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Full Length Research Paper

Epidemiological studies of white rust, downy mildew and *Alternaria* blight of Indian mustard (*Brassica juncea* (Linn.) Czern. and Coss.)

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White rust, downy mildew and *Alternaria* blight caused by *Albugo candida* (Pers.) Kuntze *Peronospora parasitica* (Pers.) (de Bary) and *Alternaria brassicicola* (Schw.) Wiltshire respectively are important diseases on Indian mustard causing considerable loss. Maximum temperature positively correlated with disease index of all the three diseases. Maximum temperature from 26-29ºC and average relative humidity of more than 65% favoured the development of all the three disease.

Key words: Disease incidence, maximum, minimum temperature, relative humidity.

INTRODUCTION

Indian mustard (*Brassica juncea* (Linn.) Czern. and Coss.) is an important oil seed crop, grown both in tropical and sub tropical regions of the world. It yields important edible oil, which cannot be easily replaced. The major constraints in growing mustard are diseases, aphid pest, frost injury, non-availability of high yielding varieties suitable for high input conditions and fluctuations in weather conditions (Kumar, 1999). Among all these, diseases such as white rust (*Albugo candida* (Pers.) Kuntze), downy mildew (*Peronospora parasitica* (Pers.) (de Bary)) and *Alternaria* blight (*A.brassicicola* (Schw.)) Wiltshire play a prominent role in reducing the yield of mustard. White rust and downy mildew together produced 37-47% fewer pods and 17-32% less seed in mustard (Bains and Jhooty, 1980). *Alternaria* blight reduced 1000 seed weight causing loss of 35.38 per cent (Kolte et al., 1987). Hence an attempt was made to study the role of various weather factors on infection and development of the disease.

MATERIAL AND METHODS

The experiment was conducted at the Regional Research Station, Gandhi Krishi Vignan Kendra, Bangalore. The variety RH-30 was sown at 15 x 15 cm spacing. The seed rate used was 5 kg per hectare. Ten plots of 10 x 10 m were sown. The extra plants were thinned out 15 days after sowing to maintain optimum plant population. Two irrigations were given, one at the time of first flowering followed by another at fruiting stage. The fertilizers added was 60:40:40 (N:P:K). The previous crop was castor (*Ricinum communis*).

In each plot (10 x10 m) five plants were selected at random, labeled and disease incidence of white rust (Table 1) downy mildew (Table 2) and *Alternaria* blight (Table 3) were recorded at seven days interval starting from the date of sowing on leaves using 0 - 5 scale as described below.

The% Disease Index (PDI) was calculated using the formula (Wheeler, 1969).

$$PDI = \frac{\text{Sum of individual rating}}{\text{Number of leaves examined x Maximum disease grade}} \times 100$$

Weather data with respect to maximum and minimum temperature, relative humidity I (7.22 IST or 7.00 LMT) and II (2.22 IST or 2.00 LMT) and rainfall were obtained and averaged for seven days. (Table 4). Simple correlation was done with the maximum temperature, minimum temperature, relative humidity (RH) I, II and rainfall.

RESULTS

The symptoms of white rust disease were noticed 38 days after sowing. The development of the disease initially was slow and reached maximum on 11th week of the crop. Highly significant positive correlation was recorded

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Table 1. Scale/Description of the symptom for white rust.

Scale	Description of the symptom
0	Leaves free from infection
1	Small white raised rust pustules covering <5% leaf area
2	Small white raised rust pustules covering 5.1-10% leaf area
3	Small white raised rust pustules join together covering 10.1-25% leaf area
4	Small white raised rust pustules join together to form irregular patches covering 25.1-50% leaf area
5	Small white raised rust pustules join together to form irregular large patches covering <50% leaf area

Table 2. Scale/Description of the symptom for downy mildew.

Scale	Description of the symptom
0	Leaves free from infection
1	Small creamy white to light brown spots on leaves covering <5% leaf area
2	Small creamy white to light brown spots with cottony downy growth covering 5.1-10% leaf area
3	Creamy white to light brown spots with cottony growth covering 10.1-25% leaf area
4	Creamy white to light brown spots with cottony growth covering 25.1-50% leaf area
5	Creamy white to light brown spots with cottony growth covering 25.1-50% leaf area

Table 3. Scale/Description of the symptom for *Alternaria* blight.

Scale	Description of the symptom
0	Leaves free from infection
1	Small irregular spots covering <5% leaf area
2	Small irregular brown spots with concentric rings covering 5.1-10% leaf area
3	Lesions enlarging, irregular brown with concentric rings covering 10.1-25% leaf area
4	Lesions coalease to form irregular and appears as a typical blight symptom covering 25.1-50% leaf area
5	Lesions coalease to form irregular and appears as a typical blight symptom covering >50% leaf area

between maximum temperature and disease index. Negative correlation was noticed between disease index and other weather factors namely minimum temperature, relative humidity I, II and rainfall (Table 5 and Figure 1).

The first symptom of white rust appeared as small, white raised pustules on leaves. The disease development of white rust was initially slow and later increased. The maximum disease incidence was seen when favourable climatic conditions like minimum temperature of 15 - 16ºC maximum temperature of 28 - 29ºC and average relative humidity of more than 65 per cent existed.

The visible symptoms of downy mildew like small creamy white to light brown spots on the under surface of lower leaves were seen 75 days after sowing. Highly significant positive correlation was recorded between maximum temperature and disease index. Non-significant positive correlation was found between disease index and minimum temperature. Relative humidity I, II and rainfall negatively correlated with disease index.

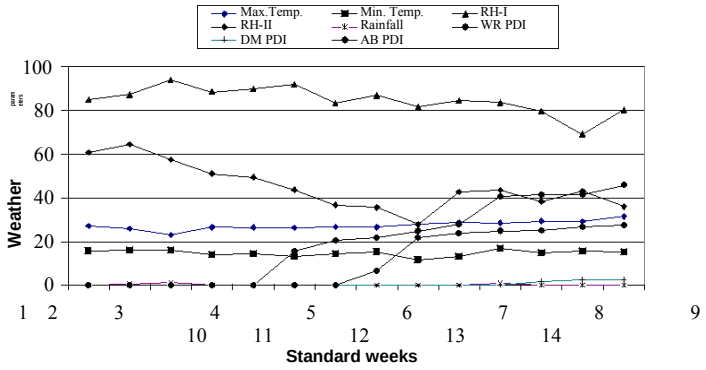

Figure 1. Effect of weather factors on development of white rust, downy mildew and *Alternaria* blight

The downy mildew incidence was very much negligible during the initial stages of crop growth. Maximum downy mildew incidence was seen when minimum temperature

Table 4. Effect of weather factors on development and severity of white rust, downy mildew and *Alternaria* blight of mustard

Observations at seven days interval	Temperature ºC		Relative Humidity (%)		Rainfall (mm)	White rust PDI		Downy mildew PDI		*Alternaria* blight PDI	
	Maximum	Minimum	I	II		Accumulated	Increase	Accumulated	Increase	Accumulated	Increase
1	27.20	15.91	85.00	60.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	26.02	16.01	87.28	64.28	0.71	0.00	0.00	0.00	0.00	0.00	0.00
3	23.11	16.08	94.00	57.57	1.38	0.00	0.00	0.00	0.00	0.00	0.00
4	26.50	13.90	88.57	51.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	26.48	14.40	90.00	49.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	26.30	13.12	92.00	43.71	0.00	15.77	15.77	0.00	0.00	0.00	0.00
7	26.67	14.40	83.28	36.71	0.00	20.52	4.75	0.00	0.00	0.00	0.00
8	26.54	15.37	86.85	35.57	0.00	21.66	1.14	0.00	0.00	6.52	6.52
9	27.80	11.77	81.57	27.71	0.00	24.86	3.20	0.00	0.00	21.88	15.36
10	28.60	13.20	84.42	42.71	0.00	27.91	3.05	0.00	0.00	23.73	1.85
11	28.51	16.97	83.57	43.57	1.11	40.71	12.80	0.00	0.00	24.85	1.12
12	29.42	14.97	79.85	38.42	0.00	41.36	0.67	1.55	1.55	25.08	0.23
13	29.25	15.54	69.14	43.14	0.00	41.64	0.28	2.39	1.84	26.79	1.71
14	31.41	15.18	80.28	36.00	0.00	45.88	4.24	2.46	0.07	27.50	0.71

Table 5. Correlation value between disease index of white rust, downy mildew and *Alter-naria* blight of Indian mustard with environmental

Weather factors	CORRELATION COEFFICIENT 'R' VALUE		
	White rust	Downy mildew	*Alternaria* blight
Maximum temperature	+0.8245**	+0.7211**	+0.8263**
Minimum temperature	-0.4139	-0.1853	-0.0340
Relative humidity I	-0.3252	-0.2009	-0.0983
Relative humidity I	-0.4645	-0.3156	-0.6147
Rainfall	-0.1723	-0.2548	-0.1052

of 14-16ºC and maximum temperature of 26-29ºC existed.

Alternaria blight symptoms appeared 53 days after sowing as minute brown to black usually round necrotic spots on older leaves. Positive, highly significant correlation was found between maximum temperature and disease index. Negative correlation was recorded between disease index and weather factors like minimum temperature, relative humidity I, II and rainfall. Further, highly significant positive correlation was noticed between maximum temperature and all the three diseases.

Maximum temperature of 27 - 28ºC, minimum temperature of 14-15ºC, and average relative humidity more than 65% was found favourable for *Alternaria* blight development.

DISCUSSION

Seasonal incidence and the role of weather factors were studied for white rust, downy mildew and *Alternaria* blight. Increase in disease development of white rust was initially slow. The maximum increase was seen when favorable climatic conditions like minimum temperature of 15-16ºC maximum temperature of 28-29ºC and average relative humidity of more than 65% existed. Saharan et al. (1988) observed increasing of rust pustules at a faster rate when average temperature was 11.5-12.5ºC, average RH was > 75% and existence of cloudy weather coupled with rain and wind velocity. Lakra and Saharan (1991) also reported faster progression of white rust when average relative humidity was more than 65% and average temperature was between 10-18ºC.

The downy mildew incidence was very much negligible during the initial stages of crop growth. The maximum downy mildew incidence was seen when minimum temperature of and maximum temperature of 26 - 29ºC existed. Nakov (1972) observed severe incidence of *P. parasitica* on cabbage at 15 - 20ºC. However D'ercole (1975) reported infection of *P. parasitica* on cauliflower at 8 - 14ºC and RH of 90 – 95%.

Maximum temperature of 27-28ºC minimum temperature of 14 - 15ºC and average relative humidity more than 65% was found favourable for *Alternaria* blight development. Sarkar and Sengupta (1978) reported optimum temperature for *A. brassicicola* growth at 27ºC on mustard. *A. brassicicae* and *A. brassicicola* both required free water with optimum temperatures of 15 and 26ºC respectively for infection of cabbage plants. Alternating wet and dry (70 - 80% RH) periods of 16 and 8 hour respectively restricted infection by both species as reported by Humpherson-Jones and Ainsworth (1983). Maude et al. (1986) reported that at least 12 h continuous high RH (>90%) and temperature of more than 14ºC were required for abundant sporulation of *A. brassicicola* below this temperature, spore production was delayed. Under field studies in 1984 - 1986 severe disease of *Alternaria* blight of rapeseed mustard was associated with low temperature (8-12ºC minimum and 21-26ºC maximum) and high RH (90%), with an average rainfall of 0.3 mm as reported by Sinha et al. (1992).

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