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MANAGEMENT OF ALTERNARIAL BLIGHT OF MUSTARD (*BRASSICA JUNCEA* L.) BY BOTANICALS, *TRICHODERMA HARZIANUM* AND FUNGICIDES

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Abstract

Alternaria blight disease caused by *Alternaria brassicae* (Berk.) Sacc. has been reported from all the continents of the world, affects most cruciferous crops and is one among the important diseases of Indian mustard causing severe yield losses with no proven source of transferable resistance in any of the hosts. The pathogen is greatly influenced by weather with the highest disease incidence reported in wet seasons and in areas with relatively high rainfall. *A. brassicae* can affect host species at all stages of growth, including seed. Symptoms of the disease are characterized by formation of spots on leaves, stem and siliquae. Field experiment was conducted at the research plot of the Department of Plant Pathology, Sam Higginbottom Institute of Agriculture Technology and Sciences Allahabad, Uttar Pradesh during the *rabi* season of 2013-14 to test the management of alternarial blight of mustard (*Brassica juncea* L.) by botanicals, *Trichoderma harzianum* and fungicides. Per cent disease severity on leaves at 60, 75 and 90 DAS, per cent alternarial pod blight at 75, 90 and 105 DAS, yield and cost/benefit ratio were recorded. Results showed that the foliar sprays of ridomil MZ 72 WP @ 2g/l significantly reduced alternarial blight, increased yield, followed by foliar sprays with *Trichoderma harzianum* @ 10g/kg, foliar sprays with bulb extract of garlic 1% (w/v), foliar sprays with bulb extract of onion 1% (w/v), foliar sprays with carbendazim 50% WP @ 2g/l, foliar sprays with mancozeb 75% WP @ 2.5g/l, and foliar sprays with ridomil MZ 72 WP @ 2g/l. However foliar sprays of mancozeb, carbendazim and bulb extract of garlic have shown results at par with the foliar sprays of ridomil in increasing the yield.

Keywords: *Allium cepa*, *Allium sativum,* Alternarial blight, Fungicides, *Trichoderma harzianum*, yield.

Introduction

Rapeseed- mustard are the major Rabi oilseed crops of India. They occupy a prominent place being next in importance to groundnut, both in area and production (Agriculture Statistics Division, 2012). Rapeseed-mustard includes toria (*Brassica campestris or Brassica rapa*), yellow and brown sarson *(Brassica campestris* or *Brassica rapa*), gobhi sarson (*B. napus*), raya or mustard (*B. juncea*), black mustard (*B. nigra*), karan rai (*B. carinata*) and taramira (*Eruca sativa*) and form an important group of oilseed crops in India. Indian mustard (*Brassica juncea* (L.) Czern. & Coss.) is an important oilseed crop which occupies almost 80 per cent of the 262.06 lakh hectares cropped under oilseed *Brassica* crops in India (Anonymous, 2017-18). The estimated area, production and productivity during 2016-17 of oilseeds in the India were 262.06 lakh hectares, 32.10 million tonnes, and 1225 kg/ha, respectively (Anonymous, 2017-18).

It is extensively grown traditionally as a pure crop as well as intercrop (mixed crop) in marginal and sub-marginal soils in the eastern, northern and north-eastern states of India (www.drmr.res.in. 24.02.2016). Cool and moist climate of winter months is the major factor for luxuriant growth and productivity of mustard in these states (Wadhwani and Dudheja, 1982). Mustard seeds are known by different names in different places e.g. sarson, rai or raya, torai or lahi. The origin and early culture of mustard is obscure. The earliest written records of mustard are found in ancient Sanskrit writings from 2000 to 1500 BC. Sarson finds mention in all the Ayurvedic sahintas (www.drmr.res.in. 24.02.2016). With the multiplicity of forms that are grown, it is quite probable that there are several areas of origin.

Alternaria blight disease, caused by *Alternaria brassicae* (Berk.) Sacc. and *A. brassicicola* (Schw.). Wiltshire, is one among the important diseases of Indian mustard, which has been reported from all the continents of the world, causing 10-70% yield losses depending on the crop species, being high in *B. rapa* with 35-40% in mustard (Chattopadhyay, 2008), depending on the prevailing environmental factors particularly at critical stages. Symptoms of the disease are characterized by the formation of spots on leaves, stem and silique (Prasad *et al*., 1970). The symptoms of *Alternaria brassicicola* primarily appears as small dark coloured areas which later on expand and become circular and consisting of concentric rings. Spots caused

by *Alternaria brassicae* are almost identical to those caused by *Alternaria brassicicola* but they tend to remain smaller and lighter in colour (Prasad *et al*., 1970). In India, it is one of the most important and widespread disease of all mustard growing areas of the Uttar Pradesh (Wadhwani and Dudheja, 1982). It appears in the epiphytotic form causing rapid blightening and death of leaves under high humidity and moderate temperature. Alternaria blight is one of the most common and destructive diseases of mustard and is caused by four species of *Alternaria*, viz., *A. brassicae* (Berk.) Sacc., *A. brassicicola* (Schwein) Wiltsh., *A. raphani* Groves and Skolko and *A. alternata* (Fr.) Keissl. (Saharan, 1998). Since mustard and rapeseed (or oilseed brassicas) are a crop of economic importance, therefore, the effect of the disease on the yield components of the crop becomes important (Mamgain *et al*., 2017). Thus the paper aims for management of *Alternaria* blight under field conditions through seed treatment and foliar spray of chemicals, phytoextracts and bioagents.

Materials and Method

Experimental place: The experiment was analyzed in randomized block design (RBD) with three replications in a plot size 2x1 m^2.

Isolation and identification of pathogen: Leaves were collected from infected mustard plants bearing characteristic symptoms of concentric rings of alternarial blight. Leaves showing symptoms after mounting on slide were examined under microscope to confirm the presence of *Alternaria* sp.

Isolation: The infected leaf parts were cut into small pieces of two to three mm dimension in a manner so that pieces may have some healthy portion also. Such leaf bits were surface sterilized with 0.1 per cent mercuric chloride ($HgCl_2$) solution for 30 seconds and washed three times with sterile distilled water to remove any traces of mercuric chloride adhered with leaf bits. 2-3 leaf bits were transferred on potato dextrose agar medium contained in petri plates aseptically with the help of sterilized forceps. These petri plates were incubated at 25 ˚C ± 2˚C. After 45 hours mycelia growth was observed around leaf bits from this colony growth, a portion from the periphery having single hyphal tip were separated and transferred to other petri plates having medium to get pure culture and identification of the pathogen was confirmed by observing the morphological features of colony, spore characteristics and referring the relevant literature.

Morphological studies of the pathogen: Morphological studies of the pathogen were conducted from pure culture. Spore suspension in sterilized distilled water was made from pure culture of the pathogen grown on potato dextrose agar. One drop of the spore suspension was placed on a slide and morphological characters were noted with the help of microscope. The species of *Alternaria* affecting mustard were differentiated on the basis of morphological characters of mycelium, conidia and conidiophores.

Testing of different treatments on disease intensity on leaves of mustard at different intervals (60, 75 and 90 days after sowing) and on mustard pods at 75, 90 and 105 Days after sowing (DAS):

Treatments used: Foliar sprays with *Trichoderma harzianum* @ 10g/kg, foliar sprays with bulb extract of garlic 1% (w/v), foliar sprays with bulb extract of onion 1% (w/v), foliar sprays with carbendazim 50% WP @ 2g/l, foliar sprays with mancozeb 75% WP @ 2.5g/l and foliar sprays with ridomil MZ 72 WP @ 2g/l was tested over infected plants to measure the disease intensity. Per cent disease intensity was recorded at 60, 75, 90 and 75, 90, 105 days after incidence of Alternarial blight. The initial infections or incidence were recorded in the experimental field at 60 days after sowing.

The per cent disease index (PDI) was computed according to the formula (Wheeler, 1969) given below:

$$\text{Per cent disease index} = \frac{\text{Sum of all disease ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Yield data in all the treatments against control was also estimated. Economics of different treatments applied on cost benefit ratio of mustard was also studied.

Results and Discussion

Morphological Studies of the Pathogen

Mycelium: Mycelium of *Alternaria* species associated with mustard are branched, septate, hyaline at first, later becoming light brown to dark brown in colour, inter and intracellular with the size of 1.5-7.5 µm in diameter.

Conidiophores: Conidiophores are usually simple sometimes branched, septate, erect, straight or curved occasionally geniculation, more cylindrical but often slightly swollen at the base, pale or mid-olivaceous brown, smooth measuring 3.5-4.5x 5-7.5 µm.

Conidia: In *Alternaria brassicae* (Berk.) Sacc. conidiophores arise in fascicles and the conidia are dark obclavate, muriform, short chain of up to 4 spores. The beak is about one third the length of conidium and 5-9 µm in long and also slightly narrowed at the base, greenish brown and colourless (Fig. 2).

Testing of different treatments on disease intensity on leaves of mustard at different intervals (60, 75 and 90 DAS)

60 DAS: Result showed that the maximum disease intensity (%) was recorded in control-T_0 (17.20) and minimum disease intensity was observed in T_6- Ridomil MZ72 @ 2 g/l (14.76), followed by T_5- Mancozeb 75 % WP @ 2.5g/l (15.66), T_4- Carbendazim 50% WP @ 2gm/kg (15.93), T_2- Bulb extract of garlic extract @ 1% (w/v) (16.03), T_1- *Trichoderma harzianum* @ 10 g/kg (16.16) and T_3- Bulb extract of onion @ 1% (w/v) (16.23). However, T_6- Ridomil MZ72 WP was found superior over all the treatments and T_3- bulb extract of onion was found least significant among the treatments. All the treatments were significant over the control and also significant among themselves.

75 DAS: Result showed that the maximum disease intensity was recorded in T_0 - Control (28.50) and the minimum disease intensity was observed in T_6- Ridomil MZ 72 WP @ 2g/l (24.16), followed by T_5- Mancozeb 75% WP @ 2.5g/l (24.30), T_4 – Carbendazim 50% WP @ 2g/l (24.76), T_2- bulb extract of garlic extract @ 1% (w/v) (25.46), T_1- *Trichoderma harzianum* @ 10 g/kg (26.10) and T_3- bulb extract of onion @ 1% (w/v) (27.16). However, T_6- Ridomil MZ 72 WP was found superior over all the treatments and T_3- bulb extract of onion was found least significant among the treatments. All the treatments were significant over the control.

90 DAS: Result showed that the maximum disease intensity was recorded in T_0 - Control (49.10) and the minimum disease intensity was observed in T_6- Ridomil MZ 72 WP @ 2g/l (38.16), followed by T_5- Mancozeb 75% WP @ 2.5g/l (39.80), T_4- Carbendazim 50% WP @ 2g/l (41.83), T_2- bulb extract of garlic extract @ 1% (w/v) (43.76), T_1- *Trichoderma harzianum* @ 10 g/kg (45.50) and T_3- bulb extract of onion @ 1% (w/v) (46.13). However, T_6- Ridomil MZ 72 WP was found superior over all the treatments and T_3- bulb extract of onion was found least significant among the treatments. All the treatments were significant over the control (Table 1).

Data showed that the minimum disease intensity on leaves was by the use of Ridomil foliar spray. Similar trends on *Alternaria* blight were found by (Rathi and Singh, 2009) conducted field experiments to test the efficacy of different bio-agents, plant extract, and fungicides with different combinations as foliar sprays against *alternarial* blight in Indian mustard. Seed treatment with *Trichoderma harzianum* @ 10 g/kg seed followed by foliar spray of Ridomil MZ 72 WP @ 2 g/ l water after 50-60 days of sowing significantly reduced the alternarial leaf and pod blight up to 43.6 and 30.8 per cent, respectively. Alam *et al*. (2010) evaluated the efficacy of fungicides and plant extracts against *Alternaria* leaf blight of mustard caused by *Alternaria brassicae* and *Alternaria brassicicola.* Four fungicides and two plant extract were tested in the experiment. They observed that, the application of fungicides and plant extracts significantly influenced all of the parameters. Seed treatments with Ridomil MZ 72 WP and spraying result showed better performance.

Table 1 : Effects of different treatments on disease intensity on leaves of mustard at different intervals (60, 75 and 90 DAS).

Treatments	Disease intensity (%) on leaves		
	60 DAS	75 DAS	90 DAS
T_0-Control	17.20 [a]	28.50 [a]	48.10 [a]
T_1-*Trichoderma harzianum* @ 10gm /kg.	16.17 [b]	26.10 [bc]	45.50 [ab]
T_2-Bulb extract of garlic 1% (w/v).	16.03 [b]	25.47 [bc]	43.10 [bc]
T_3-Bulb extract of onion 1% (w/v).	16.23 [b]	27.17 [ab]	45.10 [ab]
T_4-Carbendazim 50% WP @ 2g/l.	15.93 [b]	24.77 [c]	41.83 [bcd]
T_5-Mancozeb 75% WP @ 2.5g/l.	15.67 [bc]	24.33 [c]	39.80 [cd]
T_6-Ridomil MZ 72 WP @ 2g/l.	14.77 [c]	24.17 [c]	38.17 [d]
SED (±)	**0.42**	**0.90**	**2.22**
CD (p=0.05)	**0.92**	**1.95**	**4.83**

Note:- Values in the same column followed with similar letters are not significantly different.

Testing of different treatments on disease intensity on pods of mustard at different intervals (75, 90 and 105 DAS)

75 DAS: Result showed that the maximum disease intensity was recorded in T_0- control (28.66) and the minimum disease intensity was observed in T_6- Ridomil MZ 72 WP @ 2g/l (15.33), followed by T_5- Mancozeb 75% WP 2.5g/l(16.66) T_4-Carbendazim 50% WP 2g/l (17.00), T_3- bulb extract of onion @ 1% (w/v) (22.00), T_2- bulb extract of garlic @ 1% (w/v) (28.33), T_1-*Trichoderma harzianum* @10g/kg (28.33). However, T_6- Ridomil MZ 72 WP was found superior over all the treatments and T_3- bulb extract of onion was found least significant among the treatments. Treatments (T0, T1, T3) (T2, T3) (T3, T4, T5) (T3, T4, T5) (T5, T6) were found non-significant among themselves (Table 2).

90 DAS: Result showed that the maximum disease intensity was recorded in T_0- control (37.66) and the minimum disease intensity was observed in T_6- Ridomil MZ 72 WP @ 2g/l (21.33), followed by T_5- Mancozeb 75% WP 2.5g/l (23.33), T_4- Carbendazim 50% WP 2g/l (24.66), T_2- bulb extract of garlic @ 1% (w/v) (32.33), T_1- *Trichoderma harzianum* @10g/kg (33.33) and T_3- Bulb extract of onion @ 1% (w/v) (34.66). However, T_6- Ridomil MZ 72 WP was found superior over all the treatments and T_3- Bulb extract of

onion @ 1% (w/v) was found least significant among the treatments (Table 2).

105 DAS: Result showed that the maximum disease intensity was recorded in T_0- control (44.66) and the minimum disease intensity was observed in T_6- Ridomil MZ 72 WP @ 2g/l (27.66), followed by T_5- Mancozeb 75% WP 2.5g/l (30.00), T_4- Carbendazim 50% WP 2g/l (31.00), T_2- Bulb extract of garlic @ 1% (w/v) (37.33), T_1- *Trichoderma harzianum* @10g/kg (37.66), T_3- Bulb extract of onion @ 1% (w/v) (38.33). However, T_6- Ridomil MZ 72 WP was found superior over all the treatments and T_3- bulb extract of onion was found least significant among the treatments (Table 2). In the present study, the minimum disease intensity on pods was by the use of Ridomil foliar sprays. Similar trends on leaf blight were found by Meena *et al*. (2011) who proved that Ridomil recorded the lowest mean severity (leaf: 25.1%; pod: 25.3%) of alternarial blight.

Table 2: Effects of different treatments on Alternarial pod blight of mustard at 75, 90 and 105 DAS.

Treatments	Disease intensity (%) on pods		
	75 DAS	90 DAS	105 DAS
T_0-Control	28.67 [a]	37.67 [a]	24.67 [a]
T_1-*Trichoderma harzianum* @ 10gm /kg	28.33 [a]	33.33 [b]	37.67 [b]
T_2-Bulb extract of garlic 1% (w/v)	25.33 [ab]	32.33 [b]	37.33 [b]
T_3-Bulb extract of onion 1% (w/v)	22.00 [bc]	34.67 [ab]	38.33 [b]
T_4-Carbendazim 50% WP @ 2g/l	17.00 [cd]	24.67 [c]	31.00 [c]
T_5-Mancozeb 75% WP @ 2.5 g/l	16.67 [cd]	23.33 [c]	30.00 [c]
T_6-Ridomil MZ 72 WP @ 2g/l	15.33 [d]	31.33 [c]	27.67 [c]
S. Ed. (±)	**2.57**	**3.19**	**5.99**
C. D. (p = 0.05)	**5.59**	**6.96**	**3.76**

Effects of different treatments on the yield of mustard

Result showed that the minimum yield was recorded in T_0- control (8.12 q/ha), the maximum yield were recorded in T_6- Ridomil MZ 72 WP @ 2g/l followed by T_5- Mancozeb 75% WP 2.5g/l (30.00), T_4- Carbendazim 50% WP 2g/l (31.00), T_2- bulb extract of garlic @ 1% (w/v) (37.33), T_1- *Trichoderma harzianum* @10g/kg (37.66), T_3- bulb extract of onion @ 1% (w/v) (38.33). The treatments (T_6, T_5), (T_5, T_4, T_2), (T_4, T_2, T_1) and (T_3, T_0) were not significant among themselves (Table 3).

Table 3: Effects of different treatments on the yield of mustard

Treatments	YIELD (q/ha)
T_0-Control	8.12 [d]
T_1-*Trichoderma harzianum* @ 10gm/kg.	11.10 [c]
T_2-Bulb extract of garlic 1% (w/v).	12.60 [bc]
T_3-Bulb extract of onion 1% (w/v).	9.10 [d]
T_4-Carbendazim 50% WP @ 2g/l.	13.90 [bc]
T_5-Mancozeb 75% WP @ 2.5g/l.	14.30 [ab]
T_6-Ridomil MZ 72 WP @ 2g/l.	16.20 [a]
S. Ed. (±)	**1.01**
C. D. (p = 0.05)	**2.191**

Note:- Values followed with similar letters are not significantly different.

Economics of different treatments on cost benefit ratio of mustard *(Brassica juncea* L.): The maximum cost benefit ratio was recorded in T_6- Ridomil @ 2g/l (1:5.141) followed by T_5- foliar spray with Mancozeb @ 2.5g/l (1:4.645), T_4- foliar spray with Carbendazim @ 2g/l (1:4.190), T_2- foliar spray with bulb extract of garlic @ 1% (w/v) (1:4.003), T_1- foliar spray with *Trichoderma harzianum* @ 10g/kg (1:3.723), T_3- foliar spray with bulb extract of onion (1:2.672), and T_0- control (1:2.562). Similar results were found by (Meena *et al*., 2011) who proved that highest seed yield and significant increase of 1000-seed weight were recorded from single spray of mancozeb at post-flowering stage. But maximum economic return was obtained from two spraying of Ridomil at 45 DAS and 60 DAS (Table 4).

Table 4: Economics of different treatments on cost benefit ratio of mustard

S. No.	Treatments	Cost of cultivation (Rs.ha^{-1})	Yield (q/ha^{-1})	Selling Rate (Rs.q^{-1})	Gross Return (Rs.ha^{-1})	Net Return (Rs.ha^{-1})	Cost Benefit Ratio
T0	Control	11650	8.3	5000	41500	29850	1:2.562
T1	*Trichoderma harzianum* 10g/kg.	12490	11.8	5000	59000	46510	1:3.723
T2	Bulb extract of garlic @ 1% (w/v)	12590	12.6	5000	63000	50410	1:4.003
T3	Bulb extract of onion @ 1% (w/v)	12390	9.1	5000	45500	33110	1:2.672
T4	Carbendazim 50 % WP @ 2g/l	13390	13.9	5000	69500	56110	1:4.190
T5	Mancozeb 75 % WP @ 2.5 g/l	12665	14.3	5000	71500	58835	1:4.645
T6	Ridomil MZ 72 WP @ 2g/l	13190	16.2	5000	81000	67810	1:5.141

Conclusion

Alternaria blight is destructive disease that causes higher yield losses in mustard as there is direct association of this disease in number of seeds per pod, test weight and seed yield. Due to this management of this disease is of importance. The study revealed that Ridomil MZ 75 WP @ 2% foliar spray treatment was the most effective against *Alternaria* blight of mustard. It can be used effectively to minimize disease intensity (%) and get better yield (q/ha) compare to other treatments, *Trichoderma harzianum* @ 10g/kg, bulb extract of garlic @ 1% (w/v), bulb extract of onion @ 1% (w/v), carbendazim 50 % WP @ 2g/l and mancozeb 75% WP @ 2.5g/l. This study though showed effectiveness of the various treatments applied for prevention of *Alternaria* blight but there is a scope for more experimental trials to further validate the results on larger basis.

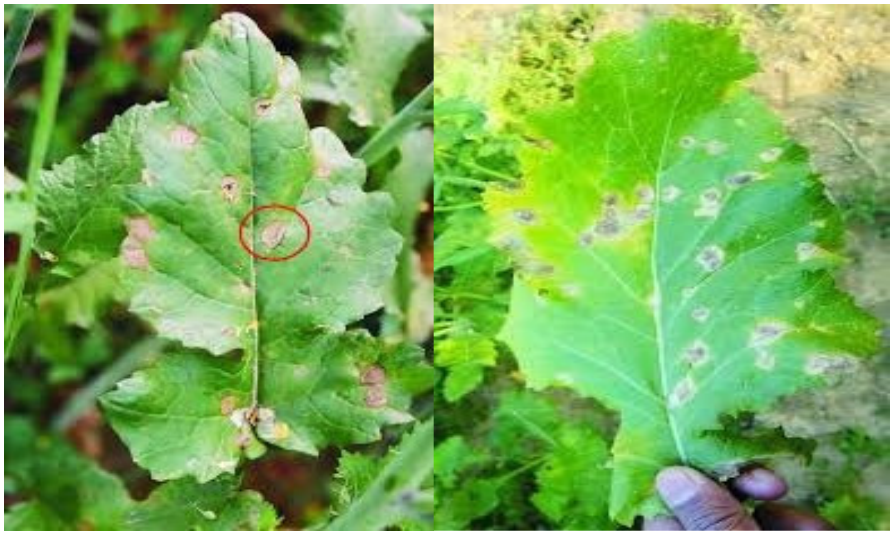

Fig. 1 : Infected leaf of mustard

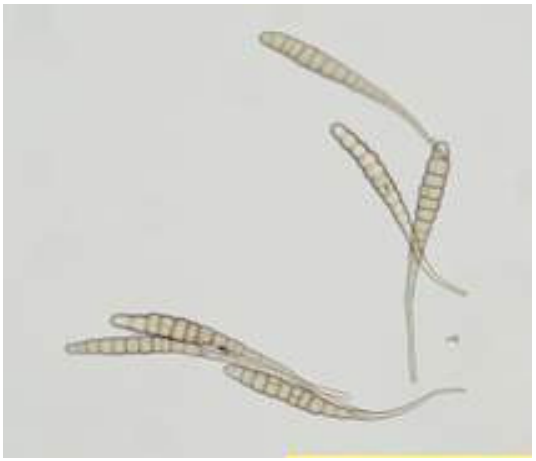

Fig. 2 : Conidia

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