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## SHORT COMMUNICATIONS

# Relationship between environmental variables and development of spot blotch caused by *Cochliobolus sativus* in wheat (*Triticum aestivum*) in eastern India

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**Key words:** Wheat, *Triticum aestivum*, spot blotch, *Cochliobolus sativus*, *Bipolaris sorokiniana,* environmental variables, correlation, regression

Wheat (*Triticum aestivum* L. emend. Fiori and Paol.) is reported to suffer from spot blotch, caused by *Cochliobolus sativus* (Ito & Kurib.) Drechs. ex Dastur [anamorph *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem.], which causes enormous losses particularly in the north eastern plains zone of India (8). Measures for managing the disease economically have been worked out (7,10), but these can be used more profitably if disease situation can be forecasted a little earlier. However, studies under field situation are lacking (5,9). Therefore, interaction of environmental variables with different growth stages of the wheat plant in the same season to arrive at most critical crop growth stage (s) x environmental variable (s) affecting spot blotch intensity were worked out and results described hereunder.

Field experiments were conducted at University Experiment Station, Kumarganj (26°47'N, 82°12' E, 113 m above mean sea level), Faizabad during 2001-02 and 2002-03 crop seasons, under rice-wheat system, in a randomized block design having six treatments and 3 replications. Late sown wheat varieties HP HP 1633, HD 2285, Sonalika, A-9-30-1, HUW 234 and NW 1014 were taken. Sowing was done on December 26 in plots of 3.0 x 1.5 meter with 23 x 5 cm plant spacing. Fertilizers were applied @ 120:60:40 kg nitrogen, phosphorus and potash/ha. Plots were given 6 irrigations. Spot blotch severity scores were recorded at jointing, booting, soft dough and pre-maturity stages following Kumar *et al.* (4). First and second digits of the scores were averaged to calculate per cent disease intensity (PDI) using formula PDI = [Total numerical ratings/Total number of observations taken x Maximum disease score] x 100. Weekly environmental variables (meteorological data) were recorded at the University Meteorological Observatory to work out correlation and regression coefficients, and correlated to the disease intensity to see the effect of these parameters on spot blotch development at different growth stages. Regression equations between disease intensity and environmental variables were derived to predict the disease situation. Equation used was $Y = a+b_1x_1 + b_2x_2 + \ldots\ldots..b_n\ x_{n,}$ where Y = per cent disease intensity, a = intercept value, $b_1$ to $b_n$ = partial regression coefficient (slope value) and $x_1$ to $x_n$ = environmental variables.

***Correlation between environmental variables and spot blotch intensity at different growth stages:*** The spot blotch intensities (dependent variables), at jointing, booting, soft dough and pre maturity stages (Table 1), estimated in field plots of six wheat varieties, viz HP 1633, HD 2285, Sonalika, A-9-30-1, HUW 234 and NW 1014, and their relationship with prevailing environmental variables (independent variables) for the same year were studied by employing simple correlation. Disease intensities observed on above six varieties, separately, and their mean, have significant positive correlation with minimum and maximum temperature. It is well known that in winter crops, with the advent

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**Table 1.** Correlation coefficient between spot blotch intensity and environmental variables at different growth stages

| Varieties | Crop growth stage | Environmental variables | Correlation coefficient | |
|---|---|---|---|---|
| | | | 2001-02 | 2002-03 |
| HP 1633 | Jointing to pre-maturity | Minimum temperature | 0.873** | 0.952** |
| | | Maximum temperature | 0.882** | 0.982** |
| | | Rainfall | -0.830** | -0.748** |
| | | Mininum relative humidity | -0.575 NS | -0.597 NS |
| | | Maximum relative humidity | -0.422 NS | -0.472 NS |
| | Booting to pre-maturity | Minimum temperature | 0.979** | 0.919** |
| | | Maximum temperature | 0.986** | 0.965** |
| | | Rainfall | -0.999** | -0.259 NS |
| | | Mininum relative humidity | -0.989** | -0.602 NS |
| | | Maximum relative humidity | -0.999** | -0.271 NS |
| HD 2285 | Jointing to pre-maturity | Minimum temperature | 0.888** | 0.934** |
| | | Maximum temperature | 0.835** | 0.865** |
| | | Rainfall | -0.708* | -0.733* |
| | | Mininum relative humidity | -0.818** | -0.970** |
| | | Maximum relative humidity | -0.899** | 0.859** |
| | Booting to pre-maturity | Minimum temperature | 0.979** | 0.975** |
| | | Maximum temperature | 0.986** | 0.942** |
| | | Rainfall | -0.999** | -0.949** |
| | | Mininum relative humidity | -0.989** | 0.900** |
| | | Maximum relative humidity | -0.999** | -0.421 NS |
| Sonalika | Jointing to pre-maturity | Minimum temperature | 0.930** | 0.998** |
| | | Maximum temperature | 0.887** | 0.976** |
| | | Rainfall | -0.776** | -0.905** |
| | | Mininum relative humidity | -0.872** | -0.998** |
| | | Maximum relative humidity | -0.938** | 0.974** |
| | Booting to pre-maturity | Minimum temperature | 0.918** | 0.967** |
| | | Maximum temperature | 0.931** | 0.930** |
| | | Rainfall | -0.987** | -0.959** |
| | | Mininum relative humidity | -0.998** | -0.885** |
| | | Maximum relative humidity | -0.977** | -0.390 NS |
| A-9-30-1 | Jointing to pre-maturity | Minimum temperature | 0.932** | 0.995** |
| | | Maximum temperature | 0.889** | 0.968** |
| | | Rainfall | -0.780** | -0.889** |
| | | Mininum relative humidity | -0.875** | -0.999** |
| | | Maximum relative humidity | -0.941** | 0.965** |
| | Booting to pre-maturity | Minimum temperature | 0.826** | 0.937** |
| | | Maximum temperature | 0.845** | 0.890** |
| | | Rainfall | -0.938** | -0.982** |
| | | Mininum relative humidity | 0.969** | -0.836** |
| | | Maximum relative humidity | 0.919** | -0.299 NS |
| HUW 234 | Jointing to pre-maturity | Minimum temperature | 0.892** | 0.953** |
| | | Maximum temperature | 0.839** | 0.892** |
| | | Rainfall | -0.714* | -0.770** |
| | | Mininum relative humidity | -0.823** | -0.982** |
| | | Maximum relative humidity | -0.902** | 0.887** |

| | | | | |
|---|---|---|---|---|
| | Booting to pre-maturity | Minimum temperature | 0.959** | 0.982** |
| | | Maximum temperature | 0.968** | 0.953** |
| | | Rainfall | -0.999** | -0.938** |
| | | Mininum relative humidity | -0.997** | -0.914** |
| | | Maximum relative humidity | -0.996** | -0.451 NS |
| NW 1014 | Jointing to pre-maturity | Minimum temperature | 0.905** | 0.923** |
| | | Maximum temperature | 0.856** | 0.849** |
| | | Rainfall | -0.735** | -0.712* |
| | | Mininum relative humidity | -0.839** | -0.962** |
| | | Maximum relative humidity | -0.915** | 0.844** |
| | Booting to pre-maturity | Minimum temperature | 0.994** | 0.998** |
| | | Maximum temperature | 0.997** | 0.985** |
| | | Rainfall | -0.990** | -0.883** |
| | | Mininum relative humidity | -0.970** | -0.956** |
| | | Maximum relative humidity | -0.996** | -0.565 NS |
| Mean | Jointing to pre-maturity | Minimum temperature | 0.914** | 0.973** |
| | | Maximum temperature | 0.867** | 0.923** |
| | | Rainfall | -0.749** | -0.815** |
| | | Mininum relative humidity | -0.851** | -0.993** |
| | | Maximum relative humidity | -0.923** | 0.919** |
| | Booting to pre-maturity | Minimum temperature | 0.949** | 0.972** |
| | | Maximum temperature | 0.959** | 0.938** |
| | | Rainfall | -0.997** | -0.952** |
| | | Mininum relative humidity | -0.999** | -0.895** |
| | | Maximum relative humidity | -0.992** | -0.411 NS |

*, significant at 5%; **, significant at 1%; NS, not significant, -, negatively

of higher temperatures, pathogens become active and, when other conditions are favourable, they can infect plants and cause disease (1). Disease intensities, from early to late growth stages (Table 1), were negatively correlated with average rainfall and minimum and maximum relative humidity on all the varieties during both the years except that these had non-significant positive correlation with maximum relative humidity in case of HP 1633, Sonalika, A-9-30-1 and varietal mean in the second year indicating variable response of different variety-pathogen interactions to these environmental variables.

Disease intensities and environmental variables at different growth stages (Table 1) between jointing to pre maturity were significantly and positively correlated with minimum and maximum temperature, negatively correlated with average rainfall during both the years and minimum and maximum relative humidity in the first year. But these were positively correlated with maximum relative humidity in case of HD 2285, Sonalika, A-9-30-1, HUW 234, NW 1014 and varietal mean and negatively in case of HP 1633 in the second year. Disease intensities at booting to pre-maturity stages were also significantly and positively correlated with minimum and maximum temperature. Rainfall was negatively correlated with disease intensities during both the years. These were negatively correlated with minimum and maximum relative humidity on all the varieties during both the years except in case of varietal mean, which was positively correlated with it in the second year only. Akram and Singh (2) studied the relationship between weather variables and disease severity based on data for 1997-98 and 1998-99 at Pantnagar. They failed to find a correlation between these in a definite fashion. Our study, however, has tried to establish correlation between weather variables and disease intensities at different growth stages for the individual years during 2001-02 and 2002-03 and succeeded in establishing certain positive and negative correlations. However, a minor hitch in establishing clear cut correlations came from the fact that plant

**Table 2.** Regression of spot blotch intensity and environmental variables on wheat varieties

| Varieties | Regression equations 2001-02 | $R^2$ | Regression equations 2002-03 | $R^2$ |
|---|---|---|---|---|
| HP 1633 | Y= 314.89+33.35 $X_1$+(-14.47) $X_2$+ 17.64 $X_3$ + (-14.32) $X_4$ + (-0.34) $X_5$ | 0.961 | Y= -11.86+3.28 $X_1$+95.47 $X_2$+ (-20.07) $X_3$ + 11.79 $X_4$ + (-13.00) $X_5$ | 0.972 |
| HD 2285 | Y= 127.64+22.84 $X_1$+17.93 $X_2$ + 1.77 $X_3$ + (-9.17) $X_4$+0.189 $X_5$ | 0.980 | Y= -30.09+4.09 $X_1$+102.44 $X_2$ + (-19.78) $X_3$+ 13.69 $X_4$+(-14.99) $X_5$ | 0.988 |
| Sonalika | Y= 333.28+33.13 $X_1$ + (-17.62) $X_2$ + 19.06 $X_3$ + (-14.90) $X_4$ + (-0.17) $X_5$ | 0.992 | Y= 215.98+(-0.58) $X_1$ + 73.46 $X_2$ + (-17.11) $X_3$ + 8.72 $X_4$ + (-11.36) $X_5$ | 0.995 |
| A-9-30-1 | Y= 473.19 + 33.95 $X_1$ + (-41.69) $X_2$ + 28.79 $X_3$ + (-17.69) $X_4$ + (-0.38) $X_5$ | 0.991 | Y= 58.31 + (-0.36) $X_1$ + 85.95 $X_2$ + (-22.92) $X_3$ + 10.21 $X_4$ + (-10.27) $X_5$ | 0.994 |
| HUW 234 | Y= 179.44+24.98 $X_1$+1.81 $X_2$+8.82 $X_3$+ (-10.34) $X_4$+ (-0.06) $X_5$ | 0.954 | Y= -74.07 + 3.42 $X_1$ + 82.49 $X_2$ + (-12.66) $X_3$ + 11.70 $X_4$ + (-12.94) $X_5$ | 0.958 |
| NW 1014 | Y= -6.49+8.81 $X_1$+17.21 $X_2$ + (-2.28) $X_3$ + (-3.29) $X_4$ + 0.24 $X_5$ | 0.932 | Y= -171.43+3.71 $X_1$+48.64 $X_2$ + (-0.867) $X_3$ + (-8.09) $X_4$ + (-9.31) $X_5$ | 0.940 |
| Mean | Y= 206.10+25.96 $X_1$+ (-2.40) $X_2$ + 10.79 $X_3$ + (-11.25) $X_4$+0.10 $x_5$ | 0.978 | Y= 40.09+1.88 $X_1$+ 81.49 $X_2$ + (-18.10) $X_3$ + 9.77 $X_4$+ (-11.04) $X_5$ | 0.985 |

Y, per cent disease intensity; a, intercept value; b, slope value; $X_1$, rainfall; $X_2$, minimum temperature; $X_3$, maximum temperature; $X_4$, minimum relative humidity; $X_5$, maximum relative humidity; $R^2$, coefficient of multiple determination

susceptibility at different growth stages differed and could not be neutralized. Increasing plant age increased the plant susceptibility and hence even if, theoretically, all the disease favouring environmental variables are provided at the jointing stage, disease intensity cannot go higher than what it is at soft dough or pre-maturity stage. Under field, however, disease favouring conditions can not be provided in equal measure at all the growth stages. Hence, a few earlier studies, conducted (3,6) under controlled conditions, partly supplement our efforts.

***Regression between environmental variables and spot blotch intensity at different growth stages:*** Based on partial regression coefficient, linear equations were derived to predict the spot blotch intensity depending upon the weekly environmental variables prevailing during crop seasons. Disease intensity data at jointing to pre maturity stages, on six wheat varieties and their mean, were taken to explain the relationships. The resulting regression equation values a, b and coefficient of determinations ($R^2$) are given in Table 2. It is evident that the dependent variable (Y = disease intensity) can be predicted prior to the onset of disease on the basis of independent variable values (partial regression) obtained from equations. The highest values of coefficient of determination (99%) were revealed for Sonalika and A-9-30-1, highly susceptible varieties, for both years, while lowest coefficient of determination recorded were 93% on NW 1014, a moderately resistant variety, in the first and 94% in the second year.

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