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Effect of weather parameters on the incidence of stripe rust in Punjab

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ABSTRACT

To identify the meteorological factors which favour the development of stripe rust disease in wheat correlation and regression analysis was carried out by using 7 years (2004-11) data. In order to evaluate the reasons for the same an effort has been made to short list the weather parameters responsible for this wide variation in the occurrence of the disease. The maximum temperature for 48th and 49th standard meteorological weeks (SMW) were positively correlated while sunshine duration for 49th to 50th SMWs were negatively related. On the other hand, minimum temperature, rainfall and RH during 2nd and 3rd SMWs were positively corelated with the disease intensity. As such the disease will be higher in those years, when temperature will be higher than normal coupled with high relative humidity during December and January.

Key words: Stripe rust, Puccinia striiformis, wheat, climate change, meteorological elements

Stripe rust commonly known as yellow rust is primarily a foliar fungal disease of wheat. Under severe infection conditions, it can infect glumes resulting in grain shrivilage. The disease is caused by the fungus *Puccinia striiformis* f. sp. *tritici*. The fungus can only survive and reproduce on wheat. The pathotype survives during hot summer seasons in north hilly regions on self sown wheat plants or collateral plants.In Punjab, the losses due to this disease vary from 2 to 68% depending upon crop growth stage when it is affected, severity of the disease and variety grown (Jindal and Sharma, 2010). Under low temperatures the latent periods increase and the mild winters and cooler wet weather favour the development of the disease (Zadoks 1961). Yellow rust needs free moisture (high humidity, rainfall or dew) for infection. The optimal temperature ranges for stripe rust disease varies from around 10 to 15°C. As weather factors are driving forces in plant disease development, they are essential in plant disease prediction including the effect of weather on different parts of the disease cycle – dormancy, reproduction, dispersal and pathogenesis and also effect yield (Thomas *et al*, 1989., Pietravalle *et al*.,) The aim of this paper is to analyze disease severity in relation to weather parameters throughout the season and to develop quantitative forecasting model for yellow rust under Punjab conditions.

MATERIALS AND METHODS

Historical data pertaining to meteorological elements and percent disease severity were collected for Ludhiana for 7 years period (2004-2011) from departments of Agricultural Meteorology and Plant Breeding & Genetics, PAU, Ludhiana. The weekly weather data i.e. maximum (Tmax) and minimum (Tmin) temperature , morning (RH_1) and evening (RH_2) relative humidity, rainfall (mm), number of rainy days (RD), sunshine hours (BSS) and wind speed (WS). The weekly parameters were calculated corresponding to standard meteorological weeks (SMW) as demonstrated by Mavi *et al* (1992).

The data on stripe rust was collected from surveys carried out at 7-10 days interval in Ludhiana district of Punjab starting from January to March since 2004-05 to 2010-11. Randomly fields were observed for the rust prevalence at 5-6 spots after every 20 km distance by moving 500 m area on both sides of road. The fields were observed for disease prevalence and severity. The susceptible wheat variety PBW 343 occupied large area and observations were mainly recorded on this variety. Based on these observations every year was given following rating for the disease depending upon the stripe prevalence and its intensity.

The disease intensity was calculated as follows:

Rating	% spots showing disease	Disease intensity*
1	<10 %	traces to 10 S
2	10 %	~ 10 S
3	20-30 %	~ 20 S
4	40-70 %	20 S – 40 S
5	>80 %	40 S – 60 S

* More than 80 % samples from the fields showing the disease intensity and about 20 % samples show either very high or low intensity.

The disease severity variables (1 to 5) included were percentage fields showing infection and disease intensity.

Coefficients of correlation of stripe rust were worked out with all the meteorological elements separately for every week starting from 48th SMW to 13th SMW. The critical periods when weather parameters exert significant influence on disease incidence were located. They were then used to calculate the multiple correlations with the disease. Multiple correlations of all the combinations were calculated and those parameters which were statistically significant at the mandatory levels were used in the final equation and best regression models from statistical point of view was chosen to find out if this can be of any utility for forecasting the yellow rust.

RESULS AND DISCUSSION

The data showed that yellow rust mostly appeared in the month of February. During this period crop was at flowering stage which appeared to be the most susceptible stage besides the minimum and maximum temperatures during the period from 48th SMW to 12th SMW ranged from 5.5 to 15.0°C and 15.7 to 29.8°C, morning and evening relative humidity ranged from 91 to 98% and 37 to 68%, total rainfall varied from 0 to 113 mm and SSH varied from 4.0 to 9.2 hrs, which were congenial for disease development. All the meteorological elements showed (Table 1) good relationships for different standard meteorological week (SMW). The maximum temperature for 48th and 49th were positively correlated while sunshine duration for 49th to 50th SMWs were negatively correlated. The other three parameters like minimum temperature, rainfall and number of rainy days showed positive relationship during 2nd and 3rd SMW (in the month of January). Although these parameters during different periods were considered for regression analysis but the later period of the crop season from 9th to 12th SMWs showed continuous relationship of all the weather parameters in which maximum temperature and sunshine hours were positively correlated and minimum temperature, relative humidity (both morning & evening), rainfall and number of rainy days were negatively correlated with disease intensity (Table 2). Among these parameters maximum temperature and sunshine hours are the important weather factors influencing the probability of damaging epidemics as they are highly positively correlated ($r=0.52$ and $r=0.59$ during 10th SMW), respectively. While rainfall and number of rainy days are highly negatively correlated ($r=0.78$ and $r=0.81$ during 10th SMW) and are second most important weather factors influencing the occurrence of a damaging epidemic.

The maximum temperature during 48th week on the other hand has shown positive relationship (0.45) with the disease occurrence indicating that high daytime temperature during this period coupled with bright sunshine hours conditions might have helped in formation and multiplication of sporidia (Table 1). Kaurav and Mathur (1980) have also reported similar observations in rice. Therefore, increase in maximum temperature along with bright sunshine seems to be the major determining factor in the disease outbreak during December and January. Overall it has been observed that early sown crop shows higher infection under such conditions.

On the basis of above findings, a multiregression model was developed taking into consideration the highly correlated meteorological elements (with disease) viz. maximum temperature and sunshine hours during SMW 48th to 50th and minimum temperature, rainfall and no. of rainy days for 2nd and 3rd SMWs.

For Ludhiana district the best-fit model developed for predicting severity of yellow rust is:

$$DI = -1.82 + 0.41\,Tmax. - 0.36\,Tmin. + 0.28\,RF - 0.21\,RD - 0.29\,BSS$$

$$R^2 = 0.95$$

Where,

DI = Disease Intensity

Tmin. = Min. Temperature (°C)

Table1: Relationship between meteorological parameters and disease rating for yellow rust of wheat for Ludhiana region

Year	Disease rating	Tmax (°C) (48-49)	Tmin (°C) (2-3)	Rainfall (mm) (2-3)	Rainy days (2-3)	BSS (Hrs) (49-50)
2004-05	2	22.8	5.3	0.5	0.0	8.0
2005-06	3	23.0	6.7	5.3	1.0	8.3
2006-07	3	20.9	3.0	0.0	0.0	4.9
2007-08	4	21.3	6.9	7.4	1.0	4.6
2008-09	5	25.3	7.4	7.3	1.0	5.7
2009-10	3	23.5	6.0	0.0	0.0	5.1
2010-11	4	23.2	4.9	2.7	1.0	6.8
Corr. Coeff		**0.45**	**0.46**	**0.73***	**0.68***	**-0.43**

*Significant at 0.05 % level

Table 2: Coefficients of correlations of epidemic window for yellow rust disease of wheat at Ludhiana region

Meteorological Parameters	Standard meteorological weeks 9	10	11	12
Tmax	0.21	0.52	0.51	0.41
Tmin	-0.53	-0.33	-0.40	0.17
RH_1	-0.67*	0.09	-0.74*	- 0.33
RH_2	-0.46	-0.61	-0.68*	-0.71*
BSS	0.35	0.59	0.56	0.40
Rainfall	-0.11	-0.78*	-0.36	-0.40
RD	-0.06	-0.81*	-0.73*	-0.30

Tmax = Max. Temperature (°C)

RF = Rainfall (mm)

RD = Number of rainy days

BSS = Sunshine duration (hr day^{-1})

The model explained 95 percent of the variation of the disease using meteorological parameters. High R^2 value is probably due to the fact that in endemic areas, the disease is very much dependent on weather conditions.

As such, crop at vulnerable stage is exposed to the inoculum present in the field and other thing is favourable temperature conditions, which is probably allowing rust to establish in warm weather conditions. Further analysis of more detailed meteorological data is likely to improve the model accountability for disease prediction with higher precision.

REFERENCES

Kaurav, L.P. and Mathur, S.C. (1980). False smut and bunt diseases in international rice observational nurseries entries. *IRRN* (6):5.

Mavi, H.S., Jhorar, O.P., Sharma, I., Singh, Gurmeet, Mahi,G.S., Mathauda, S.S. and Aujla, S.S. (1992). Forecasting karnal bunt disease of wheat - A meteorological method. *Cereal Res. Communications*, Vol.20 (1-2): 67-74.

M M Jindal and I Sharma. (2010). Losses due to stripe rust in different varieties of wheat. Silver Jubilee Celebrations – Brain storming session on Recent Status of Cereal Rusts in India at PAU, Ludhiana. Organized by Indian Society of Plant Pathologists. PS-19.

Pietravalle S, Shaw M W, Parker, S R and Van den Bosch, F. (2003). Modeling of relationships between weather and septoria tritici epidemics on winter wheat: A critical approach. *Phytopahology*,93: 1329-39.

Zadoks J C. (1961). Yellow rust on wheat. Studies in epidemiology and physiologic specialization. *Tijdschrift Plantenziekten*, 67: 69-256.

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