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Effect of weather parameters on karnal bunt disease in wheat in Karnal region of Haryana*

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ABSTRACT

Data pertaining to average infection (%) of karnal bunt disease of wheat and meteorological parameters of 1st to 12th standard meteorological week (1st January to 25th March) for 25 crop seasons (1981-82 to 2004-05) of Karnal station were correlated to study the effect of weather parameters on Karnal bunt disease in wheat for most sensitive crop growth period corresponding to ear emergence and subsequent growth stages. The frequency of disease intensity and weather parameters indicated that when the maximum temperature exceeded normal accompanied by little or poor rainfall during 6 to 8th SMW, the disease intensity was low. Rainfall during the 3rd week of January showed strong relationship indicating favourable role in the formation and further multiplication of secondary spordia. However, during 9th SMW, maximum temperature, relative humidity, rainfall and sunshine duration showed considerably high correlations, whereas remaining parameters had weak correlation coefficients. Meteorological parameters during 6 to 12 SMW satisfactorily explained the occurrence of Karnal bunt disease with R^2 values of 0.84 that indicated only 16% variation of disease remained unaccounted.

Key words : Correlation, karnal bunt disease, meteorological parameters, wheat

Weather not only directly affects the plants but also affects the pathogens, insects (including vector of plant pathogens) and weeds that reduce the crop yield. Karnal bunt (KB) of wheat is caused by soil- and seed-borne inoculum of *Tilletia indica.* Mitra occurs sporadically, but may cause huge losses in epidemic years reducing wheat yields by 10 to 30% (Joshi *et al*., 1983). The disease is first visible only when the grains are formed. The grains are partially or wholly converted into a black powdery mass enclosed by the pericarp. All the grains in an ear may not be uniformly infected. Hence, it was also known as ‘‘Partial bunt’’. The incidence of Karnal bunt varies considerably from year to year due to its dependence on favourable weather during heading (Gill *et al*., 1993; Singh, 1994; Singh *et al*., 1996; Rush *et al*., 2005). The disease has historically caused minor overall yield and quality losses in countries where it occurs (Brennan *et al.,* 1990; Singh, 1994; Rush *et al*., 2005). Significant yield or quality losses are typically localized, occurring in highly susceptible cultivars grown in fields with high inoculum density during seasons with unusually favourable weather. Disease is affected more by microclimatic conditions in the plant canopy than by the macroclimate. However, since macro-climatic conditions produce the microclimate, research to define these macroclimatic conditions that regulate the abundance of plant pathogens on wheat could help ameliorate the effect of weather variability.

MATERIALS AND METHODS

Data pertaining to average infection (%) of Karnal bunt disease and meteorological parameters of 1st to 12th standard meteorological week (1st January to 25th March) for 25 crop seasons (1981-82 to 2004-05) of Karnal station were obtained, respectively, from Departments of Plant Pathology and Agricultural Meteorology from CCS Haryana Agricultural University, Hisar. The weekly weather parameters viz., maximum and minimum temperature, actual vapour pressure at morning and evening, relative humidity at morning and evening, rainfall and number of rainy days, sunshine duration and wind velocity were collected from the Agro-meteorological Observatory at Karnal. Weekly means of these parameters except rainfall and rainy days were calculated corresponding to the standard weeks 1 to 12. The weekly totals were obtained for rainfall amount and number of rainy days for the corresponding weeks. The relation between the meteorological parameters and average Karnal bunt infection (%) was worked out for most sensitive crop growth period corresponding to the ear emergence and subsequent reproductive stages (standard weeks 1-12). The correlation coefficients were calculated by considering the average disease infection as dependent variable and the meteorological parameters as independent variable. Multiple regression analysis was carried out for evaluating the various combinations of the independent variables for forecasting the Karnal bunt disease.

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Table 1: Frequency of Karnal bunt diseases intensity and weather parameters

Disease intensity	Tmax (°C)	Tmin (°C)	RHm (%)	RHe (%)	SS (h)	WS (km/h)	Evap (mm day^{-1})	R (mm)	RD (day)
				6th SMW					
0.00-0.005	21.2	8.0	94	54	0.0	6.9	1.9	1.0	1.0
0.005-0.200	21.2	7.5	91	52	6.8	6.2	1.4	1.4	1.0
0.20-0.80	20.9	7.4	91	56	7.6	6.9	1.6	11.6	2.0
Normal	21.0	7.5	91	53	4.0	7.5	2.1	8.4	-
1984-85	22.6	6.3	90	38	0.0	9.0	2.3	0.0	0.0
2002-03	22.3	6.3	99	57	0.0	7.9	1.7	0.0	0.0
				7th SMW					
0.00-0.005	22.3	9.1	92	56	0.0	7.2	2.2	1.7	1.0
0.005-0.200	22.3	8.7	90	53	5.1	7.4	1.9	5.6	1.0
0.20-0.80	21.6	8.3	90	55	7.0	6.1	1.4	11.2	2.0
Normal	22.2	9.0	91	52	3.9	7.2	2.2	7.5	-
1984-85	23.8	5.4	90	37	0.0	9.6	2.5	0.0	0.0
2002-03	22.5	10.7	94	65	0.0	6.4	2.2	0.0	0.0
				8th SMW					
0.00-0.005	23.1	9.2	89	52	0.0	8.4	2.5	8.1	1.0
0.005-0.200	22.6	8.1	89	49	6.8	6.5	1.9	9.2	1.1
0.20-0.80	21.5	7.4	90	53	4.5	7.5	2.3	10.6	2.0
Normal	22.8	8.9	89	48	4.4	8.1	2.8	7.9	-
1984-85	25.9	7.9	83	42	0.0	9.4	3.1	0.0	0.0
2002-03	23.4	9.4	95	61	0.0	7.5	2.8	0.0	0.0

Tmax–maximum temperature, Tmin–minimum temperature, RHm–morning relative humidity, RHe–evening relative humidity, WS–wind speed, SS–sunshine hours, Evap–rate of evaporation, R–rainfall and RD–rainy day.

RESULTS AND DISCUSSION

The frequency of disease intensity and weather parameters are presented in Table 1. It well indicated that when the maximum temperature exceeded normal accompanied by little or poor rainfall during 6 to 8th SMW, the disease intensity was low. However, if there is no rainfall occurrence during 6th and 7th SMW, there will be no chance of disease occurrence during that year.

Simple linear regression analysis

The meteorological parameters having highly significant correlation with disease were identified and their importance for particular crop growth period was established. The correlation values indicated a week relation for standard meteorological weeks 7 and 8 (Table 2). Rainfall during the 3rd week of January showed strong relationship indicating favourable role in the formation and further multiplication of secondary spordia. Similar findings were found by Stansbury and McKirdy (2002). However, during 9th SMW, maximum temperature, relative humidity, rainfall and sunshine duration showed considerably high correlations, whereas remaining parameters had weak correlation. In the present study the minimum temperature and wind velocity did not influence the disease. This may be because night temperature during this period always remained low and wind had no role in either primary infection or secondary spread of the disease. Thus, the weather parameters viz., rainfall, maximum (day-time) temperature, relative humidity at evening, sunshine duration and number of rainy days, are important for outbreak and spread of the disease. Similar findings have been reported by Kaur *et al*. (2002).

Multiple regression analysis

$$Y=-0.141-0.042Evap_6-0.004R_6+0.029RD_6-0.027Tmin_7+0.033RD_8-0.035\,RD_9+0.010RHe_9+0.072\,RD_{11} \qquad R^2=0.84$$

Where, subscripts are the number of standard meteorological weeks; R–rainfall, Evap–rate of evaporation; Tmin–minimum temperature; RHe–relative humidity at evening; RD–number of rainy days.

From above, it was concluded that the use of five meteorological parameters in the equation during standard

Table 2: Correlation coefficients between meteorological parameters and average karnal bunt infection (%) in wheat

Weather parameters	6th week	7th week	8th week	9th week	10th week	11th week	12th week
Tmax	0.19	-0.01	0.27	-0.48*	-0.31*	-0.28*	-0.32*
Tmin	0.22	-0.02	0.44*	0.14	0.14	-0.10	0.01
RHm	-0.10	-0.11	-0.12	0.59*	0.36*	0.32*	0.34*
RHe	0.04	-0.16	0.11	0.64*	0.27*	0.13	0.23*
WS	0.38*	0.15	0.16	0.12	0.15	0.13	0.15
SS	-0.01	0.30*	-0.08	-0.28*	-0.06	-0.18	-0.09
Evap	-0.12	-0.05	-0.03	-0.33*	-0.24*	-0.19	-0.11
R	0.11	-0.12	0.38*	0.32*	0.26*	0.28*	0.07
RD	0.24*	-0.10	0.40*	0.23*	0.23*	0.52*	0.66*

*Significant at P=0.05 level. Tmax–max. temperature, Tmin–min. temperature, RHm–morning RH, RHe–evening RH, WS–wind speed, SS–sunshine hours, Evap–rate of evaporation, R–rainfall, RD–rainy day.

meteorological weeks 6 to 12 satisfactorily explained the occurrence of Karnal bunt disease for Karnal zone which can be explained upto 84%. The R^2 values of the magnitude of 0.84 obtained indicated that only 16% variation of disease remained unaccounted.

REFERENCES

Brennan, J. P., Warham, E. J., Hernandez, J., Byerlee, D. and Doronel, F. (1990). Economic losses from Karnal bunt of wheat in Mexico. CIMMYT Econ. Work. Pap. 90/02. Mexico : CIMMYT.

Gill, K. S., Sharma, I. and Aujla, S. S. (1993). Karnal bunt and wheat production. Ludhiana, Punjab, India : Punjab Agric. Univ. Press. pp. 153.

Joshi, L. M., Singh, D. V., Srivastava, K. D. and Wilcoxson, R. D. (1983). Karnal bunt–A minor disease that is now a new threat to wheat. *Bot. Rev.,* 43 : 308-38.

Kaur, S., Singh, M. and Singh, K. (2002). Factors affecting telial and sporidial inoculum of *Neovossia indica. Indian Phytopath.* 55 : 14-18.

Rush, C. M., Stein, J. M., Bowden, R. L., Riemenschneider, R., Boratynski, T. and Royer, M. H. (2005). Status of Karnal bunt of wheat in the United States 1996 to 2004. *Plant Dis.,* 89 : 212-23.

Singh, A. (1994). Epidemiology, and management of Karnal bunt disease of wheat. *Res. Bull. No. 127.* Pantnagar, India : Dir. Exp. Stn., G. B. Pant Univ. Agric. Technol. pp. 167.

Singh, D., Singh, R., Rao, V. U. M., Karwasra, S. S. and Beniwal, M. S. (1996). Relation between weather parameters and Karnal bunt (*Neovossia indica*) in wheat (*Triticum aestivum*). *Indian J. Agric. Sci.*, 66 : 522-25.

Stansbury, C. D. and McKirdy, S. J. (2002). Forecasting climate suitability for Karnal bunt of wheat : A comparison of two meteorological methods. *Australian Plant Pathol.*, **31** : 81-92.