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Dynamics of white rust disease in mustard (*Brassica juncea*) in relation to date of sowing and weather parameters*

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Mustard (*Brassica juncea* (Linn.) Czern. and Coss.) is an important oilseed crop which occupies almost 80% of the 7 million ha cropped with rapeseed-mustard (oilseed *Brassica*) in India (Mishra *et al*. 2009). White rust caused by *Albugo candida* (Pers.) Kuntze. is a major disease of mustard. In India, white rust causes annual yield losses of 20–60% in mustard. Mustard grown in Western Uttar Pradesh usually suffers seriously from this disease. Based on a preliminary survey, Biswas *et al.* (2004) reported 17.58% leaf infection and 23% floral infection of white rust in the region. Considering the economic importance of the disease the present investigation was taken up to study the effect of sowing dates on the severity and dynamics of white rust. Weather parameters, associated with the progress of the disease were also studied to understand the development of white rust.

Field experiment was conducted during winter (*rabi)* season of 2003–06 at PDFSR Research Farm, Modipuram, Meerut. The treatments comprised six dates of sowing, viz 10 and 17 October (early sown), 24 October and 1 November (timely sown) and 8 and 15 November (late sown). The experiment was laid out in randomized block design with four replications. The mustard variety Pusa Bold was sown at 30 cm row spacing in 2.4 m × 10 m plots with seed rate of 5 kg/ha. Recommended doses of fertilizers (80:17.6:16.7 N:P:K kg/ha) and for insect control methyl dematon 25 EC @1ml /litre was applied. Ten plants in each plot were selected and tagged for recording observations on disease severity. For disease scoring on leaves, 0- 5 scale was used wherein 0 = no infection, 1= 1–10 % leaf area infected, 2= 11–25 % leaf area infected, 3= 26–50 % leaf area infected, 4= 51–75 % leaf area infected, 5= 76–100 % leaf area infected. The seed yield of mustard was recorded at the harvest. The weather data on temperature, humidity and rainfall were recorded regularly during crop season in both the years from the adjacent meteorological station of the Directorate (Fig1). Disease observations were recorded at fortnightly intervals. The correlations of PDI with the concerned weather parameters were found out. The effect of the weather parameters on the disease was estimated using multiple regression analysis with the prediction equation: $Y = b_o + b_1 x_1 + b_2 x_2 + b_n x_n$ where, Y is percent disease severity, b_o is a constant, b_1 b_2 …b_n are regression co-efficients and x_1, x_2… x_n are independent weather variables.

During both the years, the initial disease symptom appeared in the second week of December in case of 10 and 17 October-sown crops. In 2004–05, the disease severity reached its peak at the end of January and in 2005–06, the maximum disease severity was recorded in the second week of February in early-sown, timely-sown as well as late-sown crops. The peak disease severity was only 0.94% and 1.61% in10 and 17 October sown crops in the first year and next year it was 10.1% and 11.5% respectively.

The initial disease symptom appeared in the third week of December in case of 24 October-sown crop and in the last week of December in1 November-sown crop. The disease severity reached its peak at the end of January and thereafter showed a declining trend (Fig.1). Saharan *et al*. (1988) also reported that the severity of white rust increased upto certain period and then gradually reduced. In 2004–05 the peak disease severity was 5.65% and 6.07% in 24 October and 1 November sown crops and in 2005–06 it was 21.7%, 23.8% respectively. Although the disease appeared more or less at the same time in the last week of December in case of 8 November and in the first week of January in case of 15 November sown crops the late sown crop suffered badly due to the disease. The peak disease severity was 10.63 and

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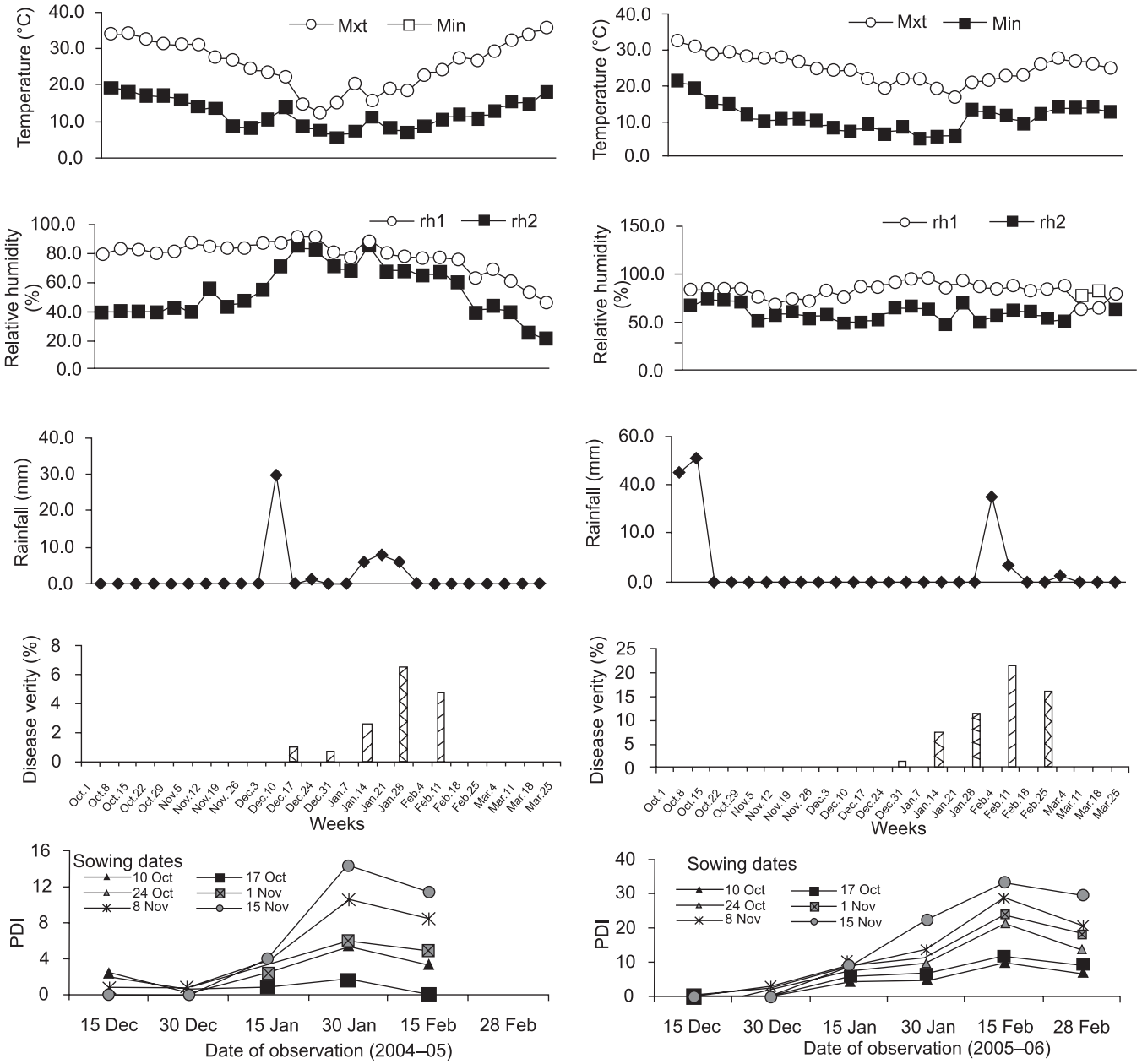

Fig 1 Per cent disease index and disease severity of white rust in relation to different weather parameters (rainfall, relative humidity and temperature) in mustard during 2004-05 and 2005-06

14.35% in the first year and 28.6% and 33.3% in the next year in 8 and 15 November-sown crops respectively.

The disease severity was lowest (2.61%) in case of 10 October-sown crop and it gradually increased with delay in sowing being recorded highest (10.35%) in 15 November-sown crop (Table 1). Khunti *et al* (2002) reported that foliar infection appeared late in December and increased significantly in late-sown (November) crop with 20–25% damage. Similarly, Dange *et al* (2003) also reported that early sowing of mustard in October resulted in less severity of white rust than late sowing in November.

The disease appeared as small, white raised pustules on leaves. Initially, the disease development was slow, but it increased later and reached the maximum when favourable weather conditions prevailed with minimum temperature of 10.9°C, maximum temperature of 22.45°C and average relative humidity of 73.9%. Sangeetha and Siddaramaiah (2007) noticed maximum disease development of white rust under minimum temperature of 15–16°C, maximum temperature of 28–29°C and average relative humidity more than 65%. The disease severity (expressed as per cent disease index) showed negative correlation with minimum

Table 1 Effect of date of sowing on disease intensity and yield of mustard under different weather parameters (pooled data)

Date of sowing	Disease intensity (%)	Yield (tonne/ha)	Temperature (°C) Minimum	Temperature (°C) Maximum	Relative humidity (%)	Average rainfall (mm)
10 October	2.61	2.28	11.1	25.1	71.0	34.1
17 October	3.27	2.20	10.6	24.6	71.04	8.6
24 October	5.78	1.81	10.2	24.1	71.04	8.6
1 November	6.64	1.69	9.7	23.5	71.4	8.6
8 November	8.05	1.37	9.3	22.9	72.1	8.6
15 November	10.35	1.07	9.1	22.3	72.8	8.6
CD (*P*=0.05)	6.33	0.42	0.75	1.44	2.56	15.7

temperature under all the sowing dates, however, it was significant only in case of 10 October (r =–0.62), 17 October (r=–0.59) and 1 November(r=-0.60) sowing (Table 2). The PDI showed non-significant negative correlation with maximum temperature and mean temperature as well. Relative humidity is positively correlated with the disease severity (Saharan *et al*. 1988). In the present investigation the PDI showed non- significant positive correlation with mean relative humidity under all the sowing dates except in 15 November sowing. However, Sangeetha and Siddaramaiah (2007) reported non-significant negative correlation of white rust severity with relative humidity. Rainfall showed significantly positive correlation with the disease severity under all the sowing dates (r=0.76–0.82), similar to the reports made by Saharan *et al*. 1988.

Pooled data of two years experimentation revealed that maximum seed yield of 2.28 tonnes/ha was obtained in 10-October sown crop and it gradually declined with delay in sowing with lowest yield of 1.07 tonnes/ha recorded in 15-November sown crop (Table 1). Pandey and Bose (2006) reported increased yield and yield attributes in timely-sown crop as compared to early-and late-sown crop.

SUMMARY

Field trials were conducted (2003–06) on Indian mustard (cv. Pusa Bold) to study the correlation of white rust in relation to sowing date (10, 17, 24 October, 1, 8 and 15 November) and weather parameters. Data revealed higher severity of white rust in delayed sowing after 17 October. The disease severity showed negative correlation with minimum temperature under all the sowing dates, however it was significant only in case of 10 October (r =–0.62), 17 October (r=–0.59) and 1 November (r=–0.60) sowing. The PDI showed non-significant negative correlation with maximum temperature and mean temperature as well. Although rainfall showed significantly positive correlation with the disease severity under all the sowing dates(r=0.76-0.82) relative humidity did not show any consistent correlation. Pooled data of two years experimentation revealed that maximum seed yield of 2.28 tonnes/ha was obtained in 10 October sown crop and it gradually declined with delay in sowing with lowest yield of 1.07 tonnes/ha recorded in 15 November-sown crop.

Table 2 Correlation coefficients and regression equations between disease intensity and weather parameters

Date of sowing	Temperature (°C) Minimum	Temperature (°C) Maximum	Mean	Relative humidity (%) Minimum	Relative humidity (%) Maximum	Mean	Rainfall (mm)
10 October	r = –0.62* Y=24.9–2*X	r = –0.24 Y=15.04-0.5X	r = –0.43 Y=24.08–1.19X	r = 0.27 Y=–10.97+0.24X	r = –0.08 Y=11.9–0. 11X	r = 0.22 Y=–21.2+0.34X	r =0.82** Y = –0.15+0.08X
17 October	r = –0.59* Y = 26.8–2.2*X	r = –0.15 Y = 11.7–0.35X	r = –0.37 Y = 25.06–1.24X	r = 0.09 Y = –2.74+0.1X	r = –0.09 Y = 14.9–0.14X	r = 0.09 Y = –2.74+0.1X	r = 0.76** Y = 1.49+0.21X
24 October	r = –0.55 Y = 40.9–3.4X	r = –0.25 Y = 28.5–0.94X	r = –0.43 Y = 48.1–2.47X	r = 0.08 Y = –2.05+0.14X	r =0.02 Y = 2.54+0.04X	r = 0.08 Y = –7.8+0.19X	r = 0.80** Y = 2.69+0.36X
1 November	r = –0.60* Y = 55.98–5.11X	r = –0.22 Y = 29.34–0.97X	r = –0.43 Y = 58.3–3.12X	r = 0.002 Y = 6.24+0.01X	r = –0.004 Y = 7.12–0.01X	r =0.03 Y = 1.97+0.07X	r = 0.82** Y = 2.85+0.44X
8 November	r = –0.53 Y = 68.64–6.5X	r = –0.24 Y = 35.2–1.19X	r = –0.40 Y = 62.77–3.4X	r = –0.01 Y = 8.88–0.01X	r = 0.11 Y = –17.79+0.3X	r = 0.07 Y = –4.76+0.18X	r = 0.82** Y =3.63+0.52X
15 November	r = –0.51 Y = 93.99–9.22X	r = –0.18 Y = 35.19–1.12X	r = –0.32 Y = 67.32–3.63X	r = –0.04 Y = 16.03–0.09X	r = 0.23 Y = –73+0.97X	r = –0.08 Y = –8.44+0.26X	r = 0.79** Y = 4.6+0.66Xa

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