Journal of Crop and Weed, 14(2): 183-187 (2018)

Screening of Indian mustard (*Brassica juncea*) genotypes for resistance or tolerance against *Alternaria* blight under natural and artificially inoculated conditions

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Received : 17-12-2017 ; Revised : 03-08-2018 ; Accepted : 05-08-2018

ABSTRACT

Alternaria blight caused by Alternaria brassicae (Berk.) Sacc., is a major disease of Indian mustard (Brassica juncea (L.) Czern. and Coss.) and rapeseed (Brassica campestris var. toria) in Assam. It causes significant reduction (upto 30%) in seed yield. Considering the economic loss caused by the disease, lack of resistant varieties and eco-friendly oilseed production, the present study was carried out to identify genotypes of Indian mustard showing resistance/tolerance to this devastating disease under both natural and artificially inoculated conditions at Shillongani, Assam during Rabi 2015-16. Out of 55 genotypes, seven (RH 1301', '3 IJ3403', 'RH 1134', 'DRMR 1-5', 'LES 50', 'EJ8-118' and PRL-2010-8') recorded Alternaria blight severity ranging from 23.4 to 25.0 per cent on leaf at 75 days after sowing (DAS), which were rated as moderately resistant under natural conditions. However, they failed to show resistance at 100 DAS on leaf, only one genotype ('CS 2800-1-2-3-5-1') was found to be moderately resistant (25% disease severity on leaf) at 75 DAS.

***Keywords*:** *Alternaria* blight, artificially inoculated condition, disease severity, Indian mustard genotypes, natural field condition

Brassica also known as rapeseed-mustard is an important group of oilseed crops in the whole world. Among the Brassicas, rapeseed-mustard contributes around 22.6 per cent of the total oilseed production in India, and it is the second largest indigenous oilseed crop. Indian mustard [*Brassica juncea* (L.) Czern and Coss.] and rapeseed (*B. campestris* L.var. *toria*) is grown extensively as a pure crop as well as intercrop (mixed crop) in marginal and sub-marginal soils in the eastern, northern and north western states of India. The area, production and productivity during 2011-12 in the world were 33.1 million ha, 60.7 million t, and 1832 kg ha^{-1}, respectively . Globally, India accounts for 20.2 and 10.7 per cent of the total acreage and production (Anonymous, 2012). India ranks second in the world in acreage and production after China. The crop is predominantly cultivated in the states of Rajasthan, Jharkhand, Uttar Pradesh, Haryana, Madhya Pradesh and West Bengal, which account for about 87 per cent of the total national production. Among the rapeseed-mustard group, toria is predominant in Assam because of the suitability of prevailing agro-climatic conditions and early duration of the crop, which enable the farmers to go for the summer crop after harvest of toria. Rapeseed is cultivated mainly as rainfed crop during the Rabi season. The area, production and productivity of rapeseed-mustard in Assam was 2.81 lakh ha^{-1}, 1.88 lakh t and 667 kg ha^{-1}, respectively (2014-15). The present production can meet only about 31.5 per cent of the state's requirement, and the deficit of 68.5 per cent has to be brought in annually. This might be attributed to the wide gap between the potential and realized yield due to various biotic and abiotic stresses, resultant of poor management in particular.

Amongst the biotic stresses, Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc., is a major disease of Indian mustard [*Brassica juncea* (L.) Czern. and Coss.] and rapeseed (*Brassica campestris* var. *toria*) in Assam. A. brassicae infects host species at all growth stages and affects seed germination and both quality and quantity of oil (Meena *et al*., 2010). The disease usually appears on 45 day- old plants and becomes severe on 75 day-old plants (Meena *et al*., 2004). This disease appears first on lower leaves as black points, which enlarges into round, conspicuous spots and becomes severe at the time of siliquae formation stage causing 17-48 per cent yield loss in India (Saharan *et al*., 1984 and Saharan, 1991). The infection on leaves and siliquae results in pre-mature pod ripening and shedding of seeds, thus, adversely affecting normal seed development, colour, seed weight, and per cent oil content (Meena *et al*., 2010). Although, varying degree of control using chemical pesticides has been reported, but due to growing awareness on health hazards, use of disease tolerant cultivars, cultural practices, bio-agents and plant extracts are gaining importance. Considering the economic importance of the disease and health hazards caused by pesticides, an experiment was conducted at Regional Agricultural Research Station, Shillongani, Nagaon, Assam during

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the winter season of 2015-16 to evaluate Indian mustard varieties/lines for their resistance/tolerance against Alternaria blight under both natural and artificially inoculated field conditions..

MATERIALS AND METHODS

The field experiment was conducted at Regional Agricultural Research Station, Shillongani, Nagaon, Assam during *Rabi* 2015-16 to identify genotypes or lines of *B. juncea*, *B. rapa* var. *toria* and *B. rapa* var. yellow sarson showing resistance or tolerance to the major disease, *Alternaria* blight under both natural and artificially inoculated conditions. The genotypes were received under AICRP programme from the Directorate of Rapeseed-Mustard, Bharatpur, Rajasthan. The station lies at a longitude of 91º482 E, latitude of 26º212 502 2 N and 41.20 m altitude. Fifty five genotypes (43 of *B. juncea*, 5 of *B. rapa* var. *toria* and 1 of *B. rapa* var. yellow sarson) including 6 checks were sown in 3 m row in randomized completely block design (RCBD) with two replications on 23 November maintaining a spacing of 30 × 10 cm, and the crop was fed with 60:30:30 N, P_2O_5, K_2O kg ha^{-1}. Susceptible checks were used after every two test rows. The genotypes/lines were harvested in the second week of March. Rainfall received during the crop season was 93.9 mm. Rainfall received in the months of November, December, January, February and March was 19.0, 30.2, 33.9, 0.4 and 60.4 mm, respectively. The average maximum and minimum temperature in the respective months were 27.8, 23.7, 22.1, 25.4 and 28.4ºC, and 17.3, 12.7, 11.2, 15.0 and 17.7ºC.

The test plants were inoculated at initiation of flowering and siliquae formation stage with conidial suspension (105cfu ml^{-1}) of pure culture of *Alternaria brassicae*. The disease severity was recorded at 75 DAS on leaves and at 100 DAS on siliquae when there was maximum disease pressure. A 0-9 scale (Conn *et al*., 1990) was used for rating of entries. The scale is as follows:

Average severity score = {(N-1 x 0) + (N-2 x 1) + (N-3 x 3) + (N-4 x 5) + (N-5 x 7) + (N-6 x 9)}/Number of leaf samples

Per cent Disease Intensity (PDI) = [{(N-1 x 0) + (N-2 x 1) + (N-3 x 3) + (N-4 x 5) + (N-5 x 7) + (N-6 x 9)} x 100]/ No. of leaf samples x 9

Where N-1 to N-6 represents frequency of leaves in the respective score.

The data were statistically analysed (Panse and Sukhatme, 1961).

RESULTS AND DISCUSSION

Out of 55 genotypes, seven ('RH 1301', 'IJ3403', 'RH 1134', 'DRMR 1-5', 'LES 50', 'EJ8-118' and 'PRL-2010-8') recorded *Alternaria* blight severity ranging from 23.4 to 25.0 per cent on leaf at 75 DAS (Table 1), which were rated as moderately resistant under natural conditions. However, they failed to show resistance at 100 DAS on leaf as well as on siliqua. The rest 46 genotypes were found susceptible (26 to 50 per cent disease severity).

Under artificially inoculated infector-row field conditions, only one genotype ('CS 2800-1-2-3-5-1') was found to be moderately resistant (25% disease severity on leaf at 75 DAS) and the rest fifty four genotypes were rated as either susceptible or highly susceptible based on disease severity recorded at 100 DAS on leaves (Table 2). On siliquae, all the genotypes were found to be susceptible (26 to 50 % disease severity).

Different workers evaluated the rapeseed-mustard varieties/lines and our results are in accordance with those in many cases. Where there is some deviation that may be due to environmental factors and differences among genotypes and races of pathogens (Anonymous, 2016). The same set of genotypes/lines was screened against *Alternaria* blight at Behrampur, Odisha, Dholi, Bihar and Navgaon, Rajasthan under natural epiphytotic conditions during *Rabi*, 2015-16. At the former two research stations, none of the genotypes was found to be relatively free from visible symptoms of the disease. All of them were rated as susceptible to highly susceptible. At the latter research station, overall disease

Scale	Description
0	No lesion
1 (HR)	Non-sporulating pinpoint size or small brown necrotic spots, < 5% leaf area covered by lesion
3 (R)	Small roundish slightly larger brown necrotic spots, about 1-2 mm in diameter with a distinct margin or yellow halo, 5-10% leaf area covered by lesion
5 (MR)	Moderately sporulating, non-coalescing, larger brown spots, about 2-4 mm in diameter with a distinct margin or yellow halo, 11-25% leaf area covered by the spots
7 (S)	Moderately sporulating, coalescing larger brown spots about 4-5 mm in diameter, 26-50% leaf area covered by the lesions
9 (HS)	Profusely sporulating, rapidly coalescing brown to black spots measuring more than 6 mm diameter without magins covering more than 50% leaf area

Table 1: Screening of *Brassica* AVT-I and II strains against different diseases under natural condition, 2015-16

Sl. No.	Entries	*Alternaria* blight severity on leaves (%)		*Alternaria* blight severity on siliqua (%)
		75 DAS	100 DAS	100 DAS
1	Rohini (RC)	35.8(36.73)*	54.75(47.73)	32.8(34.93)
2	PHR-2 (TC)	32.35(34.66)	53.8(47.18)	34.3(35.84)
3	EC 399301 (TC)	33.6(35.41)	48.45(44.11)	35.75(36.72)
4	EC 399299 (RC)	34.85(36.17)	52.5(46.44)	33.75(35.50)
5	EC 339000 (RC)	26.9(31.23)	43.25(41.12)	30.2(33.32)
6	DLSC 1 (RC)	25.1(30.04)	44(41.55)	29.75(33.05)
		B. juncea		
7	RH 1301	24 (29.32)	50.25(45.14)	26.75(31.13)
8	RH 0725	25.75 (30.49)	46.2(42.82)	29.85(33.10)
9	DRMR 1165-40	33.4 (35.30)	53.15(46.81)	35.25(36.40)
10	RMWR 09-5	27.8 (31.81)	51.75(46.00)	30.25(33.36)
11	DRMRIJ 14-01	26.3 (30.85)	51.35(45.77)	29.75(33.04)
12	RH 673	27 (31.30)	50.4(45.23)	32.8(34.93)
13	3 IJ3403 (Hybrid)	24.4 (29.60)	49.9(44.94)	30.75(33.67)
14	PRO 0306	32 (34.44)	54.2(47.41)	34.8(36.14)
15	RH 1134	24 (29.32)	49.55(44.74)	30.75(33.67)
16	KM 108	30.9 (33.76)	57.8(49.49)	34.25(35.82)
17	RMM-09-1-1-2	29.9 (33.14)	56.7(48.86)	33.8(35.54)
18	RB 50	29.5 (32.88)	54.95(47.85)	30.3(33.40)
19	KMR(L) 14-6	32.3 (34.63)	56.05(48.49)	34.2(35.79)
20	PRO 5111	33.3 (35.24)	54.3(47.47)	35.3(36.44)
21	45S31	33.65 (35.44)	55.2(47.99)	36.2(36.98)
22	PRE 2011-6	30 (33.20)	46.5(42.99)	31.2(33.96)
23	45S35	30.4 (33.45)	49.3(44.60)	32.2(34.57)
24	RLC 4	32 (34.43)	48.75(44.28)	33.2(35.17)
25	PDZ 1	28.4 (32.2)	47.4(43.51)	32.75(34.90)
26	DRMR 1-5	23.4 (28.91)	46.05(42.73)	26.8(31.17)
27	LES 49	34.8 (36.14)	55.2(47.99)	36.2(36.98)
28	DRMR 2-11	30.4 (33.45)	51.95(46.12)	31.65(34.22)
29	LES 50	23.7 (29.11)	46.55(43.01)	27.7(31.75)
30	EJ8-369	30.4 (33.45)	51.4(45.80)	33.75(35.51)
31	PDZ 3	31.9 (34.38)	54.25(47.44)	34.2(35.78)
32	PDZ 2	29.8 (33.08)	50.85(45.49)	33.2(35.18)
33	RLC 3	33.4 (35.30)	53.5(47.01)	35.4(36.51)
34	EJ8-118	24.6 (29.72)	50.75(45.43)	26.3(30.82)
35	PDZ 4	30.5 (33.51)	51.2(45.69)	33.9(35.60)
36	Q 90009	34 (35.67)	54.45(47.56)	36.9(37.40)
37	DRMR 1153-12	30.3 (33.39)	51.55(45.89)	33.4(35.29)
38	RH 923	33.3 (35.24)	52.2(46.26)	36.3(37.04)
39	CS 700-3-3-2-6	32.85 (34.96)	44.9(42.07)	35.8(36.75)
40	RGN 330	35.75 (36.72)	57.1(49.09)	38.7(38.47)
41	RGN 337	36 (36.87)	55.2(47.99)	37.2(37.58)
42	CS 1500-1-2-2-1	36.8 (37.34)	48.85(44.34)	40.3(39.40)
43	RH 1053	34.8 (36.14)	48.45(44.11)	37.8(37.92)
44	RGN 368	30.3 (33.39)	49.45(44.68)	33.2(35.18)
45	PRL-2010-8	25 (29.97)	44.85(42.04)	30.2(33.32)
46	CS 2800-1-2-3-5-1	33.4 (35.30)	54.35(47.5)	35.7(36.69)
47	RH 919	35.5 (36.57)	54.9(47.82)	37.3(37.64)
48	PBR 417	36.7 (37.28)	51(45.57)	38.2(38.17)
49	CS 11000-1-2-2-3	35.95 (36.82)	52.75(46.58)	37.3(37.64)
50	DRMRIJ 13-38	41.9 (40.33)	55.75(48.31)	38.4(38.28)
		B. rapa var. toria		
51	TH 1102	42.8 (40.86)	59.8(50.66)	46.45(42.96)
52	JT 90-1	43.4 (41.20)	58.85(50.10)	44.7(41.96)
53	PT 2010-5	46.8 (43.16)	64.7(53.56)	47.35(43.48)
54	TS 46	44 (41.55)	65.4(54.00)	47.35(43.48)

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Table 1 Contd.

		***B.rapa* var. yellow sarson**			
55	PYS 2010-3	44 (41.55)	67.3(55.13)		45.3(42.30)
	LSD (0.05)	**0.86**	**0.98**	**0.86**	
	CV%	**3.91**	**3.82**		**3.79**

*Note: Data are the mean of 2 replications; *Figure in the parenthesis are angular transformed value*

Table 2: Screening of *Brassica* AVT-I and II strains against different diseases using artificially inoculated infector-row under field condition, 2015-16

Sl.No.	Entries	Alternaria blight severity on leaves (%)		Alternaria blight severity on pods (%)
		75 DAS	100 DAS	100 DAS
1	Rohini (RC)	36.7(37.27)	56.8(48.91)	32.7(34.88)
2	PHR-2 (TC)	34.05(35.69)	55.3(48.05)	35.75(36.72)
3	EC 399301 (TC)	35.4(36.50)	49.2(44.54)	36.65(37.25)
4	EC 399299 (RC)	36.1(36.92)	53.2(46.84)	35.3(36.44)
5	EC 339000 (RC)	28.3(32.13)	45.3(42.30)	31.8(34.32)
6	DLSC 1 (RC)	26.3(30.84)	45.2(42.24)	31.3(34.01)
		B. juncea		
7	RH 1301	25.2(30.13)	52.25(46.29)	28.2(32.06)
8	RH 0725	27.3(31.50)	48(43.85)	30.7(33.63)
9	DRMR 1165-40	34.95(36.24)	54.8(47.75)	36.7(37.27)
10	RMWR 09-5	29.2(32.71)	52.8(46.61)	31.7(34.26)
11	DRMRIJ 14-01	29.85(33.11)	53.2(46.84)	31.8(34.32)
12	RH 673	29.25(32.74)	52.75(46.58)	31.2(33.93)
13	3 IJ3403 (Hybrid)	30.15(33.29)	51.3(45.74)	33.9(35.60)
14	PRO 0306	26.3(30.85)	50.7(45.40)	32.7(34.87)
15	RH 1134	33.7(35.48)	55.7(48.28)	36.2(36.98)
16	KM 108	25.8(30.52)	50.7(45.40)	32.7(34.87)
17	RMM-09-1-1-2	33.2(35.18)	58.7(50.01)	34.9(36.21)
18	RB 50	31.7(34.26)	58.25(49.75)	34.8(36.15)
19	KMR(L) 14-6	31.2(33.95)	56.25(48.59)	31.7(34.26)
20	PRO 5111	34.25(35.81)	57.65(49.41)	35.3(36.45)
21	45S31	35.2(36.38)	55.2(47.99)	36.2(36.98)
22	PRE 2011-6	35.3(36.44)	57(49.02)	37.3(37.64)
23	45S35	31.7(34.26)	48.2(43.97)	33.3(35.24)
24	RLC 4	32.3(34.63)	51.3(45.75)	33.7(35.49)
25	PDZ 1	33.7(35.48)	50.3(45.17)	34.4(35.90)
26	DRMR 1-5	30.7(33.65)	48.9(44.37)	33.95(35.63)
27	LES 49	25.35(30.22)	47.7(43.68)	28.4(32.19)
28	DRMR 2-11	37(37.46)	57.2(49.14)	37.25(37.61)
29	LES 50	32.2(34.56)	53.2(46.84)	33.25(35.19)
30	EJ8-369	25.4(30.26)	47.9(43.80)	29.75(33.05)
31	PDZ 3	32.2(34.56)	53.2(46.84)	34.8(36.15)
32	PDZ 2	33.15(35.13)	55.8(48.33)	35.2(36.37)
33	RLC 3	32.4(34.69)	52.2(46.26)	35.3(36.45)
34	EJ8-118	35.5(36.57)	54.8(47.76)	37.2(37.58)
35	PDZ 4	26.2(30.77)	52.2(46.26)	27.2(31.40)
36	Q 90009	45.2(42.25)	69.2(56.32)	46.7(43.11)
37	DRMR 1153-12	36.2(36.99)	55.75(48.30)	38.2(38.17)
38	RH 923	32.2(34.56)	52.7(46.55)	34.7(36.09)
39	CS 700-3-3-2-6	34.7(36.09)	53.75(47.15)	42.3(40.56)
40	RGN 330	34.25(35.81)	48.25(44.00)	37.3(37.64)
41	RGN 337	37.2(37.58)	59.4(50.43)	40.7(39.64)
42	CS 1500-1-2-2-1	37.3(37.64)	57.7(49.44)	38.25(38.20)
43	RH 1053	37.75(37.91)	50.75(45.43)	42.2(40.51)
44	RGN 368	35.75(36.71)	50.75(45.43)	39.4(38.86)
45	PRL-2010-8	32.15(34.53)	51.3(45.75)	34.7(36.09)
46	CS 2800-1-2-3-5-1	25(29.97)	44.85(42.04)	30.2(33.32)

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Table 2 Contd.

Sl.No.	Entries	Alternaria blight severity on leaves (%)		Alternaria blight severity on pods (%)
		75 DAS	100 DAS	100 DAS
47	RH 919	33.4(35.30)	54.35(47.5)	35.7(36.69)
48	PBR 417	35.5(36.57)	54.9(47.82)	37.3(37.64)
49	CS 11000-1-2-2-3	36.7(37.28)	51(45.57)	38.2(38.17)
50	DRMRIJ 13-38	35.95(36.82)	52.75(46.58)	37.3(37.64)
		B. rapa var. toria		
51	TH 1102	41.9(40.33)	55.75(48.31)	38.4(38.28)
52	JT 90-1	42.8(40.86)	59.8(50.66)	46.45(42.96)
53	PT 2010-5	43.4(41.20)	58.85(50.10)	44.7(41.96)
54	TS 46	46.8(43.16)	64.7(53.56)	47.35(43.48)
		***B.rapa* var. yellow sarson**		
55	PYS 2010-3	32.7(34.87)	52.3(46.32)	35.3(36.45)
	LSD (0.05)	**0.85**	**0.96**	**0.88**
	CV%	**3.76**	**3.66**	**3.91**

*Note: Data are the mean of 2 replications; *Figures in the parentheses are angular transformed values*

pressure was very low (2.1 to 6.4% disease severity), probably due to dry weather conditions (Anonymous, 2016) At N.D. University of Agriculture and Technology, Faizabad, 81 lines/varieties of Indian mustard were screened against this disease under natural conditions and reported that only one 'YET-25' was fairly resistant to leaf blight, however, 10 and 61 lines were reported moderately resistant and moderately susceptible, respectively (Singh *et al*., 2009). Rahman *et al*., 2010 found varying degree of disease severity in 26 varieties or lines of rapeseed-mustard at Jamalpur, Bihar. Only six among them appeared to be moderately resistant. A study conducted by Yadav *et al*., 2014 at CCS PG college Etawah, U.P. revealed that none of the 31 test entries was found immune or highly resistant. Only one genotype, *viz*., 'NPN-PR-2003-30' was found to be moderately resistant.

This study was warranted to trigger safer strategy for eco-friendly disease management for providing *Alternaria* blight free production system of Indian mustard with improved crop health. There is need of continuous evaluation of genotypes/entries for *Alternaria* blight resistance under both natural and artificial conditions to find out material(s) suitable for environment-friendly sustainable/organic production system and also for inclusion in breeding strategies.

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