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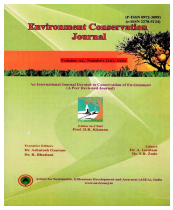

Efficacy of eco-friendly treatments on yield attributes in Indian mustard (*Brassica juncea* L.) against alternaria blight

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ABSTRACT

Indian Mustard that is emerged as the core oilseed crop is cultivated in the northern regions of India during *Rabi* season. Alternaria blight is one of the most destructive pathogens for Indian Mustard resulting in huge losses in quality and quantity of the produce. A research study was taken up to control the alternaria blight in Indian Mustard with selected eco-friendly treatments by monitoring disease intensity and yield attributes. It is noted that T_2 – *Trichoderma viride* has shown significant results on disease intensity and yield attributes, where disease intensity has significantly minimised in T_2 may be due to the mycoparasitic nature and ability to generate volatile and non-volatile compounds against pathogen with great anti-microbial activity. The results showed that maximum plant height (56.10 cm), test weight (4.11 g) and seed yield (1.21 t/ha) of Indian Mustard with minimum disease intensity (40.21 %) were recorded in the treatment T_2 and followed by T_6 – neem leaf extract @15% that has shown significant results on Alternaria blight.

Introduction

Indian Mustard that belongs to the Brassicaceae family is considered as the "Miracle for the Mankind" due to its wide gamut of benefits. It is also grown under wide agroclimatic conditions across the globe. Its oil is used as the main cooking medium in the northern regions of India which is irreplaceable by any other edible oil and the seeds are of high energy content having 28-32% oil and relatively high protein content of 28-36% (Fahad, 2012). It also has a versatile use in the medical and tanning industry. Its oilcake is used as cattle feed. The sustainable cultivation of Rapeseed Indian Mustard is ravaged by several destructive fungal pathogens among which the diseases like downy mildew (*Peronospora parasitica*), Alternaria blight (*Alternaria brassicae*), white rust (*Albugo candida*) and powdery mildew (*Erysiphe polygoni*) are of major importance. Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc. and *Alternaria brassicicola* is one among the important diseases of Indian Mustard with severe losses up to 70% in Rapeseed (*Brassica campestris*) (Kolte 2002); (Kolte *et al.,* 1987), which had reported from across the globe causing 10-70% yield losses in which 15 to 71% losses were reported from India (Kadian and Saharan, 1983; Ram and Chauhan, 1998) depending on the crop species, being high in *Brassica rapa* with 35-40% in Indian Mustard (Chattopadhyay, 2008). These fungal pathogens chase the crops in every stage of the crop growth ultimately resulting in huge losses in the quality of the produce. Several management strategies have merged in recent times which relied primely on chemicals resulting in hazardous effects on mankind and the environment. Considering the above mentioned facts, a research study was planned to study the efficacy of selected eco-friendly treatments on Indian Mustard against Alternaria blight.

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Material and Methods

The present study was conducted at Central Research Field of Naini Agricultural Institute, U.P. The study was conducted with selected treatments mentioned in (table 1) during *Rabi* season in 2021. The field was laid out in random block design with three replications (Fig 4). Infected plant parts with typical disease symptoms are fetched from standing field of Indian Mustard and brought to the laboratory for further studies. Identification of the pathogen based on characteristics was done through microscopic examination. Though, the damage due to *Alternaria brassicae* at initial stages may not be prominent but at later stages, the incidence of the disease becomes very high resulting in great losses. However, in severe cases, the plant may die Jay *et al.* (2019). Pre-post-harvest observations such as disease intensity (%), plant height (cm) at regular intervals, seed yield (t/ha) and test weight (1000 seeds) are recorded from randomly selected plants from each plot.

Table 1: Details of the selected eco-friendly treatments against *Alternaria brassicae*

Treatments		Mode of application
T_1	Control	-
T_2	*Trichoderma viride* @10g/kg	Seed treatment
T_3	Nativo @0.05%	Foliar spray
T_4	Garlic bulb extract @1%	Foliar spray
T_5	*Pseudomonas fluorescens* @1%	Foliar spray
T_6	Neem leaf extract @15%	Foliar spray

Preparation of botanical extracts

The fresh parts from healthy, disease plants were collected and carefully washed in clean water. Thus, obtained plant parts were grounded with the help of mortar and pestle by adding similar amount (100 ml) of sterile distilled water (1:1 w/v). This solution was boiled at 800°C for 10 minutes in hot water bath. Later the grounded matter was filtered with the help of muslin cloth and followed by filtering with the help of Whatman No.1 filter paper. Thus, obtained plant extract was considered as 100%. Then the extract was diluted by adding required amounts of sterile distilled water as suggested by (Kavita and Dalbeer, 2013).

Morphology of pathogen

The mycelium of *Alternaria brassicae* is septate, brown to brownish-grey, and the conidiophores are dark, septate and arise in fascicles, measuring about 14-74×4-8µm. Conidia are brownish-black, obclavate, borne singly in chains of 2-4, muriform with a long beak. Initially, symptoms were noticed as black spots with yellow hallow, later these enlarge and developed into prominent round spots with concentric rings giving a target board appearance (Fig 3). As the infestation increases, these spots coalesce to form large patches and cause blighting of leaves later defoliate Dharmendra *et al.* (2014). The beak of the pathogen is usually pale brown coloured, short, cylindrical and measures about 9-131µm in length and 3-8 microns in width (Fig 2).

Disease intensity (%)

Assessment of disease was done with the grading method following a grade chart of 0-9 (table 4). Disease intensity (%) is calculated by using the formula given by Wheeler (1969).

$$\text{Disease intensity} = \frac{\text{Sum of all disease rating}}{\text{Total number of rating} \times \text{Maximum disease grade}} \times 100$$

Its disease intensity (%) was recorded at 45, 60 and 75 days after the incidence of *Alternaria brassicae*.

Results and Discussion

Disease intensity (%)

The statistical analysis of the data exhibited (table 2 and figure 3) reveals that disease intensity was notably reduced in treatment T_2 – *Trichoderma viride* @10g/kg (40.21%) followed by T_6 – neem leaf extract @15% (42.58%), T_5 – *Pseudomonas fluorescens* @1% (44.83%) and T_4 – garlic bulb @1% (45.69%) as compared to treated check T_3 – Nativo @0.05% (38.61%) and untreated control T_1 – 48.50%. All the treatments were found to be significant over control but among the treatments, T_5 and T_4 are found to be non-significant to each other. The practice of bio-agents principally *Trichoderma* species has been stated as quite effective against a broad range of pathogens (Chattopadhyay *et al.,* 2002), predominantly as a seed treatment. Similar results with *Trichoderma viride* were reported by Yogita *et al.* (2017) as the most effective bio-agent in reducing the disease intensity. Hence, from the present study, the bio-agent *Trichoderma viride* has proved to be potential enough in restricting the pathogen growth and can

Table 2: Effect of treatments on disease intensity (%) and test weight (g).

Treatments	Disease intensity (%)			Test weight (1000 seeds) - g
	45 DAS	60 DAS	75 DAS	
T_1 – Control	38.60	42.85	48.50	2.52
T_2 – *Trichoderma viride* @10g/kg	31.83	36.76	40.21	4.11
T_3 – Nativo @ 0.05%	29.30	34.52	38.61	4.33
T_4 – Garlic bulb extract @1%	35.90	39.71	45.69	2.87
T_5 – *Pseudomonas fluorescens* @1%	34.74	38.64	44.83	3.15
T_6 – Neem leaf extract @15%	33.40	37.27	42.58	3.92
C.D @ (5%)	1.11	1.12	1.25	1.02
S.Em (±)	0.34	0.35	0.39	0.32

Table 3: Effect of treatments on plant height (cm) and seed yield (t/ha).

Treatments	Plant height (cm)			Seed yield (t/ha)
	45 DAS	60 DAS	75 DAS	
T_1 – Control	38.26	43.75	51.05	0.62
T_2 – *Trichoderma viride* @10g/kg	42.23	46.82	56.10	1.21
T_3 – Nativo @0.05%	43.14	47.28	58.74	1.61
T_4 – Garlic bulb extract @1%	38.82	44.10	52.45	0.92
T_5 – *Pseudomonas fluorescens* @1%	39.22	44.91	53.95	1.09
T_6 – Neem leaf extract @15%	40.44	46.82	55.24	1.11
C.D. @ (5%)	1.34	1.21	1.23	0.42
S.Em (±)	0.42	0.38	0.38	0.54

Table 4: Disease rating scale (Ram Singh Dhaliwal and Bahadurjeet Singh 2020).

Grade	Leaf area covered	Reaction
0	0	Immune
1	Small spots covering 1% or > 1% leaf area	Highly resistant
3	Small spots (5mm) covering 1-10% leaf area	Resistant
5	Spots covering 11-25% of leaf area	Moderately resistant
7	Big patches covering 26-50% of leaf area	Moderately susceptible
9	Large spots covering >51% of leaf area	Highly susceptible

be used to manage the Alternaria leaf blight in mustard.

Plant height (cm)

The statistical data presented (table 3) reveal that maximum plant height (cm) observed in treatment T_2 – *Trichoderma viride* @10g/kg (56.10 cm) followed by T_6 – neem leaf extract @15% (55.24 cm), T_5 – *Pseudomonas fluorescens* @1% (53.95 cm) and T_4 – garlic bulb extract @1% (52.45 cm) as compared to treated check T_3 – Nativo @0.05% (58.74 cm) and untreated control T_1 – 51.05 cm. All t

the treatments were found to be significant over control and among the treatments, T_6 and T_2 are found non-significant to each other. The results obtained from the present study could be correlated with the studies made by Rini and Sulochana (2006) who evaluated the efficacy of bio-control agents against Alternaria blight when applied alone or in combination. The height of the plant increased greatly in *Trichoderma viride*, may be due to the inhibitory effect of bioagents related to the bio-control agent's hyper parasitism/mycoparasitism feature.

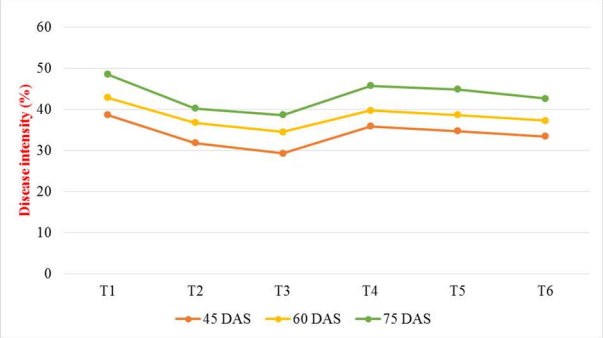

Figure 1: Effect of different treatments on disease intensity (%) of Indian Mustard.

Figure 2: Pure culture and microscopic view of *Alternaria brassicae.*

Figure 3: Symptoms caused by the pathogen.

Figure 4: Experimental trial of Indian Mustard. T_2 –

Seed yield (t/ha):

The analysed data depicted in the table 3 discloses that seed yield considerably increased in treatment *Trichoderma viride* @10g/kg (1.21) followed by T_6 – neem leaf extract @15% (1.11), T_5 – *Pseudomonas fluorescens* @1% (1.09) and T_4 – garlic bulb extract @1% (0.92) as compared to treated check T_3 – Nativo @0.05% (1.61) and untreated control T_1 – 0.62. All treatments found to be merely equal to control but the treatments (T_1 and T_4), (T_4, T_5, T_6 and T_3), (T_5, T_6 and T_2), (T_6 and T_2) and (T_2 and T_3) are found non-significant among themselves.

Test weight (g):

The analysed data and presented in the (table 2) explain that test weight considerably increased in treatment T_2 – *Trichoderma viride* @10g/kg @ (4.11) followed by T_6 – neem leaf extract @15% (3.92), T_5 – *Pseudomonas fluorescens* @1% (3.15) and T_4 – garlic bulb extract @1% (2.87) as compared to treated check T_3 – Nativo @0.05% (4.33) and untreated control T_1 – 2.52. All the treatments were found to be significant over control and the treatments (T_1, T_2 and T_5), (T_4 and T_5), (T_5, T_6 and T_2), (T_6, T_2 and T_3) and (T_2 and T_3) were found not significant themselves.

Similar discoveries were also reported by Yogita *et al.* (2017) *Trichoderma viride* was proven as the most effective bio-agent recorded maximum yield (t/ha). *T. Viride* seems to possess an antagonistic effect on fungal plant pathogens due to its parasitic nature, competition for space, nutritional supply and antagonistic chemical produced. It has been involved in the production of antibiotics like Trichodermin, extracellular enzymes such as chitinase, cellulase and unsaturated monobasic acids like dermadine and peptides that can harm the plant pathogens Mamgain *et al.* (2013) and Rehman *et al.* (2013).

Conclusion

The results revealed that minimum disease intensity with maximum plant height (cm), test weight (g) and seed yield (t/ha) are observed in treatment T_2 – *Trichoderma viride* @10g/kg. In a view to cutdown the indiscriminate use of the chemical fungicides and their uncertainties on the environment and mankind, such an attempt was made to evaluate the efficacy of the bio-control agents and botanicals on

the Alternaria blight of rapeseed. Thus, it is evident from the present study that the application of bio-control agents and botanicals is more efficient in defeating pathogen growth and it is eco-friendly to utilise. These can provide a way better and effective management practice for the pathogen. However, further freedom is there for more research trials for better results in a broader view.

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Conflict of interest

The authors declare that they have no conflict of interest.

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