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RESEARCH ARTICLE

Effect of weather parameters and date of sowing on intensity of Alternaria blight of rapeseed mustard

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Abstract

The production and productivity of oilseed brassicas are revelation to the biotic and abiotic stresses that divulges to lower the world average. The Alternaria blight disease severity is confided to weather conditions, varieties, age of host plants and the pathogens. Experiment was set up, to analyze the effect of weather variable and sowing dates on the disease severity of rapeseed mustard and its effect on yield. The data for the Rabi season (2017–2018) shown that the periodical increase in the disease severity with the delay in sowing. Percent diseases intensity (PDI) progression was higher during 3rd sowing (D3) at 75 and 100 Days after sowing in *Brassica juncea* varieties followed by *Brassica napus* and *Brassica nigra* varieties. The disease severity differed significantly among the sowing dates and varieties, RLC-3 showed maximum PDI (52.19%) whereas, PC-6 indicated minimum PDI (0.98%).The maximum seed yield (20.37 q/ha) was recorded on 1st sowing (D1) followed by 2nd sowing (D2) (12.59 q/ha). Giriraj showed maximum seed yield followed by GSC-7. Highest Area under disease progressive curve value was recorded in RLC-3 variety (3885.91) having 3rd sowing (D3) and the lowest was recorded in PC-6 variety (54.77) having 1st sowing (D1). The maximum temperature (15.7–30.3 °C) and minimum temperature (3.3–12.6 °C) was positively correlated with disease severity, disease severity increases with increase in temperature and vice versa.

Keywords Weather parameters · *Alternaria brassicae* · Disease intensity · AUDPC

Introduction

In India, oilseeds constitute the second largest group after cereals. It contributes 32% of the total oilseed production in India. In India, rapeseed-mustard occupies an area of 57.62 lac ha with a production of 68.22 lac tons and productivity of 1184 kg ha^{-1} (Anonymous 2016). Brassica oilseed crops play an important role in the diversification in cropping system and also in providing the quality food by meeting the fat requirement to same extent. The low productivity of these crops leads to significant shortfall in the supply of required quantity. Therefore, the huge amount of foreign exchange is drained for imported, the massive quantity of oilseeds to meet the national requirement. Oilseeds are mainly grown for edible oils, spices, condiments and fodder for livestock. Pests and disease are the major constrains in the production of brassica. Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc. is the devastating diseases of rapeseed-mustard. In India, yield losses of 35–45% in yellow sarson, 25–45% in brown sarson, and 17–48% in raya reported by (Saharan et al. 2005). The disease appears annually during the cropping season (from October to February) in different parts of India and causes enormous loss (Prasad and Vishnuvat 2006).

In Punjab, from the last 10 years, the area under rapeseed mustard is being decreased. A major contributory factor to this gap is its unchallenged exposure to biotic, mesobiotic and abiotic stresses. This is due to the fact brassica crops are more vulnerable to several abiotic stresses viz., temperature (16–28 °C), humidity (< 60%) and rainfall are the most congenial weather factors for the development of the disease under field conditions (Meena et al. 2011). Alternaria blight assessed the higher disease severity of due to variation of sowing dates in rapeseed-mustard, this effect is widely studied by Mian and Akanda 1989; Ayub 2001; Khatun et al. 2011. The A-value AUDPC (area under disease progress curve) was increased with the delay of sowing was reported by Sunita and Srikanta

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(2015). Another most cost-effective and eco-friendly management strategy would be adopting the genotypes retaining the resistant/tolerance reaction against this disease. The genotypes were found partially resistant NPC-15, PBC-2004-1, PRQ-2004-1, NDR-03-06 and PR-2003-30 whereas mostly were susceptible for Alternaria blight (Yaday et al. 2014). This work aims to study the effect of environmental factors and sowing dates on the severity of Alternaria leaf blight of rapeseed-mustard.

Materials and methods

Field trials at Guru Kashi University, Talwandi Sabo (29.96° N, 75.12° E) were conducted in 2017–2018, Rabi crop season in a split plot design with three replications. The four varieties of *B. juncea* (Giriraj and RLC-3), *B. napus* (GSC-7) and *B. nigra* (PC-6) were sown on three sowing dates [October 28th (D1), November 11th (D2) and November 25th (D3)] standard spacing and recommended doses of N, P and K fertilizer were applied. No protection measures were taken in contrast to any diseases. Data for the initial date of appearance of Alternaria blight and gradual progress on leaves of rapeseed-mustard were scrutinized. Observations for percent disease intensity (PDI) were recorded once in 7 days. Weather data was collected from Agro Meteorological Observatory, K.V.K. Regional Station, Bathinda. Ten randomly selected plants in each plot and were tagged for taking observations for disease component. There was a considerable variation in leaf size of different test cultivars. Therefore, Percent disease intensity (severity) was calculated as per 0–9 disease rating scale developed by Mayee and Datar (1986) (Table 1). Percent Disease Intensity was calculated using the following formula;

$$\text{Percent disease intensity} = \frac{\text{Sum of the individual Rating scale}}{\text{No. of disease Plants/leaves observed} \times \text{Maximum disease rating}} \times 100.$$

AUDPC (area under disease progressive curve)

Using the formula of Wilcoxson et al. (1975), who computed the AUDPC as A-value:

$$\text{AUDPC} = \sum_{t-1}^{k} \frac{1}{2} 1\left(y_i + y_{i-1}\right) \times d$$

where y_i = Disease intensity at ith day of evaluation. k = Number of successive evaluation. d = Interval between i and $i-1$ evaluation of the disease.

Apparent rate of infection (r-value)

The apparent rate of disease development (r) is a rate of the speed at which an epidemic develops. The Alternaria blight severity noted at 7 days interval. Van der plank (1963) derived an equation to determine the rate (r):

$$r = \frac{2.3}{t_2 - t_1} \log_{10} \frac{X_2\left(1 - x_1\right)}{X_1\left(1 - x_2\right)}$$

where 'r' = Apparent infection rate. t_1 = time of initial disease rating (x_1). t_2 = time of second disease rating (x_2). x_1 = Disease index at t ime (t_1). x_2 = Disease index at time (t_2).

Results and discussion

Effect of sowing date on severity of Alternaria blight

At GKU field, during October–March, the maximum temperature was 15–30.3 °C, minimum temperature 3.3–12.6 °C, relative humidity > 80%. In the Rabi season Giriraj and RLC-3 showed the earliest occurrence of the symptoms on cotyledon leaves of few plants. The date of appearance of Alternaria blight on leaves in the form of pinhead was first recorded in RLC-3 followed by Giriraj, GSC-7 and PC-6 sowing respectively in October 28th, November 11th and November 25th. The RLC-3 variety showed early symptoms at 21 DAS whereas, PC-6 showed the late symptoms at 100 DAS (Table 2). The phenotypic symptoms of Alternaria blight on different Species of Brassica (Fig. 1 and Table 3) were evaluated. Significant difference among cultivars and time intervals was observed for all the components of disease resistance viz, the number of spots and disease intensity. Percent Disease Intensity (PDI) for Alternaria blight severity on leaves of different cultivars of rapeseed and mustard were analyzed (Table 4). The disease severity elevated in crops with delay in sowing between October 28th (D1),

Table 1 Alternaria blight disease rating scale

Rating scale	Disease intensity per cent	Disease reaction
0	0	Immune (I)
1	> 5%	Highly Resistant (HR)
3	5–10%	Resistant (R)
5	11–25%	Moderately resistant (MR)
7	26–50%	Susceptible(S)
9	> 50%	Highly susceptible (HS)

Table 2 The disease appearance on the varieties at different sowing dates

Date of sowing	Varieties	Initial appearance of the disease (DAS)
D1(28/10/2017)	V1	32(48th week)
	V2	29 (48th week)
	V3	97 (6th week)
	V4	99 (6th week)
D2 (11/11/2017)	V1	24 (49th week)
	V2	21 (49th week)
	V3	99 (07th week)
	V4	100 (07th week)
D3 (25/11/2017)	V1	32 (52th week)
	V2	26 (52th week)
	V3	65 (05th week)
	V4	72 (06th week)

November 11th (D2) to November 25th (D3). Among three sowing dates, significantly the highest overall mean Alternaria blight intensity of 40.36, 52.19, 13.28 and 7.56% was recorded, respectively on 3rd sowing, followed by the 2nd sowing with comparatively reduced disease intensity of 35.27, 50.07, 4.92 and 2.67% and in October 1st sowing with 35.52, 44.85, 3.36 and 0.98% respectively. All the four varieties revealed increased disease severity with the delay in sowing, thus validated the finding of Meena et al. (2002). All the cultivars had shown highly resistant to highly susceptible disease reaction against Alternaria blight which recorded 47.33–62.50% disease intensity on leaves at 75 DAS and 100 DAS that revealed maximum PDI on RLC-3 which was followed by Giriraj. The minimum PDI on leaves 0–2.33% was observed on the cultivar PC-6 at 75 DAS and 100 DAS respectively.

Effect of variety on severity of Alternaria blight

Results divulge that in all four rapeseed-mustard cultivars, the disease augmented with the age of crop and significantly varied with the sowing dates (Table 4 and Fig. 2). PC-6 (highly resistant) recorded comparatively minimum mean disease intensity (0.98%), on 1st sowing, followed by the (highly resistant) GSC-7 (3.36%), whereas RLC-3 found highly susceptible with maximum mean disease intensity of 44.85, 50.07 and 52.19% in the crop sown on D1, D2 and D3, respectively. The disease intensity was maximum in susceptible cv. RLC-3 apart from Giriraj, GSC-7 and PC-6. Interaction effects (D × V) with respect to disease intensity at various intervals was found significant.

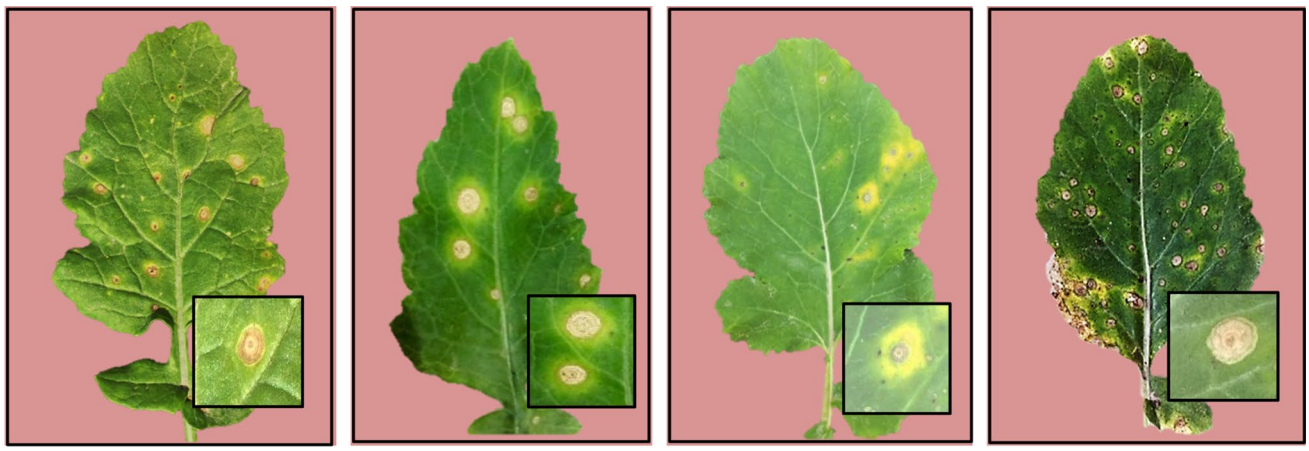

Fig. 1 Symptoms of Alternaira blight on different Species of Brassica

Table 3 Symptoms of Alternaira blight on different Species of Brassica

Cultivars	Spot colour	Periphery colour	Concentric ring	Central point	Yellow halo
Giriraj-*B. juncea*	Brown	Brown	Present	Present (brown)	Present
RLC-3-*B. juncea*	Brown	Brown	Present	Present (brown)	Present
GSC-7-*B. napus*	Gray	Brown	Present	Present (gray)	Present
PC-6-*B. nigra*	Light gray	Light gray	Present	Present (light gray)	Absent

Table 4 Effect of sowing dates and rapeseed-mustard cultivars on Alternaria blight intensity during *Rabi,* 2017–2018

Sowing dates	Cultivars	Per cent disease intensity			
		Plant			
		75 DAS	100 DAS	Overall mean	Disease reaction
D1 (28.10.2017)	Giriraj	20.11	25.33	32.52	S
	RLC-3	36.67	41.30	44.85	S
	GSC-7	00	16.67	3.36	HR
	PC-6	00	2.33	0.98	HR
				20.43	
D2 (11.11.2017)	Giriraj	33.66	47.00	35.27	S
	RLC-3	46.00	52.00	50.07	HS
	GSC-7	00	33.66	4.92	HR
	PC-6	00	16.65	2.67	HR
				23.23	
D3 (25.11.2017)	Giriraj	36.97	50.90	40.36	S
	RLC-3	47.33	62.50	52.19	HS
	GSC-7	13.45	40.37	13.28	MR
	PC-6	14.32	22.99	7.56	R
				28.34	
C.D. ($P=0.05$)	D	1.39			
	V	1.42			
	D×V	2.46			
C.V.	D	5.14			
	V	5.99			

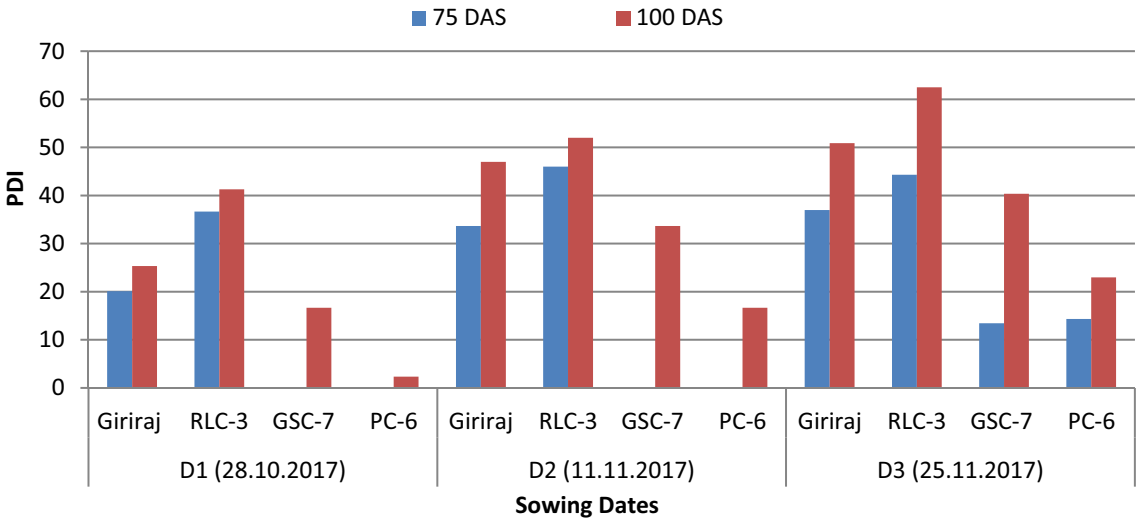

Fig. 2 Effect of sowing dates and rapeseed-mustard cultivars on Alternaria blight intensity during *Rabi,* 2017–2018

Effect of sowing date, variety and their interaction on seed yield

The seed yield of rapeseed-mustard was significant with respect to dates of sowing, varieties and interaction between dates of sowing and variety. The seed yield was the lowest in 3rd sowing for all the four varieties. The maximum seed yield (20.37 q/ha) was recorded on 1st sowing followed by 2nd sowing (12.59 q/ha).The maximum seed yield was harvested on 1st sowing in Giriraj (21.97 q/ha) shadowed by GSC-7(20.2 q/ha) and lowest on RLC-3 in 3rd sowing (11.64) (Table 5 and Fig. 3). Among the four cultivars tested

PC-6 sown on all the dates showed significantly less disease followed by GSC-7, Giriraj and RLC-3. Biswas et al. (2007) also testified that with the variation in date of sowing the Alternaria blight of mustard could be reduced. Howlider et al. (1989) testified that delay in sowing increases the infection severity and reduction in yield. Mian and Akanda (1989) have suggested that Alternaria leaf blight disease was minimum by early sowing.

Table 5 Effect of sowing dates of rapeseed-mustard cultivars and blight disease intensity on seed yield during *Rabi,* 2017–2018

Sowing dates	Cultivars	Seed yield (q/ha)	PDI
D1 (28.10.2017)	Giriraj	21.97	32.52
	RLC-3	19.70	44.85
	GSC-7	20.2	3.36
	PC-6	19.63	0.98
		20.37	20.43
D2 (11.11.2017)	Giriraj	17.90	35.27
	RLC-3	15.55	50.07
	GSC-7	16.96	4.92
	PC-6	13.54	2.67
		15.99	23.23
D3 (25.11.2017)	Giriraj	14.22	40.36
	RLC-3	11.64	52.19
	GSC-7	12.04	13.28
	PC-6	12.48	7.56
		12.59	28.34
C.D. ($P=0.05$)	D	1.01	1.39
	V	0.79	1.42
	D×V	1.37	2.46

Effect of weather parameters on Alternaria blight intensity

Correlation analysis of disease index with weather factors indicated that maximum temperature (15.7–30.3 °C) and minimum temperature (3.3–12.6 °C) has a significant correlation with disease intensity. Average temperature also showed the significant correlation, while minimum relative humidity (36.0–74.3), maximum relative humidity (77.6–94.4) and rainfall has no significant correlation (Table 6). Bal and Kumar (2014) testified the result of weather factors on Alternaria leaf blight (*A. brassicae*) of mustard had a positive correlation between the disease intensity and temperature, it was negatively correlated with rainfall and relative humidity.

An AUDPC (A-value) increase with the delay of sowing was reported by Sunita and Srikanta (2015), which support the results of present study. Apparent infection rate (r-value) was weekly recorded on the basis of average disease index on leaf of different cultivars under field conditions. The results revealed that apparent infection rate on leaf (r = 0–0.018 r/unit/day). Maximum apparent infection rate (r = 0.018 r/unit/day) in RLC-3 followed by Giriraj (r = 0.017 r/unit/day) on 3rd sowing (Table 7). Similarly, apparent infection rate was minimum (r = 0.00 r/unit/day) in PC-6 followed by GSC-7 (0.009 r/unit/day) on 1st sowing (Table 8).

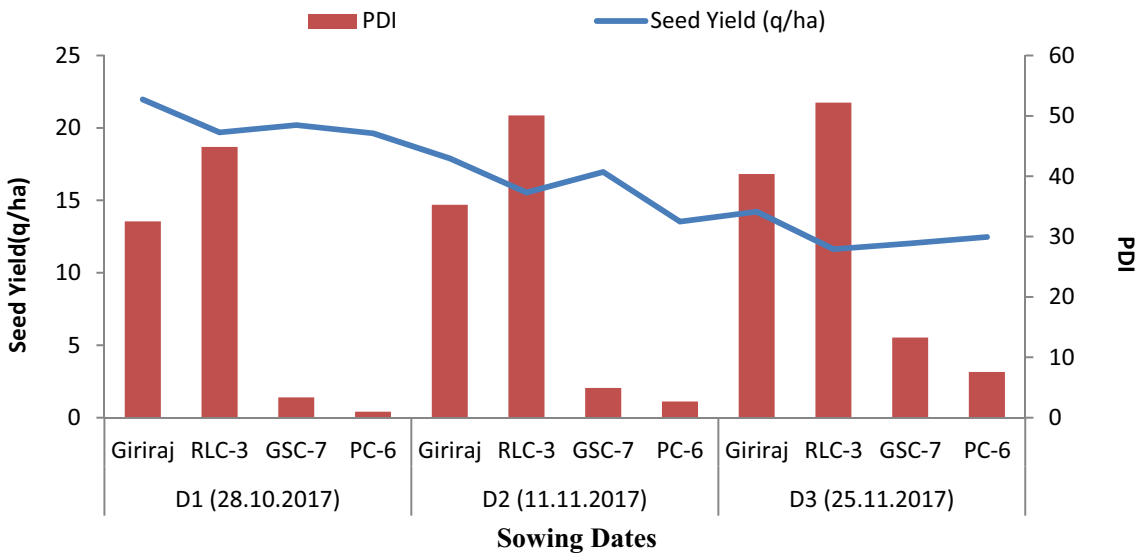

Fig. 3 Effect of sowing dates and mustard-rapeseed cultivars on average Alternaria blight disease intensity and seed yield during *Rabi,* 2017–2018

Table 6 Correlation coefficient between weather factors and Alternaria blight disease index

Cultivar	Date of sowing	Correlation coefficient (r) weather factor				
		X1	X2	X3	X4	X5
Giriraj	D1	−0.1088	−0.2808	0.0782	0.2996	−0.1047
	D2	0.1666	0.5094	0.2122	0.2721	−0.0817
	D3	0.65	0.7513	−0.4258	−0.21	−0.1109
RLC-3	D1	−0.0803	−0.5688	0.3887	0.0086	−0.2746
	D2	0.0095	−0.1168	0.2936	0.0507	−0.0033
	D3	0.386	0.4137	−0.3633	−0.278	−0.0587
GSC-7	D1	0.4739	0.1638	−0.736	−0.4698	−0.2634
	D2	0.5677	0.8806	−0.3836	0.0066	−0.09
	D3	0.8237	0.8654	−0.6862	−0.4388	−0.2292
PC-6	D1	−0.4088	0.353	0.187	0.3863	0.3899
	D2	0.3535	0.9162	−0.1776	0.22	0.099
	D3	0.8237	0.9364	−0.577	−0.3296	−0.19

X1 = Temperature (max.) °C, X2 = temperature (min.) °C, X3 = relative humidity (max.) %, X4 = relative humidity (min) %, X5 = total RAINFALL (mm)

Table 7 AUDPC (A-VALUE) for severity of Alternaria blight on rapeseed and mustard

Sowing dates	Cultivars	AUDPC
D1 (28.10.2017)	Giriraj	2345.49
	RLC-3	3327.73
	GSC-7	170.31
	PC-6	54.775
D2 (11.11.2017)	Giriraj	2651.56
	RLC-3	3752.38
	GSC-7	222.74
	PC-6	163.24
D3 (25.11.2017)	Giriraj	3032.99
	RLC-3	3885.91
	GSC-7	922.70
	PC-6	550.62

Table 8 Apparent infection rate (r) of alternaria blight on leaf of cultivars of rapeseed-mustard

Sowing dates	Cultivars	Apparent infection rate (r = value)
D1 (28.10.2017)	Giriraj	0.010
	RLC-3	0.013
	GSC-7	0.009
	PC-6	00
D2 (11.11.2017)	Giriraj	0.014
	RLC-3	0.015
	GSC-7	0.013
	PC-6	0.009
D3 (25.11.2017)	Giriraj	0.017
	RLC-3	0.018
	GSC-7	0.015
	PC-6	0.012

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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