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Effect of resistance inducing chemicals on Alternaria Blight disease of mustard (*Brassica juncea* L.)

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Alternaria blight disease of rapeseed mustard, caused by *Alternaria brassicae* (Berk.) Sacc. and *Alternaria brassicicola* (Schw) Wiltshire, plays very important role for qualitative and quantitative yield loss of the crop. A study was conducted under field condition to identify some resistance inducing chemicals against the pathogen and can play a significant role in managing the Alternaria Blight disease. The resistance inducing chemicals which were tested at varying level of concentrations were salicylic acid, phosphoric acid, isonicotinic acid, benzoic acid, acebenzolarsmethyl and azooxytrobin 25% SC (as fungicidal check). Minimum disease severity of 31.49 %and 29.47 % was recorded on leaves and siliqua respectively in case of isonicotinic acid 1000 ppm. The maximum inhibitory effects on spot development were recorded in case of isonicotinic acid 1000 ppm with minimum average number of spot (3.21) and average diameter of a single spot (3.70 mm). Maximum seed yield was recorded in case of isonicotinic acid 1000 ppm (1602 kg/ha) with an yield increase of 77.21 % over unsprayed control.

Keywords: Alternaria blight, Disease Management, Induced resistance, Mustard,

INTRODUCTION

Among various oilseed crops, rapeseed mustard is second most important oilseed crop in India after groundnut and it plays significant role in oilseed productionof the country. In India, during 2015-16, rapeseed mustard production was 67.96 million MT with a productivity of 1183 kg/ha.It contributes 24 % and 25% in terms of total oilseed production and vegetable oilseed production respectively.Per capita consumption has been increasing and is projected atround 24 kg by 2025 (Singh *et. al*. 2017).

There is a wide gap between actual production and demand of oilseeds in India. Alternaria blight of rapeseed mustard, caused by *Alternaria brassicae* (Berk.) Sacc. And *Alternaria brassicicola* (Schw.) Wiltshire, is one of the most important disease of this crop limiting the productivity. It affects the qualitative as well as quantitative parameters of the yield. The loss caused due to the prevalence of this disease has also been reported by many workers across the world. The yield loss varies from 17 to 45% in mustard (Kumar *et. al.* 2009; Singh and Singh, 2005).Losses ranging from 15 to 71 percent have also been recorded by many Plant Pathologists.The losses in 1000-seed weight of mustard may extend up to 24%. The loss in test weight due to Alternariablight has also been reported by some other auther (Mamgain*et.al*. 2017). The disease reduces the oil content of mustard. In Canada, losses in oil content up to 4.8% have been reported but higher losses of upto14.6-36 % have been recorded in India.

As the disease resistance is governed by polygenes, it's often very difficult to manage the disease through resistant breeding. Use of fungicides and some selected botanicals gives

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some effective control of the disease. Adoption of technology like inducing resistance against the pathogen not so much tested. An attempt was made to find out some easily available, effective and economically viable chemicals to minimise the disease severity under field condition.Inclusion of any of such chemicals in integrated disease management system may give further benefit to the economyof disease management.

MATERIALS AND METHODS

Field experiment was conducted in Anandapur ($22^0$33'N, $87^0$24'E), Dist- Paschim Medinipur, West Bengal, India during *rabi*2011-12and 2012-13 seasons. The crop variety was Varuna of mustard (*Brassica junceaL.*). The crop was grown following all recommended agronomic practices. The fertilizer dose was N: P_2O_5:K_2O@100: 50: 50. The cultivar was sown in the first week of November in each season and in a Randomized Block Design (RBD) with three replications having 5mX3m plot size with a spacing of 0.30 m X 0.10m. Total five test chemicals *viz.* salicylic acid, phosphoric acid, isonicotinic acid, benzoic acid, acebenzolar S-methyl each at a concentration of 500 ppm and 1000 ppm were taken for testing including one fungicidal check azoxystrobin 25% SC (0.1%). The required amount of chemical was calculated, weighed and spray solution was prepared. The spraying was done with high volume knapsack sprayer @ 500 lit water/ha. The first spray was given immediately after appearance of the disease in the field. The second spraying was given at 15 days interval and third spraying was given at flowering stage of the crop. The disease severity was recorded on leavesatregular interval. The final disease severity on leaves was recorded at maximum flowering stage and on pod at full maturity stage. For recording data, twenty five plants were selected randomly selected and tagged from each replication in each treatmentThe data on disease severity on leaves and siliqua was recorded in each replication for each treatment.The calculation of disease severity was done on following standard SES scale(0-6).

0 = No disease
1= Up to 5 % leaf/pod area infected.
2=5.1-10 % leaf/pod area infected.
3= 10.1-20 % leaf/pod area infected.
4 = 20.1-30 % leaf/pod area infected.
5= 30.1-50 % leaf/pod area infected.
6= > 50% leaf/pod area infected.

The percent disease severity was calculated following the formula :

$$\text{Percent Disease Index} = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves observed x Maximum grade}} \times 100$$

Number of spots/25mm^2 were recorded from each of the bottom ten leaves of the selected plants and from this data average number of spots/ leaves was calculated. The diameter (in mm) of the spots including yellow halo and chlorotic areas was recorded from the samebottom ten leaves of each selected plant at maximum flowering stage. From this data, average diameter (in mm) of a single spot were calculated.

The crop was harvested when eighty percent population showed maturity and yield was harvested from each treatment separately. The percent increase in yield was calculated following formula as:

$$\text{Percent Yield increase} = \frac{\text{(Yield obtained in treatment – Yield obtained in unsprayed control) x 100}}{\text{Yield obtained in unsprayed control}}$$

RESULTS AND DISCUSSION

The data on disease severity on leaves and siliqua, characters of the spot (size and number) has been recorded and presented in Table1.Yield response and test weight have also been recorded and presented in table 2. Perusal of the data revealed that among the test chemicals, isonicotinic acid 1000 ppm recorded minimum disease severity on leaves (PDI= 31.49 %) as well as on siliqua (PDI= 29.47 %) among the test chemicals. It was followed by salicylic acid 1000 ppm (PDI on leaf 33.23 % and siliqua 31.76 %).In case of disease severity on leaves after salicylic acid 1000 ppm,acebenzolarsmethyl 1000 ppm gave less infection(PDI=35.08 %) But in case of siliqua infectionaftersalicylic acid 1000 ppm,isonicotinic Acid 500 ppm recorded less disease severity (PDI=32.08 %).Regarding the characters of the spot on leaves, minimum number of spots (3.21)with smallest spot size (3.70 mm in diameter) was recorded in case of isonicotinicacid 1000 ppmamong the test chemicals. It was followed by salicylic acid 1000 ppm (3.30 spots and size 3.85 mm) and acebenzolarsmethyl 1000 ppm (4.50

Table 1: Effect of different chemicals on Alternaria blight disease of mustard *var.*Varuna

Treatments	Percent disease severity		Percent reduction on disease severity		Characters of the Spot on leaves.		Percent reduction	
	Leaves	Siliqua	Leaves	Siliqua	Avg. spot size (dia.in mm)	Avg. number of spots/leaf	Avg. spot size	Avg. number of spots/leaf
Salicylic acid 500 ppm	38.93 (38.60)	37.15 (37.55)	44.50	32.08	7.12	4.94	54.41	46.36
Salicylic acid 1000ppm	33.23 (35.20)	31.76 (34.30)	52.63	41.93	3.85	3.30	75.35	64.16
Phosphoric acid 500 ppm	49.69 (44.82)	42.48 (40.67)	29.16	21.34	8.21	6.24	47.43	32.24
Phosphoric acid 1000ppm	41.21 (29.94)	41.13 (39.89)	41.25	24.79	7.42	5.23	52.49	43.21
Isonicotinic acid 500 ppm	35.11 (36.34)	32.08 (34.50)	49.95	41.35	4.05	4.66	74.07	49.40
Isonicotinic acid 1000ppm	31.49 (34.14)	29.47 (32.88)	55.10	46.12	3.70	3.21	76.31	65.14
Benzoic acid 500 ppm	45.70 (42.53)	41.70 (40.22)	34.85	23.75	8.10	5.80	48.14	37.02
Benzoic acid 1000ppm	38.30 (38.23)	40.91 (39.76)	45.40	25.20	6.50	4.91	58.38	46.68
Acebenzolar S methyl 500 ppm	43.42 (41.22)	40.74 (39.66)	38.10	25.52	7.81	5.70	50.00	38.11
Acebenzolar S methyl 1000ppm	35.08 (36.32)	39.70 (39.06)	50.00	27.41	3.95	4.50	74.71	51.14
Azoxystrobin 25 % SC 1000 ppm	20.98 (27.26)	19.89 (26.49)	70.09	63.63	3.50	2.13	77.59	76.87
Control (unsprayed)	70.15 (56.88)	54.70 (47.70)	-	-	15.62	9.21	-	-
SE(m)+.	2.03	2.41	-	-	0.40	0.34		
CD (5%)	5.96	7.05			1.18	0.99		
CV %	9.0	11.0			10.5	11.7		

Figures in parenthesis indicate angular transformed values and statistics applied to them.

spots and 3.95 mm). Further, from the data presented in Table1, it is also seen that maximum percent inhibition of disease severity on leaves (55.10 %) and siliqua (46.12 %) was recorded in case of isonicotinic acid 1000 ppm followed by salicylic acid 1000 ppm (reduction on leaf 52.63% and on siliqua 41.93 %).In case of reduction in disease severity on leaves after salicylic acid 1000 ppm, acebenzolarsmethyl 1000 ppm gave 50.00% reduction. But in case of siliqua infection aftersalicylic acid 1000 ppm, isonicotinic acid 500 ppm recorded 41.35 % reduction. Maximum percent inhibition (76.31%)on average spot size was recorded in case of isonicotinic acid 1000 ppm followed by salicylic acid 1000 ppm (75.35%) and acebenzolarsmethyl 1000 ppm (74.71%). Isonicotinic acid 1000 ppm recorded maximum percent inhibition (65.14%)on average number of spot followed by salicylic acid 1000 ppm (64.16 %) and acebenzolarsmethyl 1000 ppm (51.14 %). From the data presented in Table 2, it is observed that the impact of minimum disease severity on leaf and siliqua is expressed with maximum test weight and seed yield of mustard. The highest test weight was recorded in case of isonicotinicacid 1000 ppm (5.54 gm) followed by salicylic acid 1000 ppm (5.43 gm) and isonicotinic acid 500 ppm (5.11 gm). The maximum seed yield was recorded in case of isonicotinicacid 1000 ppm (1602 kg /ha) followed by salicylic acid 1000 ppm (1517kg/ha) and isonicotinic acid 500 ppm (1485 kg/ha). From the data in Table 2, it is also observed that the percent increase in test weight over the control (unsprayed) was maximum in case of isonicotinic acid 1000 ppm (52.95 %) followed by salicylic acid 1000 ppm (49.94%) and isonicotinic acid 500 ppm (41.14%).

The percent increase in yield over unsprayed control was maximum in case of isonicotinic acid 1000 ppm (77.21 %) followed by salicylic acid 1000

Table 2: Yield response of different treatments against Alternaria blight disease of mustard *var.* Varuna.

Treatments	Test weight(gm)	Yield (kg/ha)	Percent increase in test weight	Percent increase in yield
Salicylic acid 500 ppm	4.61	1365	27.29	50.99
Salicylic acid 1000ppm	5.43	1517	49.94	67.80
Phosphoric acid 500 ppm	4.54	1143	25.93	26.43
Phosphoric acid 1000ppm	4.58	1295	26.37	43.25
Isonicotinic acid 500 ppm	5.11	1485	41.14	64.26
Isonicotinic acid 1000ppm	5.54	1602	52.95	77.21
Benzoic acid 500 ppm	4.57	1233	26.15	36.39
Benzoic acid 1000ppm	4.59	1319	26.73	45.90
Acebenzolar S methyl 500 ppm	4.58	1275	26.40	41.03
Acebenzolar S methyl 1000ppm	4.60	1344	27.06	48.67
Azoxystrobin 25%SC (0.1%)	5.84	1832	61.17	102.65
Control (Unsprayed)	3.62	904	--	-
SE(m)+- CD (5%) CV %	0.28 0.83 10.2	77.36 226.45 9.9	-	-

ppm (67.80%) and isonicotinic acid 500 ppm (64.26 %)..

The results of this experiment clearly show that all chemicals sprayed on mustard plants, have varying level of effects in reducing disease severity both on leaves as well as siliqua. The reduction may be due to less infection and less progress or inhibition of the pathogen internally. The less infection on leaf is expressed by the reduced number of spots on individual leaf. Such reduction in the average number of spots may be correlated with decreased productionof secondary inocula or reduced secondary infection in plant tissue because after primary infection further spread of the pathogen occurs from secondary inocula. Thereduced internal progress of the pathogen is indicated by the decreased spot size on leaf. The reduction in internal progress of the pathogen may be due to the development of cellular resistance which may be attributed to the synthesis of various phenol compounds,*denovo* production of pathogenesis related proteins such as chitinase andglucanases,phytoallexins(Heil andBostock 2002).Such induced resistance may also be due to enhanced defensive capacity developed by the plant when appropriately stimulated and contributed to Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR) (Atwal and Sangha 2004; Conorath 2006; Pye *et.al*., 2013).This result is also supported by previous works(Kumar *et.al.* 2014; Singh *et. al*. 2012, 2014; 2014 a; Walters *et al.*2013; Yadav *et.al.* 2015).

CONCLUSION

It is concluded from this experiment that all the test chemicals have positive effect in reducing the disease severity on leaves as well as siliqua. It also reduces the chances of secondary infection of the pathogen. The best result was obtained from isonicotinic acid 1000 ppm which reduces the infection of the pathogen on leaves as well as siliqua and increases seed weight as well as yield.

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