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Efficacy of plant extract and biocontrol agents against powdery mildew of mustard (*Brassica juncea* (L.)

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Abstract

The present investigation was conducted to evaluate the efficacy of plant extracts and biocontrol agents against powdery mildew of mustard (*Brassica juncea* (L.) Czern. & Coss.) during Rabi 2025-26 at the Research Farm, School of Agriculture, Suresh Gyan Vihar University, Jaipur. The experiment was laid out in a Randomized Block Design with three replications. Seven treatments comprising neem, karanj and garlic extracts (10%) and *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Bacillus subtilis* (10 g l⁻¹), along with an untreated control, were evaluated. Among the treatments, *Trichoderma harzianum* recorded the lowest disease severity (24.86% PDI) and maximum disease control (47.77%), followed by *Pseudomonas fluorescens* (26.50% PDI and 44.33% disease control) and *Bacillus subtilis* (28.14% PDI and 40.88% disease control). Among the botanicals, garlic extract recorded the lowest disease severity (31.05% PDI) and highest disease control (34.77%). *Pseudomonas fluorescens* produced the highest seed yield (19.26 q ha⁻¹) and maximum yield increase (24.18%) over the control, followed by *Trichoderma harzianum* (18.22 q ha⁻¹ and 17.47%). The untreated control recorded the highest disease severity (47.60% PDI) and lowest seed yield (15.51 q ha⁻¹). The study demonstrated that biocontrol agents, particularly *Trichoderma harzianum* and *Pseudomonas fluorescens*, along with garlic extract, have considerable potential for eco-friendly management of powdery mildew and improving mustard productivity.

Keywords: Mustard, *Brassica juncea*, powdery mildew, *Erysiphe cruciferarum*, *Trichoderma harzianum*, *Pseudomonas fluorescens*, garlic extract, biocontrol

1. Introduction

Indian mustard (*Brassica juncea* (L.) Czern. & Coss.) is an important oilseed crop of the family Brassicaceae, with a chromosome number of 2n = 36 (Rai *et al.*, 2022) [11]. Rapeseed-mustard is the fourth-largest oilseed group globally, while India is a major producer, with Rajasthan contributing the largest share of national production. Mustard productivity is affected by several biotic stresses, among which powdery mildew caused by *Erysiphe cruciferarum* is an important disease. The pathogen produces characteristic white powdery growth on leaves and other aerial parts and can cause considerable reductions in seed yield and oil content. Disease development is favoured by moderate temperature, low relative humidity and dry weather conditions (Meena *et al.*, 2018 and Verma *et al.*, 2023) [7, 15]. Although chemical fungicides are effective against powdery mildew, their repeated use may lead to fungicide resistance, environmental pollution and residue problems. Therefore, eco-friendly alternatives such as biocontrol agents and plant extracts have gained importance. Bioagents including *Trichoderma* spp., *Pseudomonas fluorescens* and *Bacillus subtilis*, along with botanicals such as neem and garlic extracts, have demonstrated antifungal potential (Woo *et al.*, 2023 and Nanjundan *et al.*, 2020) [16, 10].

2. Materials and Methods

The present study entitled "Efficacy of Plant Extract and Biocontrol Agents Against Powdery Mildew of Mustard (*Brassica juncea* (L.)" various experiments were conducted at Department of Plant Pathology, School of Agricultural, Suresh Gyan Vihar University, Jaipur, Rajasthan. The experimental plot was laid out in a Randomized block design (RBD) having three replications for each treatment. Mustard variety 'NRCHB-506' show increased susceptibility to powdery mildew disease was used for field trial.

All recommended agronomic practices were followed during whole cropping season. The treatments used for evaluating the efficacy of plant extracts and bio-agents against powdery mildew viz., T₁-Neema extract (10%), T₂-Karanj extract (10%), T₃-Garlic extract (10%), T₄-*Trichoderma harzianum* (10 g/l), T₅-*Pseudomonas fluorescens* @ 10 g/l, T₆-*Bacillus subtilis* @ 10 g/l and T₇-Control (water spray). Disease incidence of powdery mildew was recorded periodically after the appearance of first disease symptoms in the field. Observations were taken randomly from selected ten plants in each plot. The number of infected plants showing typical symptoms of powdery mildew were counted and expressed as percentage. The

disease incidence were calculated using the following formula:

$$\text{Disease Incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Disease severity was assessed using a standard disease rating scale based on the percentage of leaf area covered by powdery mildew infection. Data on severity of powdery mildew was recorded by recommended rating scale (0-5) on ten randomly selected plants from each plot/replication at regular intervals till the maturity of the crop. A disease rating scale (0-5) was used for assessment of disease severity as follows:

Scale	Disease severity description
0	Healthy plants free from powdery mildew
1	Infection in traces on lower leaves; covering up to 10% leaf area
2	Slight infection, white patches on leaves covering 11 to 25% leaf area, stem showing slight infection, siliquae free
3	Moderate infection, white powdery growth covering 26 to 50% leaf area, middle leaves showing severe infection, stem moderately infected, siliquae usually free
4	Heavy infection; powdery growth or discolored areas covering 51 to 75% leaf area, stem heavily infected, siliquae moderately infected
5	Severe infection, powdery growth or discoloured areas covering 76 to 100 percent leaf area, stems and siliquae severely infected, defoliation common

Disease severity was expressed as percent Disease Index (PDI) using the following formula (McKinney, 1923) ^[17]

$$\text{PDI} = \frac{\sum \text{Sum of Individual rating}}{\text{Total number of plant observed} \times \text{Maximum rating}} \times 100$$

Seed yield of net plot area of each plot was recorded after harvest of the crop. Percent increase in seed yield in each treatment over the control was also worked out by following formula.

$$\text{Percent yield increase} = \frac{\text{Yield in Treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

The data recorded during the investigation were subjected to statistical analysis following the procedure described by Panse and Sukhatme (1967) ^[18] for Randomized Block Design (RBD).

3. Results and Discussion

The efficacy of different plant extracts and bio-agents against powdery mildew of mustard under in-vivo conditions. The results revealed that all the treatments significantly reduced disease severity and increased disease control over the untreated control. Among the different treatments, *Trichoderma harzianum* @ 10 g l⁻¹ (T₄) proved to be the most effective bio-agent which recorded the significantly lowest disease severity (24.86% PDI) and the highest disease control (47.77%) followed by *Pseudomonas fluorescens* @ 10 g l⁻¹ (T₅), (26.50%) with 44.33 percent disease control. *Bacillus subtilis* @ 10 g l⁻¹ (T₆) (28.14%) with 40.88 percent disease control. Among the botanical extracts, garlic extract (10%) (T₃) was found significantly which recorded 31.05 percent PDI and 34.77 percent disease control, followed by neem extract (10%) (T₁) (35.15%) and 26.16 percent disease control. The karanj extract (10%) (T₂) was comparatively less effective which recorded 37.20 percent PDI and 21.85 percent disease control. The untreated control (T₇) recorded the highest disease severity (47.60% PDI) and no disease control. The

data presented in Table 1 further indicated that all the treatments significantly increased seed yield over the untreated control. The highest seed yield (19.26 q ha⁻¹) and maximum yield increase (24.18%) were recorded with *Pseudomonas fluorescens* @ 10 g l⁻¹ (T₅) followed by *Trichoderma harzianum* @ 10 g l⁻¹ (T₄), (18.22 q ha⁻¹) with 17.47 percent yield increase. *Bacillus subtilis* @ 10 g l⁻¹ (T₆) (17.78 q ha⁻¹) seed yield with 14.64 percent yield increase, while garlic extract (10%) (T₃) recorded 17.68 q ha⁻¹ seed yield and 13.99 percent yield increase. Neem extract (10%) (T₁) and karanj extract (10%) (T₂) recorded seed yields of 16.96 and 16.45 q ha⁻¹, with corresponding yield increases of 9.35 and 6.06 percent, respectively. The lowest seed yield (15.51 q ha⁻¹) was recorded in the untreated control (T₇). These findings clearly indicated that effective suppression of powdery mildew resulted in a corresponding increase in seed yield and productivity of mustard.

The superior performance of *Pseudomonas fluorescens* may be attributed to its effective colonization, production of antimicrobial metabolites, competition for nutrients and induction of systemic resistance, thereby restricting pathogen establishment (Mukherjee *et al.*, 2022) ^[9]. Similarly, *Trichoderma harzianum* suppresses pathogens through mycoparasitism, antibiosis, nutrient competition and production of cell wall-degrading enzymes (Mukherjee *et al.*, 2022; Singh *et al.*, 2024) ^[9, 14]. The better performance of garlic extract could be due to allicin and other organosulfur compounds, which inhibit fungal growth and spore germination (Borlinghaus *et al.*, 2014; Bayan *et al.*, 2014) ^[2, 1]. The present findings are in agreement with Meena (2013) ^[6] and Singh *et al.* (2015) ^[13], who reported effective suppression of powdery mildew by *Trichoderma* and *Pseudomonas*. Lomate *et al.* (2014) ^[4] and Modak *et al.* (2019) ^[8] also observed significant disease reduction with biological agents. The superior efficacy of garlic extract corroborates Choudhary *et al.* (2025) ^[3], who reported maximum powdery mildew suppression with garlic extract. Similar effectiveness of *Trichoderma harzianum* and *Pseudomonas fluorescens* was reported by Meena *et al.*

(2024) ^[5] and Sharma and Yadav (2024) ^[12]. Overall, the results indicate that biocontrol agents and garlic extract have considerable potential as eco-friendly components for managing powdery mildew of mustard.

Conclusion

Based on the present investigation, *Trichoderma harzianum* and *Pseudomonas fluorescens* can be effectively utilized for eco-friendly management of powdery mildew in mustard, with garlic extract as a promising botanical alternative.

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