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# Effect of weather parameters on yellow rust incidence of wheat under different growing environment

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**A**BSTRACT **:**

Yellow rust is the major wheat disease and is influenced by prevailing weather conditions. Field experiment was conducted to investigate the effect of weather parameters on yellow rust incidence under different growing environments. Wheat varieties HD 2967, PBW 550 and PBW 343 were sown under three row spacing *viz.*,15 cm, 22.5 cm and 30 cm. Yellow rust incidence was recorded at weekly intervals. Disease incidence was higher (100%) during *Rabi* 2012-13 as compared to 2013-14 (90%). Among different row spacing the disease incidence was maximum (100 %) in 15 cm row spacing followed by 22.5 cm and minimum in 30 cm spacing 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 $R^2$ (0.91 and 0.92) was found when maximum meteorological parameters were combined in PBW 550 and PBW 343, respectively.

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## INTRODUCTION

Wheat is one of the first domesticated food crops, cultivated since the start of settled agriculture 10,000 years ago. Today, wheat is unrivalled in its range of cultivation and is one of the most important food crops, with more than 600 million tonnes produced each year, providing 16 per cent of total dietary calories consumed globally (Dixon *et al.*, 2009). Constraints on wheat yields directly affect food prices and impact the world's poor. Increasing the yield potential of wheat is therefore a high priority objective in current wheat research. While the genetic yield potential of wheat varieties determines possible yield values, the effects of diseases, pests and abiotic stresses influence actual outcomes. Plant diseases affect 55 per cent of the global wheat growing area, causing an estimated loss of 20 million tonnes of wheat per annum (Kosina *et al.*, 2007). Among the wide array of micro-organisms causing diseases on wheat, the fungal diseases leaf rust, stem rust and stripe rust (caused by *Puccinia triticina* (Pt), *Puccinia graminis* f. sp. *tritici* (Pgt) and *Puccinia striiformis* f. sp. *tritici* (Pst), respectively). Leaf rust can occur wherever wheat is grown, but usually causes relatively small losses except for severe epidemic situations (Singh *et al*., 2002). *P. triticina* has a wide virulence range and is broadly adapted to diverse climatic conditions, leading to regular and significant yield losses over large geographical areas. Stripe rust is traditionally important for wheat grown in cooler environments due to the lower temperatures required for optimum development (Singh *et al*., 2002). With the current global situation requiring higher wheat production from declining land areas, more productive farming systems will potentially increase pressure from diseases such as stripe rust or yellow rust. 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. The cool weather at night allows stripe rust to develop and the pathogen to survive. 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 triticina* has a wide virulence range and is broadly adapted to diverse climatic conditions, leading to regular and significant yield losses over large geographical areas. Severity 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 different weather parameters and growing environment on yellow rust incidence.

## MATERIAL AND METHODS

Wheat varieties HD 2967, PBW 550 and PBW 343 were sown under three row spacing *viz.*,15 cm, 22.5 cm and 30 cm during *Rabi* seasons of 2012-13 and 2013-14. The crop was raised as per recommendations of Punjab Agricultural University. Daily meteorological observations on temperature (°C), relative humidity (%), sunshine hours (hrs/day) and rainfall (mm) were recorded at the Agro meteorological Observatory (30° 54' N, latitude and 74° 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. Values of correlation co-efficient (r) and co-efficient of determination ($R^2$) were statistically analysed and level of significance was checked.

## 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 growing environment :

The pathogen causing yellow rust infects the green tissues of plants of cereal crops and grasses. Infection can occur anytime from the one-leaf stage to plant maturity provided plants are still green. Yellow rust incidence was observed in different wheat varieties *viz.*, HD 2967, PBW 550 and PBW 343 under different row spacing *viz.*, 15 cm, 22.5 cm and 30 cm. Variety HD 2967 did not show any symptom of yellow rust incidence and was observed as highly resistant variety. Whereas variety PBW 343 and PBW 550 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. 1a-d). Among different row spacing, disease incidence was comparatively higher in narrow row spacing (15 cm) as compared to wider row spacing (30 cm). This may be due to the congenial conditions in narrow row spacing for disease development. Disease incidence was maximum in variety PBW 343 sown under narrow row spacing. Comparatively, higher relative humidity within crop canopy in narrow row spacing may be the reason for higher disease incidence. Similarly, Friedrich (1995)

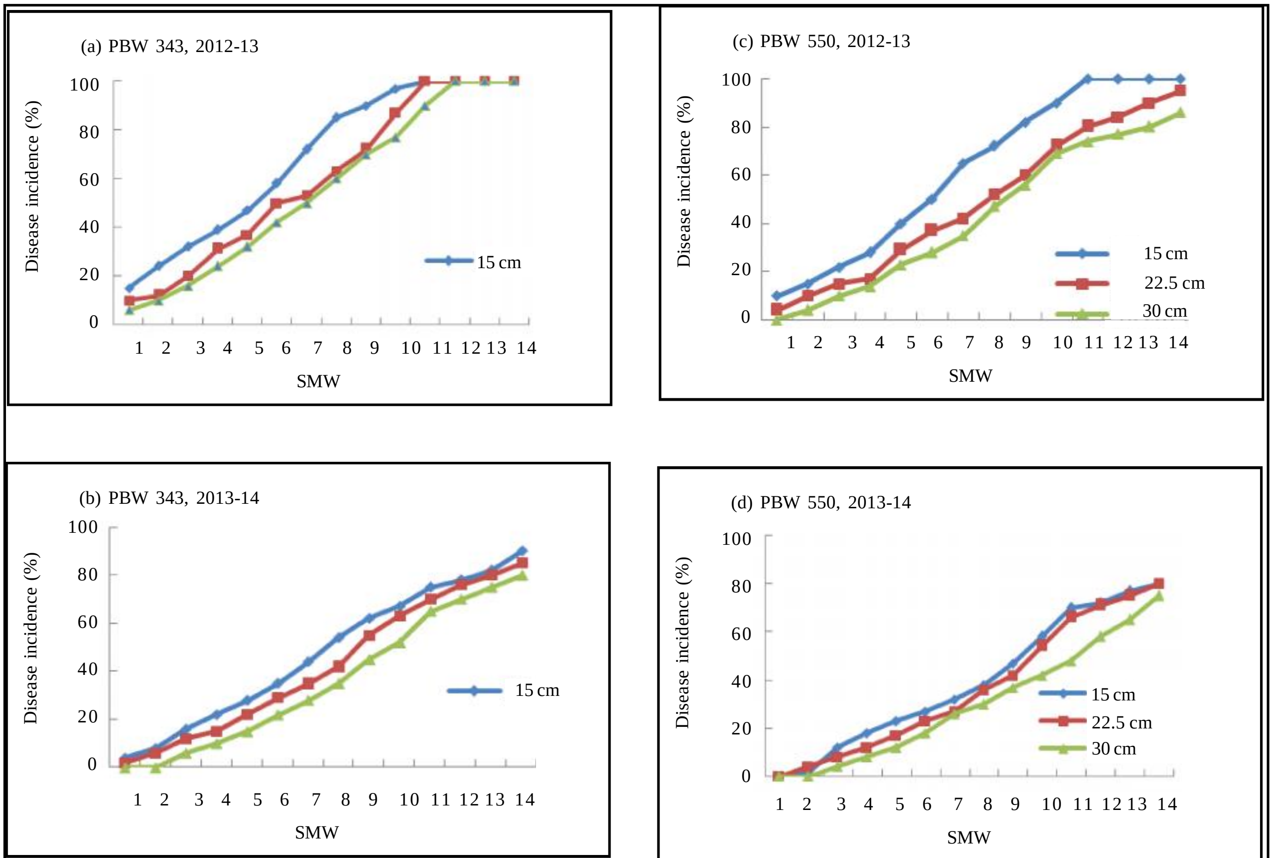


**Fig. 1(a-d): Comparison of disease incidence in wheat during 2012-13 and 2013-14 crop seasons**

found that 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 weather parameters :

The development of yellow rust depends more on the specific weather conditions when pathogen inoculum (urediniospores) and susceptible host plants are present. The three most important weather factors affecting epidemics of yellow rust are moisture, temperature and wind (Chen, 2005). The correlation co-efficients were worked out between disease incidence and meteorological parameters. The weekly meteorological

**Table 1: Correlation co-efficient between different weather parameters and yellow rust incidence on wheat varieties under different row spacing**

| | Tmax | Tmin | RHm | RHe | RF | SSH |
|---|---|---|---|---|---|---|
| **PBW 550** | | | | | | |
| 15 cm | 0.941* | 0.949* | -0.528* | -0.650* | -0.056 | 0.777* |
| 22.5 cm | 0.940* | 0.953* | -0.547* | -0.657* | -0.044 | 0.774* |
| 30 cm | 0.947* | 0.947* | -0.585* | -0.681* | -0.084 | 0.767* |
| **PBW 343** | | | | | | |
| 15 cm | 0.917* | 0.930* | -0.466 | -0.589* | -0.001 | 0.770* |
| 22.5 cm | 0.924* | 0.939* | -0.500* | -0.608* | -0.017 | 0.767* |
| 30 cm | 0.944* | 0.951* | -0.572* | -0.668* | -0.065 | 0.772* |

Where, Tmax - Maximum temperature (°C) Tmin - Minimum temperature (°C) RHm - Morning relative humidity (%)
RHe - Evening relative humidity (%) RF - Total rainfall (mm) SSH - Sunshine hours (hours/day)
* indicate significance of value at P=0.05

**Table 2: Regression analysis between yellow rust incidence (Y) and different weather parameters under different row spacing (Pooled data 2012-13 and 2013-14)**

| | Regression equation | $R^2$ |
|---|---|---|
| **PBW 550** | | |
| 15 cm | Y=-194.6+3.09Tmax+4.61Tmin+1.05RHm+0.38RHe-0.21RF+1.83SSh | 0.89* |
| 22.5 cm | Y= -149.9+1.99Tmax+5.43 Tmin+0.91RHm+0.13RHe-0.12RF+1.83SSh | 0.90* |
| 30 cm | Y=-108.6+2.92Tmax+3.62Tmin+0.28RHm+0.24RHe-0.15RF+0.95SSh | 0.91* |
| **PBW 343** | | |
| 15 cm | Y= -198.4+5.54Tmax+1.52 Tmin+0.42RHm+1.13RHe-0.04RF+2.34SSh | 0.87* |
| 22.5 cm | Y= -184.0+4.29Tmax+3.29 Tmin+0.58RHm+0.73RHe-0.10RF+2.04SSh | 0.88* |
| 30 cm | Y= -99.2+2.99Tmax+3.93 Tmin+0.06RHm+0.39RHe-0.12RF+1.56SSh | 0.92* |

Where, Tmax - Maximum temperature (°C) Tmin - Minimum temperature (°C) RHm - Morning relative humidity (%)
RHe - Evening relative humidity (%) RF - Total rainfall (mm) SSh - Sunshine hours (hours/day)
*indicate significance of value at P=0.05

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 different row spacing 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. But the rainfall may have played role in increase in relative humidity and spread of yellow rust within field. 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 weather parameters as independent variables. The multiple regression analysis between disease incidence and weather parameters for different treatments is presented in Table 2. The $R^2$-value in different treatments showed very high variability in disease incidence due to different weather 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. Disease prediction is of fundamental importance for the successful and efficient use of chemicals to manage rusts. 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 (De Wolf and Isard, 2007).

## Conclsusion :

On the basis of this experiment it can be concluded that wider row spacing can be beneficial in yellow rust prone areas. 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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