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Studies on the epidemiology of white rust and Alternaria leaf blight and their effect on the yield of Indian mustard

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High severity of white rust and Alternaria leaf blight diseases is an important constraint in the production of Indian mustard. An experiment was conducted at the Regional Research Station, Gurdaspur during *Rabi*, 2011 to 2012 to investigate the role of weather conditions like humidity, temperature and rainfall on these diseases and to measure the loss in yield due to them. The first visible symptoms of white rust first appeared 42 days after sowing while those of Alternaria leaf blight appeared at 61. The development of white rust and Alternaria leaf blight was favoured by a mean temperature ranging between 11.4 to 17.7°C and 13.5 to 19.3°C, respectively along with an average relative humidity of more than 70%. A highly significant positive correlation was observed between disease severity as well as maximum and minimum temperatures. The average loss in seed yield due to these diseases was estimated to be 36.88%.

Key words: Epidemiology, white rust, Alternaria leaf blight, mustard, yield loss.

INTRODUCTION

Indian mustard (*Brassica juncea* (Linn) Czern and Coss.) is an important oilseed crop. The crop is affected by many biotic and abiotic stresses. Among the biotic ones, white rust caused by *Albugo candida* (Pers.) Kuntze and Alternaria leaf blight caused by *Alternaria brassicae* (Berk.) Sacc. are the most destructive diseases of rapeseed mustard, which can cause high yield reduction within a short period of time. Alternaria blight can cause a yield loss of 10 to 71% (Chattopadhyay, 2008) and 32.57% (Shrestha et al, 2005). A reduction of 24% in 1000 grain weight in mustard due to Alternaria blight was reported by Kolte et al. (1987). Yield losses ranging between 23 to 54.5% due to white rust have been reported from India (Saharan et al., 1984).

Environmental factors like temperature, relative humidity and rainfall play an important role in the development of white rust and Alternaria leaf blight (Sinha and Sinha, 1992). Sangeetha and Siddaramaiah (2007) have reported that a maximum temperature of 26 to 29°C, a minimum temperature of 14 to 15°C and average relative humidity of more than 65% favour the development of these diseases. The pustules of white rust developed at a faster rate when the average relative humidity was more than 65% and average temperature was between 10 to 18°C (Lakhra and Saharan, 1991). Shrestha et al. (2005) reported that Alternaria leaf blight appeared when relative humidity was above 80% with maximum and minimum temperatures ranging between 18 to 25°C and 10 to 14°C, respectively. The present investigations were planned with the following objectives:

i) To study the effect of weather on the development of Alternaria blight and white rust.
ii) To study the effect of these diseases acting together

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Table 1. Rating scale used for scoring white rust.

Disease rating	Disease severity description
0	No symptoms on leaf.
1	Rust pustules small, scattered covering ≤5% leaf area.
2	Rust pustules covering 5.1 to 10% leaf area.
3	Typical rust pustules covering 10.1 to 25% leaf area.
4	Typical rust pustules covering 25.1 to 50% leaf area. Leaf shedding.
5	Typical rust pustules covering > 50% leaf area. Defoliation severe.

Table 2. Rating scale used for scoring Alternaria blight.

Disease rating	Disease severity description
0	No symptoms on leaf.
1	Small light brown spots scattered covering ≤5% leaf area.
2	Spots small, brown, with concentric rings, covering 5.1 to 10% leaf area.
3	Spots large, brown, irregular, with concentric rings, covering 10.1 to 25% leaf area.
4	Large, brown, irregular lesions with typical blight symptoms, covering 25.1 to 50% leaf area.
5	Large, brown, irregular lesions with typical blight symptoms, covering more than 50% leaf area.

on the seed yield.

MATERIALS AND METHODS

The experiment was conducted at Regional Research Station, Gurdaspur during *Rabi*, 2011-2012. The seed of variety RLM 619 was sown in 10 plots with a plot size of 7.5 m^2 each. The recommended agronomic practices like weeding, thinning, irrigation and protection technologies to control insect-pests were adopted.

Five plots were sprayed with fungicides as per recommendation and five plots were kept unsprayed. The first spray was applied at 75 days old crop with Indofil M-45 at 0.25% followed by a second spray with Score at 0.1%. A third spray was applied with Indofil M-45 at 0.25%. The sprays were applied at 15 days interval. The development of the diseases under natural conditions was studied on ten randomly selected and tagged plants per plot. After the initiation of the disease on leaves, the disease incidence was recorded at weekly intervals. The disease assessments were continued until there was a total defoliation in the untreated plots. The scoring scales (Tables 1 and 2) were used to assess the disease.

The formula given by Wheeler (1969) was used to calculate the percent disease index (PDI) as follows:

$$PDI = \frac{\text{Total sum of individual ratings}}{\text{Number of leaves examined} \times \text{Maximum rating}} \times 100$$

The weather data with respect to daily maximum temperature, daily minimum temperature, relative humidity and rainfall were obtained from the nearby observatory. Simple correlation was done between the disease index and weather parameters.

At harvest, the total yield per plot and 1000 seed weight was measured for both the sprayed and unsprayed plots. The loss in yield was calculated by using the formula as given below:

$$Y_L(\%) = \frac{Y_S - Y_U}{Y_S} \times 100$$

Where, Y_L = percent yield loss
Y_S = yield in sprayed plot
Y_U = yield in unsprayed plot

RESULTS AND DISCUSSION

Effect of weather on the PDI of white rust

The effect of different weather parameters on the severity of white rust is presented in Table 3. The typical pustules of white rust appeared on the leaves after forty-two days of sowing, during the last week in December. During this week, the daily maximum and minimum temperature ranged between 14.1 to 20.6°C and 3.6 to 7.1°C respectively, with an average relative humidity of more than 75%. Initially, the development of the disease was slow but after 11 weeks of sowing, the number of rust pustules and the percent leaf area affected increased significantly. The increase in disease severity reached its maximum during 16th week, when there was a mean maximum and minimum temperature of 23.2 and 12.1°C respectively with mean relative humidity of more than 75% (Figure 1). Highly significant positive correlation was observed between PDI of white rust and the mean maximum and minimum temperatures (Table 4). However, the other weather factors like rainfall and relative humidity had a negative correlation with disease severity. It was observed that the mean maximum temperature of 16.3 to 23.2°C, mean minimum temperature of 6.2 to 12.1°C with an average temperature of 11.4 to 17.7°C and an average RH of more than 70% was very favorable for the rapid spread of white rust disease. Similar observations have been

Table 3. Effect of weather parameters on the development of white rust and *Alternaria* blight.

Week	Mean temperature (°C)			Relative humidity (%)			Total rainfall (mm)	White rust		Alternaria blight	
	T_{max}	T_{min}	T_{ave}	RH_{max}	RH_{min}	RH_{ave}		PDI	% increase	PDI	% increase
1	24.7	13.6	19.1	99.0	60.7	80.1	0.0	0	-	0	-
2	23.0	10.6	16.8	99.0	57.7	78.6	0.0	0	-	0	-
3	23.6	11.3	17.5	97.9	52.9	75.6	1.5	0	-	0	-
4	20.1	9.8	15.0	99.0	66.9	82.9	12.5	0	-	0	-
5	18.0	5.3	11.6	99.0	58.0	78.7	0.0	0	-	0	-
6	18.0	3.9	11.0	99.0	57.0	78.0	0.0	0	-	0	-
7	17.5	5.7	11.6	99.0	75.0	87.1	0.0	0.2	0.2	0	-
8	14.5	5.5	10.0	97.9	87.9	93.6	59.0	0.6	0.4	0	-
9	13.7	7.2	10.4	99.0	96.7	97.9	39.0	0.8	0.2	0.4	0.4
10	14.8	5.0	9.9	99.0	99.0	99.0	0.5	1.0	0.2	0.6	0.2
11	17.4	4.3	10.9	99.0	99.0	99.0	0.0	1.8	0.8	1.8	1.2
12	16.3	6.6	11.5	99.0	88.3	93.7	0.5	5.4	3.6	2.8	1.0
13	16.5	6.2	11.4	99.0	70.9	85.0	6.0	12.4	7.0	5.6	2.8
14	17.4	8.0	12.7	99.0	90.7	93.6	6.5	17.4	5.0	7.8	2.2
15	19.3	7.6	13.5	99.0	54.4	76.3	0.0	22.0	4.6	13.2	5.4
16	23.2	12.1	17.7	94.7	56.4	75.7	7.5	40.8	18.8	20.2	7.0
17	21.8	10.3	16.2	96.7	45.0	71.0	6.5	55.6	14.8	31.6	11.4
18	24.4	14.1	19.3	92.9	52.0	72.6	0.0	63.6	8.0	48.4	16.8
19	26.8	14.4	20.6	87.1	44.1	66.0	0.0	68.8	5.2	49.6	1.2
20	31.3	18.2	24.8	85.0	42.1	63.7	0.0	69.4	0.6	49.8	0.2

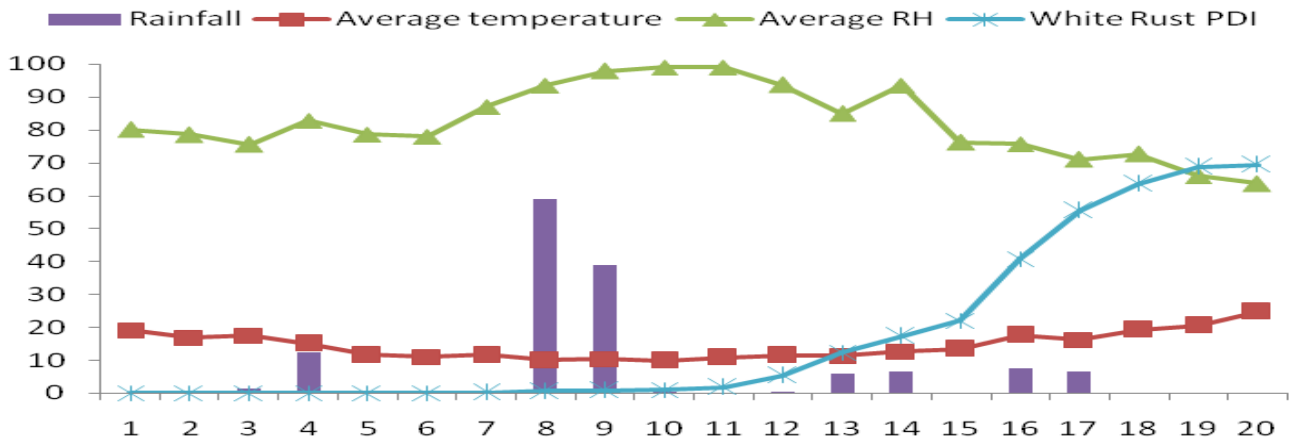

Figure 1. Development of white rust as influenced by weather parameters.

reported by Saharan et al. (1988). Lakhra and Saharan (1991) also reported that an average temperature of 10 to 18°C with an average relative humidity of more than 65% favoured the development of white rust pustules. The results were also confirmed by those of Sangeetha and Siddaramaiah (2007) who reported that the climatic conditions like minimum temperature ranging between 15 to 16°C, maximum temperature of 28 to 29°C and average relative humidity of more than 65% increased the buildup of white rust disease.

Effect of weather on the PDI of Alternaria blight

The data on the severity of Alternaria blight as affected by different weather parameters is presented in Table 3. The characteristic symptoms of Alternaria blight as small round, necrotic spots, brown to black in colour became visible on the leaves after sixty-one days of sowing. During this period (9th week after sowing), the mean maximum and minimum temperatures were 13.7 and 7.2°C respectively, with an average relative humidity of

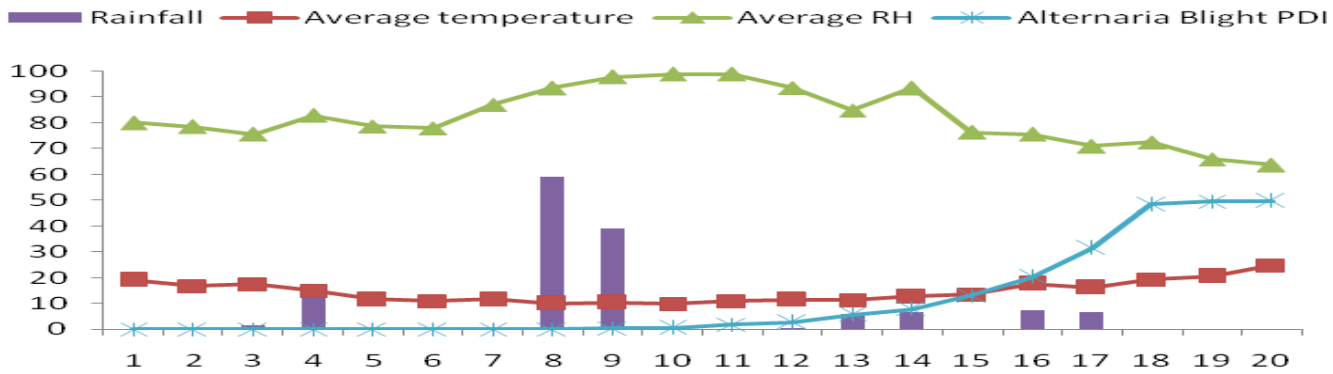

Figure 2. Development of Alternaria blight as influenced by weather parameters.

Table 4. Correlation coefficients between the weather parameters and the PDI of White rust and Alternaria blight.

Weather parameter	White rust	Alternaria blight
Maximum temperature	+0.69	+0.75
Minimum temperature	+0.72	+0.76
Average temperature	+0.72	+0.77
Relative humidity (Morning)	-0.86	-0.96
Relative humidity (Evening)	-0.60	-0.58
Average relative humidity	-0.69	-0.69
Rainfall	-0.21	-0.22

Table 5. Effect of disease severity on seed yield and 1000 grain weight.

Treatment	PDI of		Yield (kg/ha)	Yield loss (%)	1000 grain weight (g)	1000 grain weight loss (%)
	White rust	Alternaria blight				
Sprayed	18.7	9.5	1626.67	-	5.74	-
Unsprayed	71.2	49.1	1026.67	36.88	4.12	28.22

more than 90%. Total rainfall during this week was 39.0 mm which provided the wetness on the leaves. Afterwards, the disease severity increased gradually. The maximum increase in the disease severity was observed during 18th week during which the mean maximum and minimum temperatures were 24.4 and 14.1°C with an average relative humidity of more than 70% (Figure 2). There was a highly significant positive correlation between PDI of Alternaria blight and the mean maximum and minimum temperatures while, disease severity was negatively correlated with rainfall and relative humidity (Table 4). The highest intensity of Alternaria blight was noticed with a mean maximum temperature of 19.3 to 24.4°C, mean minimum temperature of 7.6 to 14.1°C, average temperature of 13.5 to 19.3°C and an average relative humidity of more than 70%. Sinha et al. (1992) associated the high severity of Alternaria blight with a minimum temperature of 8 to 12°C and high relative humidity of more than 90%. Shrestha et al. (2005) also reported that the development of Alternaria blight was maximum during the period when daily minimum temperature was between 10 to 14°C, daily maximum temperature was between 18 to 27°C and average relative humidity ranged between 60 to 96%.

Effect of disease intensity on the seed yield

Disease severity significantly affected the seed yield and 1000 grain weight (Table 5). In the sprayed plots, both the white rust and Alternaria blight progressed at a much slower rate than in the unsprayed plots. There was a total defoliation in the unsprayed plots, whereas, in the sprayed plots the leaves remained attached to the plants

until senescence. The average seed yield and 1000 grain weight was significantly higher in the sprayed plots than the unsprayed plots. The loss in seed yield was found to be 36.88% and the reduction in 1000 grain weight was 28.22%. Saharan et al. (1984) reported that White rust caused a yield loss of 23 to 54.5%. A loss of 32 to 57% due to Alternaria blight in mustard has been reported by Shrestha et al. (2005). Kolte et al. (1987) reported that Alternaria blight can reduce the 1000 seed weight of mustard by 24%.

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