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Short Communication

Epidemiological study of soybean anthracnose and pod blight (*Colletotrichum truncatum* (Schw.) Andrus and Moore)

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Soybean (*Glycine max* L. Merril), a major oil seed cropcultivated in India and throughout the world, suffers from the devastating anthracnose disease caused by *Colletotrichum truncatum*. This disease affects nearly all of the plant's aboveground parts, including seedlings, stems, petioles, leaves, and pods, and results in significant yield losses worldwide(Sharma *et al*., 2011). The disease is recognised by irregular shaped dark-brown lesions or sunken lesions on the stem, petioles, and pods. Fungus survives externally and internally in seeds causing, local and systemic infections. As a result, soybean seed viability, seed germination and seedling stand all are reduced (Begum *et al*., 2008). Epidemiological studies play a very important role in developing forecasting models about disease progress in relation to environmental factors and also used to develop effective and successful integrated disease management strategies (Nutter, 2007).However, related information on the role of various weatherin favour of the occurrence and subsequent spread of soybean anthracnose/pod blight are inadequate. Therefore, the present study was conducted to investigate the role of environmental factorsin the development of soybean anthracnose/ pod blight disease caused by *C. truncatum*.

Study area

A three-year field study was conducted from 2017 to 2019 at the Soybean Pathology Block, Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar (79°29'27" E 29°01'19" N), to investigate the effect of meteorological factors on the development of foliar anthracnose and pod blight disease on four soybean varieties *viz*., PS 1042, PS 23, PS 1092, and Shivalik. The sowing of all tested varieties was done on July 17th, 2017, July7th, 2018 and July 1st, 2019, respectively, in a randomised block design with three replications. Each experimental plot measured 3 x 1 m^2 with row spacing of 30-40 cm and a plant spacing of 10 cm. Fertilizer was applied at the recommended rate of 20, 40, and 60 kg NPK ha^{-1}.

The disease pressure was measured from the onset of the disease to harvesting on a Standard Meteorological Week (SMW) basis, i.e., from the 36th to the 45th SMW. Ten plants of each variety were randomly selected and tagged to document the natural occurrence of foliar anthracnose and pod blight. Weekly observations of disease severity on leaves and pods were made using the 0 to 9 rating scale and further these scales were converted to percent disease index (PDI) using Wheeler's (1969)formula:

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of individual disease rating}}{\text{Number of plants assessed X Maximum rating}} \times 100$$

Weekly weather data on morning time relative humidity (RHm), evening relative humidity (RHe), minimum temperature (T_{min}), maximum temperature (T_{max}), and rainfall were obtained from agrometeorology observatory, located at nearby CRC, Pantnagar. The weather parameters were collected to establish their correlation with disease development using the Pearson correlation coefficient (r). On the basis of average weekly meteorological data and average weekly data of disease severity, the multiple regression analysis and step wise regression analysis was done for prediction of disease using SPSS software.

In a study, on the basis of data on percent disease index (PDI) of anthracnose and pod blight, four varieties: PS 1042, PS 23, PS 1092, and Shivalik, were evaluated as moderately resistant(14.93 and 14.77%), moderately susceptible (25.75 and 22.10%), susceptible (36.05 and 36.72%), and highly susceptible (56.32 and 56.07%), respectively. The disease initiated on leaves in the first fortnight of September (37th SMW) and on pods from the second fortnight of September (38th SMW) and gradually increased till the end of October and the first week of November, respectively. Disease appeared late in moderately resistant and moderately susceptible

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Table 1: Correlation coefficient of weather parameters with foliar anthracnose and pod blight of soybean for pooled data of three years

Weather Parameters	Correlation Coefficient (r) (Anthracnose)				Correlation Coefficient (r) (Pod Blight)			
	PS 1042	PS 23	PS 1092	SHIVALIK	PS 1042	PS 23	PS 1092	SHIVALIK
T_{max} (^{0}C)	-0.68	-0.69	-0.61	-0.66	-.91**	-.91**	-.89**	-.87**
T_{min} (^{0}C)	-.98**	-.99**	-.99**	-.99**	-.94**	-.96**	-.97**	-.97**
MRH (%)	-0.35	-0.37	-0.52	-0.48	0.15	0.12	0.06	0.02
ERH (%)	-.93**	-.96**	-.99**	-.98**	-.81**	-.83*	-.86**	-.88**
Rainfall (mm)	-0.61	-0.65	-0.69	-0.69	-0.56	-0.59	-0.63	-.64*

** Significant at 1% probability, * Significant at 5% probability, T_{max}= Maximum Temperature, Tmin= Minimum Temperature, MRH = Morning relative humidity, ERH = Evening relative humidity

Table 2: Multiple regression equations for foliar anthracnose and pod blight disease severity on soybean varieties for pooled data of three years

Cultivar	Multiple Regression Equation (Foliar anthracnose)	R^2	Multiple Regression Equation (Pod Blight)	R^2
PS 1042	$Y= -19.152 + 0.937X_1 – 2.071 X_2 + 0.293 X_3 + 0.192X_4 - 0.014 X_5$	0.98	$Y=20.983 – 0.311X_1 – 2.163 X_2 + 0.038 X_3 + 0.564 X_4 - 0.031 X_5$	0.96
PS 23	$Y= -34.553 + 1.159X_1 – 1.905X_2 + 0.790 X_3 - 0.382X_4 - 0.01- X_5$	0.99	$Y=45.889 – 0.807X_1 – 2.666 X_2 + 0.059 X_3 + 0.595 X_4 - 0.042 X_5$	0.97
PS 1092	$Y= 64.077+ 1.402X_1 – 2.993X_2 – 1.118X_3 - 0.345X_4 - 0.016 X_5$	0.99	$Y=100.144 – 1.250X_1 – 4.252 X_2 - 0.169 X_3 + 0.894 X_4 - 0.071 X_5$	0.98
SHIVALIK	$Y= 155.214 + 0.042X_1 – 5.028X_2 -0.285X_3 - 0.024X_4 - 0.069 X_5$	0.99	$Y=173.786 – 1.303X_1 – 7.070X_2 - 0.706X_3 + 1.558 X_4 - 0.107X_5$	0.98

Y: Disease severity (PDI %), X_1: Max Temperature (ºC), X_2: Minimum Temperature (ºC), X_3: Morning Relative humidity (%), X_4: Evening Relative Humidity, X_5: Rainfall (mm)

varieties, namely PS 1042 and PS 23, when compared to susceptible varieties (PS 1092 and Shivalik).The T_{max} and T_{min} at the time of disease onset was 32 to 34^{o}C and 22 to 25^{o}C, respectively, with >85 percent relative humidity and frequent rainfall. The rapid progress of foliar anthracnose disease was recorded in the month October, when T_{max} and T_{min} ranged between 28 to 32^{o}C and 12 to 21^{o}C, respectively, with a high RHm (80 to 90%), decreasing RHe (<65%) and no rainfall or less rainfall was recorded. According to Aggarwal *et al*., (2017), for anthracnose disease initiation, temperature ranged from 22°C to 29°C, relative humidity > 80%, and optimum rainfall was found to be favourable. Frequent rainfall plays an important role in the dispersal and progression of anthracnose disease (Shukla and Adak, 2017). KAG (2014) reported that the optimal maximum and minimum temperatures for the rapid development of anthracnose disease were 27 to 28^{o}C and 22^{o}C, respectively, with 87 percent relative humidity.

The correlation matrix of the disease severity index of anthracnose and pod blight with weather parameters of three consecutive years of soybean growing season were presented in Table 1. Maximum atmospheric temperatures were significantly and negatively correlated with pod blight (r= 0.87 to 0.91), but non-significant negative correlation with foliar anthracnose. Whereas, minimum temperature was found significantly and negatively correlated with both foliar anthracnose ($r \geq 0.98$) as well as pod blight disease development ($r \geq 0.94$). The morning relative humidity was found to be negative and non-significantly correlated with the development of disease in foliage and pods over the whole course of time. The evening time relative humidity and rainfall also had a negative correlation with the disease development during all the three years. These results are in agreement with Aggarwal *et al*., (2017), who reported a significant positive correlation (r = 0.83) of black gram anthracnose with maximum temperature and negative correlation with minimum temperature (r = -0.51), morning time RH (r = -0.84), evening time RH (r = -.084) and Rainfall (r = -0.89).

Multiple regression analysis was performed to develop a quantitative relationship between disease development and weather variables (Table 2). The Coefficient of determination (R^2) calculated for anthracnose disease ranged from 0.98 to 0.99 and for pod blight from 0.96 to 0.98 for pooled data, respectively. The R^2 values indicates more than 95 percent dependence of anthracnose and pod blight disease severity on the prevailing weather factors in all varieties, whereas the rest of the variation was due to unexplained factors (error variation) or factors that were not included in the investigations. The present findings are supported by the results of Kulkarni and Raja (2019), who also found 98 per cent influence of the weather factors to anthracnose disease.

Disease prediction models

The stepwise regression equation was drawn on the basis of the best and significant subset of weather variables for the prediction of anthracnose and pod blight disease using pooled data from two seasons, *kharif* 2017 and 2018, and validated for the season 2019. For Foliar anthracnose disease development, relative humidity evening (X_4) and temperature minimum (X_2) explained 98, 98, 98 and 99 percent variability in PS 1042, PS 23, PS 1092 and Shivalik varieties, respectively with prediction equations; Y_{PS1042} = 31.64-1.53X_2 + 0.08X_4, Y_{PS23} = 61.59 - 2.24X_2 -0.10X_4, Y_{PS1092} = 104.56 - 2.38X_2 - 0.64X_4 and $Y_{Shivalik}$ = 141.17- 3.72X_2 - 0.66X_4. Whereas,for pod blight disease development, maximum temperature (X_1), minimum temperature (X_2) and evening relative humidity (X_4) explained 96, 97, 98 and 97 percent variability in PS 1042, PS 23, PS 1092 and Shivalik varieties, respectively with prediction equation; Y_{PS1042} = 54.24 -1.09X_1 -1.15X_2 + 0.12X_4, Y_{PS23} = 76.27 – 1.32 X_1 -1.38X_2-0.01X_4, Y_{PS1092} = 133.89 -2.28X_1 -2.16X_2 -0.11X_4 and $Y_{Shivalik}$ = 176.84- 2.39X_1-3.99X_2 - 0.05X_4. The graphical representation in Fig.1 showed that the predicted disease severity based on previous year's data were more or less similar to the observed disease severity for year 2019, and intercepts each

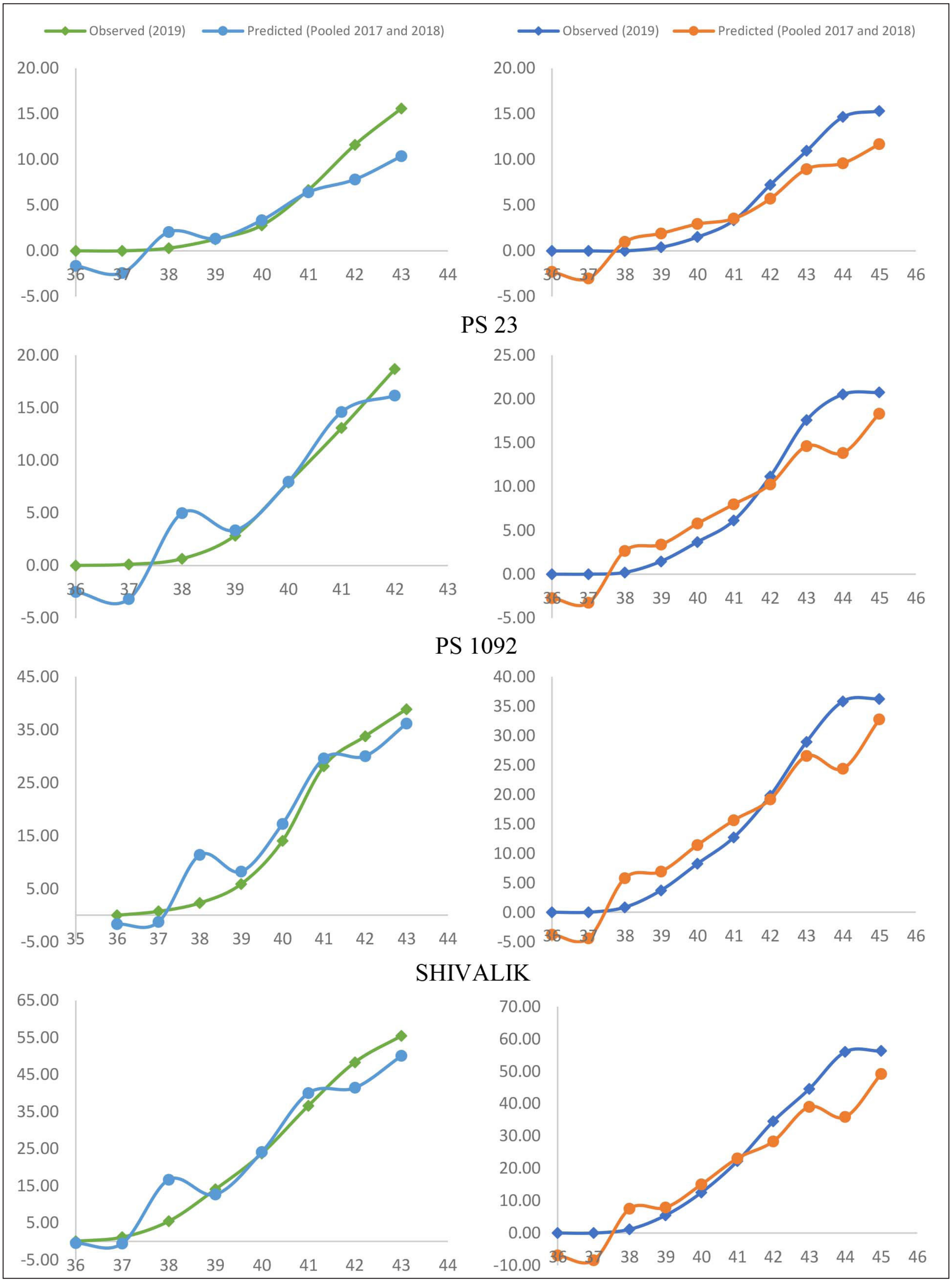

Fig. 1: Validation of a disease prediction model using pooled data from 2017 and 2018 to forecast the foliar anthracnose and pod blight disease in 2019

other at some points for both diseases. From the models, it can be inferred that weather parameters like, maximum and minimum temperature and evening relative humidity played crucial role in disease development during three years of investigation, and the regression equation formulated on the basis of these parameters appears to be the best fit. Amrate *et al*., (2021) also found best model with three significant weather variables (Mean Relative Humidity, Rainfall and Minimum temperature) for prediction of *Rhizoctonia* aerial blight of soybean.

CONCLUSION

The present study clearly indicated that temperature and relative humidity played a significant role for the maximum development of anthracnose and pod blight disease intarai conditions of Uttarakhand. Additionally, the study demonstrated that disease development in soybean can be predicted solely by significant weather factors. These prediction models help growers to apply fungicides when they need to, in a timely and effective way, before the disease starts.

Conflict of Interest Statement: The author (s) declares (s) that there is no conflict of interest.

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REFERENCES

Aggarwal, S. K., Mali, B. L., Rajput, L. S., and Choudhary, M. (2017). Epidemiology of anthracnose of black gram caused by *Colletotrichum lindemuthianum*. *Int. J. Agric. Sci.,* 9: 3656-3657.

Amrate, P. K., Shrivastava, M. K., and Pancheshwar, D. K. (2021). Crop-weather based relation and severity prediction of aerial blight incited by *Rhizoctonia solani* Kuhn in soybean. „*J Agrometeorol.*, 23: 66-73.https://doi.org/10.54386/jam.v23i1.90

Begum, M. M., Sariah, M., Puteh, A. B., and Zainal, A. M. A. (2008). Pathogenicity of *Colletotrichum truncatum* and its influence on soybean seed quality. *Int. J. Agric. Biol*., 10:393-398.

KAG, M. (2014). Studies on Anthracnose [*Colletotrichum truncatum* (Schw.) Andrus and Moore] of Mungbean. (Doctoral Dissertation, Rajmata Vijayaraje Scindia KrishiVishwa Vidyalaya, College of Agriculture, Indore, M.P., p. 90).

Kulkarni, S., and Raja. (2019). Epidemiology of greengram (*Vigna radiate*) anthracnose in northern Karnataka. *J. Pharmacogn. Phytochem*., 8: 434-437.

Nutter, F. F. (2007). The role of plant disease epidemiology in developing successful integrated disease management programs. *In*: General concepts in integrated pest and disease management. Springer, Dordrecht. pp.45-79.

Sharma, S.K., Gupta, G.K., and Ramteke, R. (2011). *Colletotrichum truncatum* [(Schw.) Andrus & W.D. Moore], the causal agent of anthracnose of soybean[*Glycine max* (L.) Merrill]—A Review. *Soy. Res.*, 9: 31–52.

Shukla, P. K. and Adak, T. (2017). Anthracnose disease dynamics of mango orchards in relation to humid thermal ratio under subtropical climatic condition. *J. Agrometeorol.*, 19: 56-61.https://doi.org/10.54386/jam.v19i1.756

Wheeler, B. E. J. (1969). An introduction to plant diseases. An Introduction to Plant Diseases. pp. 374.