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Microclimate modification to manage yellow rust incidence in wheat

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ABSTRACT

The field experiment was conducted during *Rabi* seasons of 2012-13 and 2013-14 at the Research Farm, School of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana. Wheat varieties HD 2967, PBW 550 and PBW 343 were sown under two row direction *viz.*, North-South (N-S) and East-West (E-W).Yellow rust incidence was recorded at weekly intervals. Among different row direction the disease incidence was higher under N-S row direction as compared to E-W row direction during both the years. Among three varieties HD 2967 was highly resistant to yellow rust. During both the years maximum temperature, minimum temperature and sunshine hours were positively correlated whereas morning and evening relative humidity were negatively correlated with yellow rust incidence. Highly significant value of R^2 (0.95 and 0.93) was found when maximum meteorological parameters were combined in PBW 343 in crop sown under North-South and East-West row direction, respectively

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crop in the global agricultural economy (Anonymous, 2006). Wheat is staple food of more than 40 per cent of the human population. In India it is second most important food crop, cultivated extensively in North-Western and Central zones. It contributes substantially to the national food security by providing more than 50 per cent of the calories to the people who mainly depend on it. In India, during 2013-14, wheat was grown on 31.30 million hectares with production of 95.80 million tones and per hectare yield of 30.59 quintals (Anonymous, 2014).

Wheat crop is attacked by large number of diseases and insects which often appear in epidemic proportions causing yield losses and deterioration in quality. Out of various diseases of wheat, rust diseases *i.e.* yellow rust, brown rust and black rust are the most significant. Stripe rust (yellow rust) is caused by *Puccinia striformis f.* sp. *tritici*. Periodic leaf rust epidemics have occurred in most decades of the last century, thus, worldwide leaf rust is considered as important disease of wheat. Under the north-western plain zone, which is major wheat producing area in the country, yellow rust caused by *Puccinia striformis westend.f.*sp.*tritici* is the major disease problem. In North India, due to the favourable weather conditions for disease spread the area remain perpetually under the threat of this disease. Huerta-Espino *et al.* (2011) reported that *Puccinia tritici* has a wide virulence range and is broadly adapted to diverse climatic conditions, leading to regular and significant yield losses over large geographical areas. Singh *et al.* (2004) estimated that leaf rust could affect 80 per cent of wheat production in India (21.6 m ha) under favourable conditions. Besides genetic resistance, which affects the individual crop risk, weather variables influence the incidence and severity of leaf rust (Moschini and Perez, 1999).

It is well known that the pathogens are capable of producing the new races which may overcome the resistance in particular variety or may adapt to warmer temperatures to cause severe disease in previously unfavourable environments (Milus *et al.*, 2009). Microclimate influence disease incidence and severity so modification of microclimate can be helpful to manage diseases. Incidence of yellow rust is effected by different meteorological parameters and microclimate of crop. Microclimate modification can be useful in management of yellow rust as disease is highly influenced by microclimate of the crop. So, keeping this in view, the experiments were conducted to study the effect of microclimate modification and meteorological parameters on yellow rust incidence.

MATERIAL AND METHODS

Wheat varieties HD 2967, PBW 550 and PBW 343 were sown under two row direction *viz.*, North-South (N-S) and East-West (E-W) during *Rabi* seasons of 2012-13 and 2013-14. Microclimate of crop was modified by sowing crop in two different row directions. The crop was raised as per recommendations of Punjab Agricultural University, Ludhiana. Daily meteorological observations on maximum and minimum temperatures (^oC), relative humidity (%), sunshine hours (hours/day) and rainfall (mm) were recorded at the Agro meteorological Observatory (30^o 54' N, latitude and 75^o 48' E longitude and altitude of 247 m above the mean sea level) which is situated 150 m away from the experimental area.

Incidence of yellow rust was observed at weekly interval. The disease incidence was recorded as the date of start of disease on 50 randomly selected plants in a plot and subsequently, the percentage of the plants affected by the disease were also recorded at weekly intervals.

$$\text{Disease incidence (\%)} = \frac{\text{No. of diseased plants}}{\text{Total no. of plants examined}} \times 100$$

Correlation co-efficient and multiple regression analysis was conducted between yellow rust disease incidence and different meteorological parameters like temperature, relative humidity, sunshine hours and rainfall.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Disease incidence under different row direction :

The increase of foliage disease in a cereal crop is usually the result of two simultaneous processes an increase in the proportion of leaves infected and in percentage of leaf area affected by disease here after referred as disease incidence and severity, respectively. Yellow rust incidence was observed in different wheat varieties *viz.*, HD 2967, PBW 550 and PBW 343 under different row direction *i.e.* North-South (N-S) and East-West (E-W). Variety HD 2967 did not show any symptom of yellow rust incidence whereas Variety PBW 343 and PBW 5343 showed higher disease incidence. The per cent yellow rust incidence was higher in PBW 343 as compared to PBW 550 during both the crop seasons because variety PBW 343 is more susceptible to yellow rust than PBW 550 (Fig. 1- 4). Among different row direction, disease incidence was comparatively higher in N-S row direction as compared to E-W row direction. This may be due to the congenial conditions in N-S row direction for disease development. Disease incidence was maximum in variety PBW 343 sown under N-S row direction followed by PBW 550 sown under N-S row direction and was lowest in PBW 550 sown under E-W row direction during both crop seasons. Comparatively, higher relative humidity within crop canopy in N-S row direction may be the reason for higher disease incidence. Similarly, Friedrich (1995) found that

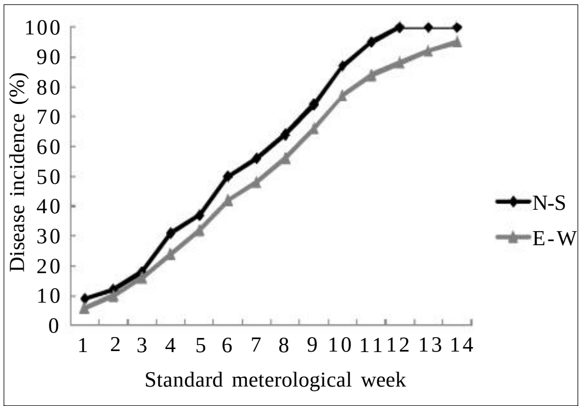

Fig. 1 : Yellow rust incidence under different row direction in PBW 343 during 2012-13

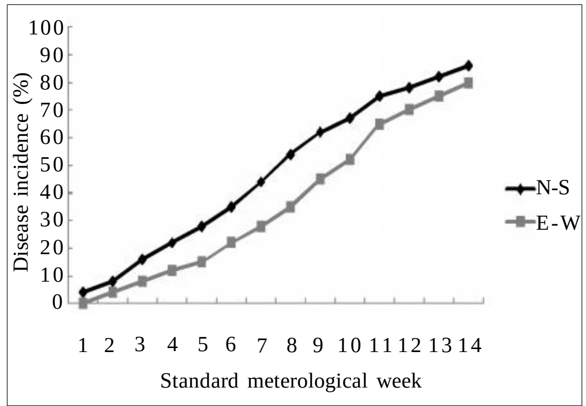

Fig. 3 : Yellow rust incidence under different row direction in PBW 343 during 2013-14

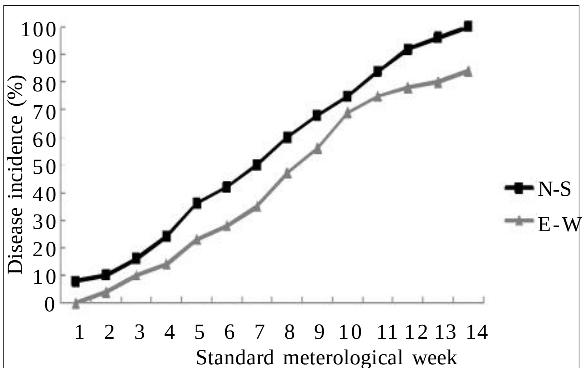

Fig. 2 : Yellow rust incidence under different row direction in PBW 550 during 2012-13

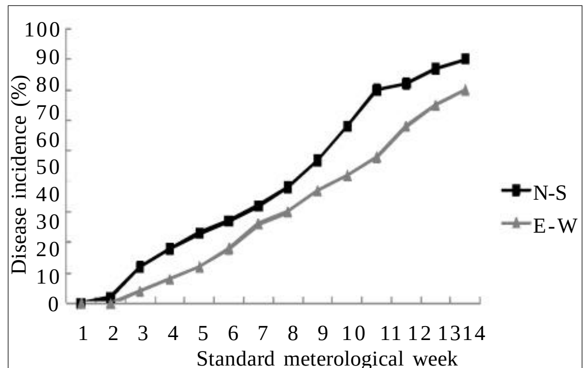

Fig. 4 : Yellow rust incidence under different row direction in PBW 550 during 2013-14

both a high and a low vapour pressure decreased the chance of disease infection. High relative humidity in the range of 95 to 100 per cent favours disease development.

Disease incidence and meteorological parameters :

Several environmental variables affect the production, dispersal and survival of uredinospores (Eversmeyer and Kramer, 1995). The correlation co-efficients were worked out between disease incidence and meteorological parameters. The weekly meteorological parameters, *viz.*, maximum temperature (Tmax, °C), minimum temperature (Tmin,°C), morning relative humidity (RHm, %), evening relative humidity (RHe,%) and sunshine hours (SSh, Hours/day) were correlated with weekly disease incidence in wheat varieties PBW 343 and PBW 550 sown under north-south (N-S) and east-west (E-W) row direction during *Rabi* 2012-13 and 2013-14 (Table 1). During both the years the maximum temperature, minimum temperature and sunshine hours were positively correlated with the disease incidence in different treatments. Similar results were reported by Murray *et al.* (2005). Papastamati *et al*. (2007) also reported that the most important weather variable for the progress of yellow rust is temperature, followed by dew period and light quantity. The disease incidence showed a negative correlation with morning and evening relative humidity. Similar results were reported by Lemaire *et al.* (2002). The rainfall during the seasons did not show any significant correlation with disease incidence. Similarly, Srinivasan (1983) also developed regression models for the prediction of yellow rust in sub-mountain and central plain regions of Punjab and he also reported that relative humidity and precipitation frequency were the major factors influencing the outbreak of this disease.

The multiple regression analysis was conducted to find the cumulative effect of different meteorological parameters on disease incidence by taking disease incidence as dependent variable and different

Table 1 : Correlation co-efficients between yellow rust incidence and different meteorological parameters during *Rabi* season 2012-13 and 2013-14 in wheat varieties PBW 343 and PBW 550

Varieties	Tmx	Tmin	Tme	RHm	Rhe	Rhme	RF	SSh
2012-13								
PBW 343 (N-S)	0.963**	0.900**	0.956**	-0.834**	-0.645*	-0.720*	-0.149	0.763*
PBW 550 (N-S)	0.972**	0.912**	0.966**	-0.813**	-0.639*	-0.706*	-0.111	0.772*
PBW 343 (E-W)	0.926**	0.973**	0.969**	-0.302	-0.617*	-0.624*	0.088	0.757*
PBW 550 (E-W)	0.929**	0.976**	0.973**	-0.322	-0.623*	-0.639*	0.076	0.747*
2013-14								
PBW 343 (N-S)	0.961**	0.926**	0.965**	-0.773*	-0.577*	-0.647*	-0.079	0.769*
PBW 550 (N-S)	0.937**	0.882**	0.936**	-0.771*	-0.549*	-0.642*	-0.075	0.769*
PBW 343 (E-W)	0.917**	0.965**	0.960**	-0.255	-0.592*	-0.590*	0.109	0.757*
PBW 550 (E-W)	0.918**	0.977**	0.966**	-0.316	-0.613*	-0.633*	0.116	0.735*

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Multiple regression analysis between yellow rust incidence (Y) and different meteorological parameters in wheat varieties PBW 343 and PBW 550

2012-13	Regression equation	R^2
PBW 343 (N-S)	Y=-142.9-2.84Tmax+10.9Tmin+1.88RHm-0.61RHe-0.28RF+2.42SSh	0.95
PBW 550 (N-S)	Y=-86.8-3.08Tmax+10.7Tmin+1.42RHm-0.73RHe-0.18RF+1.93SSh	0.94
PBW 343(E-W)	Y=-98.8-2.06Tmax+9.53Tmin+1.21RHm-0.42RHe-0.24RF+2.20SSh	0.93
PBW 550 (E-W)	Y=-98.9-1.29+8.73Tmin+1.00RHm-0.31RHe-0.27RF+1.49SSh	0.94
2013-14		
PBW 343 (N-S)	Y=-121.3+8.28Tmx-1.44Tmin-0.84RHm+1.26RHe-0.12RF+0.45SSh	0.94
PBW 550 (N-S)	Y=-133.9+11.8Tmax-5.29Tmin-1.51RHm+2.03RHe-0.12RF+0.17SSh	0.92
PBW 343(E-W)	Y=11.2+6.88Tmx-1.72Tmin-1.69RHm+0.84RHe-0.04RF-0.49SSh	0.92
PBW 550 (E-W)	Y=-36.7+8.10Tmax-1.83Tmin-1.45RHm+0.91Rhe+0.01RF-0.35SSh	0.94

where,

N-S: North-south; E-W: East-west
Tmax: Maximum temperature (°C); Tmin: Minimum temperature (°C)
RHm: Morning relative humidity (%); RHe: Evening relative humidity (%)
RF: Rainfall (mm); SSh: Sunshine hours (Hours/day)

meteorological parameters as independent variables. The multiple regression analysis between disease incidence and meteorological parameters for different treatments is shown in Table 2. The R^2 value in different treatments showed very high variability in disease incidence due to different meteorological parameters. Similar regression models for predicting the yellow rust in central plain regions of Punjab were developed by Dutta *et al*. (2008). Rader *et al*. (2007) developed two models to predict the occurrence of leaf rust (caused by *Puccinia recondita* or *P. triticina*) using air temperature, relative humidity and precipitation.

Conclusion :

On the basis of this experiment it can be concluded that E-W row direction can be used to lower down the rate of disease development. Higher R^2 values of multiple regression analysis between yellow rust incidence and different meteorological parameters indicated that yellow rust incidence is highly influenced by meteorological parameters *viz.*, temperature, relative humidity and sunshine hours.

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