulted in its increased share in the domestic pulse consumption. Because of the biotic and abiotic stresses there is high level of fluctuations in pulse production and prices farmers are not very interested on taking up pulse as cultivation. Low pulse yield in India compared to other countries is because of poor spread of improved varieties and technologies, climatic changes, vulnerability to pests and diseases and generally declining growth rate of total factor productivity. Peas are highly nutritive and generally contain 23 per cent protein, 48 per cent starch, 8 per cent sugar, 4 per cent lipid, 7 per cent crude fiber and 3 per cent ash **.** The annual export of pea in 2016-17 was 6.43 thousand tonnes which constituted 6.53 per cent of the total pulse export from India (Anonymous, 2017a)**.** The disease Downy mildew is caused by *Peronospora pisi* Syd, and is most common foliar disease of the pea (*Pisum sativum* L.). In susceptible varieties, it may cause yield loss up to 55 per cent. It occurs commonly in the vegetative stage of the crop leading to significant losses all around the globe wherever the peas are grown (Amey and Spencer- Phillips 2006). Variable ripening is one of the adverse effects of downy which may create serious problems for the processing industries. Epidemic of the disease was reported in the USSR. It has been reported that there was 60-85 per cent pod destruction in epidemic years.

The disease severity is highly influenced by the different weather parameters such as temperature, relative humidity, rainfall and wind velocity. The results of the present investigation revealed that the rust severity has positive relationship with temperature, rainfall and wind velocity whereas it shows negative correlation with relative humidity.

The epidemiological studies are useful in planning the agronomic practices to manage the disease. Hence, the experiment was conducted to study

*Corresponding author E-mail: pujapandey41124@gmail.com

the effect of weather parameters on incidence of downy mildew.

MATERIALS AND METHODS

The present experiments were carried out at N.E. Borlogue Crop Research (NEBCRC) Station, G.B. Pant University of Agriculture and Technology, Pantnagar [29p N latitude and 79.73p E longitude, at an altitude of 243.8 m. above the mean sea level (MSL)].

Pantnagar falls in the humid and subtropical (Tarai) climate of North West Plain Zone (NWPZ). The zone lies at the foothills of Shivalic range in lower Himalayas. The climate of Pantnagar is humid subtropical with maximum temperature ranging from 32^0 C to 43^0 C in summer and minimum from 0^0 C to 9^0 C in winter. The average relative humidity is highest (70-90%) in July-August and December-January and lowest (35-40%) in April-May. Monsoon occurs from third week of June to middle of September. Average rainfall in this area is about 1400 mm per annum.

To study the effect of weather parameters on the incidence of downy mildew of pea variety viz., arkel was sown with wider spacing of 30 x 10 cm in three replications in 2.0 x 0.6 m^2 plots size using Randomized Block Design (RBD) during *Rabi* 2013-2014 and 2014-2015. The development of the disease was studied on the basis of symptoms on the leaves. The disease severity was recorded at weekly intervals till the complete drying of the leaves. The data was correlated with various weather parameters *viz.,* temperature (maximum and minimum), relative humidity (morning and afternoon) and total rainfall. The weather parameters were correlated with per cent disease severity by calculating the *Karl Pearson's correlation coefficient* (r) (Pearson, 1896) as given below :

$$r=\frac{1}{n\text{-}1}\sum\frac{(x_i-\overline{X})(y_i-\overline{Y})}{s_x s_y}$$

Where, r = coefficient of correlation, S_x = standard deviation of x series, S_y = standard deviation of y series, n= number of series.

Partial regression equations were calculated for the meteorological factors as independent variable with the prediction equation. The significance of partial regression coefficients was determined by 't' test.

Prediction equation $Y= b_0 + b_1X_1 + b_2X_2 \ldots\ldots\ldots b_7X_7$.

where, Y= Percent disease severity, b_0 = constant; b1, b2.....b_7 = regression coefficients and X_1, X2....X_7 = Independent weather variables.

RESULTS AND DISCUSSION

The disease was recorded 30 days after germination at 10 days interval (Table 1). An attempt was made to establish the relationship between disease severity and weather parameters through correlation and step down elimination of weather factors by significance of regression co-efficient.

Correlation among different weather parameters and the disease severity at weekly interval for the year 2014 are presented (Table 4). The correlation data of 2014 indicate that there was significant and negative correlation between disease severity and maximum temperature (-.985 *). A highly significant and positive correlation was found between disease severity and afternoon relative humidity (.992**). There was positive correlation between minimum temperature and disease severity (.225).

During year 2015 same pattern was observed (Table 2). The correlation data of 2015 (Table 4) indicates that there is negative correlation between disease severity and maximum temperature (0.156). A highly significant and positive correlation was found between disease severity and evening relative humidity (0.532*). There was positive correlation between minimum temperature and disease severity (0.225). In pooled data of 2014-15 similar pattern of correlation between disease severity and weather pattern was observed (Table 3).

The multiple linear regression equation after step down elimination in pea during 2014 for disease severity was, $Y= -72.40 - 1.21X_1 + 8.78X_2 + 7.07X_3 + 1.88X_4 - 1.55X_5$ indicating an unit increase in maximum temperature and rainfall will decrease disease severity by 1.21 and 1.55 units (Table 4.). Whereas, every unit increase in minimum temperature, relative humidity (morning and afternoon) will increase the severity of disease by 8.78, 7.07 and 1.88 units. The weather factors collectively influenced the disease severity to an extent of 99 per cent (R^2=0.99).

Table 1: Role of weather parameters on downy mildew of pea (2014)

Age of crop	Disease severity	Max. temp (°C)	Min. temp (°C)	Morning relative humidity	Evening relative humidity	Rainfall (mm)
30 DAS	20.17	21.6	8.5	92	59	0.0
40 DAS	24.36	19.2	5.4	96	67	11.8
50 DAS	29.16	17.1	5.9	97	71	0.2
60 DAS	35.33	16.1	7.5	96	79	0.5

Table 2: Role of weather parameters on downy mildew of pea (2015)

Disease severity	Max. temp (°C)	Min. temp (°C)	Morning relative humidity	Evening relative humidity	Rainfall (mm)
0.00	16.8	7.4	95.6	78.4	0.0
19.85	18.5	4.9	95.4	57.0	0.0
29.12	19.1	11.5	92.6	77.4	3.1
34.66	15.7	8.4	95.3	75.4	0.0

Table 3: Role of weather parameters on downy mildew of pea (Pooled)

Age of c rop	Disease s everity	Max. t emp (°C)	Min. t emp (°C)	Morn ing relative humidity	Evening relative humidity	Rainfall (mm)
30 DAS	10.09	19.2	7.9	93.8	68.7	0.0
40 DAS	22.11	18.85	5.2	95.7	62.0	5.9
50 DAS	29.14	18.1	8.7	94.8	74.2	1.6
60 DAS	35.00	15.9	7.9	95.6	77.2	0.3

Table 4: Correlation coefficients for effect of various weather parameters on Per cent disease severity in pea during *Rabi*, 2014, 2015 and pooled.

Percent disease severity	Maximum temperature (^{0}C)	Minimum temperature (^{0}C)	Morning RH (%)	Afternoon RH (%)	Rainfall
201 4	-0.985 *	0.225	0.757 *	0.992**	-0.225
201 5	-0.156	0.282	0.060	0.532 *	-0.630
Pooled (2014-201 5)	-0.87 0	0.25 0	0.70 0	0.68 0	-0.08 0

*Correlation is significant at the 0.05 level

Dependent Parameter (Disease severity)	Multiple regression equation	R^2
2014	Y= -72.40 - 1.21X1 + 8.78X2 + 7.07X 3+ 1.88X 4 - 1.55X5	0.99
2015	Y= -5.42 - 0.15 X 1+0.31 X 2+0.06 X 3+0.53 X 4-0.714 X 5	1.00
Pooled (2014-2015)	Y= -27.37 - 0.268 X 1+2.26 X2 +2.21 X 3+0.174 X 4 -0.714 X5	0.99

The multiple linear regression equation after step down elimination in pea during 2015 for disease severity was, Y= -5.42 - 0.15 X_1+0.31 X_2+0.06 X_3+0.53 X_4-0.714 X_5 indicating an unit increase in maximum temperature and rainfall will decrease disease severity by 0.15 and 0.714 units (Table 4). Whereas, every unit increase in minimum temperature, relative humidity (morning and evening) will increase the severity of disease by 0.31, 0.06 and 0.53 units. The weather factors collectively influenced the disease severity to an extent of 100 per cent (R^2=1.00).

The pooled data of 2014 and 2015 (Table 3 & 4,) regarding correlation and regression revealed that, disease severity had a negative correlation with maximum temperature (-0.87) and positive correlation with minimum temperature (0.25), morning and afternoon relative humidity (0.70 and 0.68).

The disease severity is highly influenced by the different weather parameters such as temperature, relative humidity. The results of the present

investigation revealed that the downy mildew severity has positive relationship with minimum temperature and relative humidity whereas, it has negative relationship with rainfall and maximum temperature. Ashraf (2010) investigated on downy mildew of grapes and reported that temperature has nonsignificant relation with infection rate, whereas, relative humidity and precipitation showed a significant and positive correlation. Similar results were found by Bal and Kumar (2012) who mentioned highly significant positive correlation between the disease severity and the maximum and minimum temperatures. Singh *et al*. (2012) also observed significant and positive correlation between rust severity and temperature. However, disease severity has a strong negative correlation with relative humidity. Many more researchers have observed the similar relationship between different weather parameters and rust severity. According to Upadhyay *et al*., (2017), the rust severity has positive relationship with temperature, rainfall and wind velocity whereas it shows negative correlation with relative humidity.

CONCLUSION

It is concluded that maximum, minimum temperatures, relative humidity and rainfall are the critical parameters contributing to the development of downy mildew of pea and farmers are advised to take up preventive or protective measures.

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