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STATUS AND ECO-FRIENDLY MANAGEMENT OF ALTERNARIA BLIGHT OF RADISH (*RAPHANUS SATIVUS* L.) IN BUNDELKHAND REGION OF INDIA

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ABSTRACT

Radish (*Raphanus sativus*) is a vital root vegetable crop whose productivity is significantly affected by Alternaria blight, caused by fungus (*Alternaria* spp.) This study was conducted during the 2024–25 winter season to research the status, epidemiology, and management of Alternaria blight in the Bundelkhand region of India. Field surveys across Jhansi, Hamirpur and Mahoba districts revealed widespread occurrence of the disease, with severity ranging from 12.75% to 33.62% and incidence from 19.20% to 41.29%. The highest severity (33.62%) was observed in the Babina block of Jhansi. Epidemiological analysis showed a highly significant negative correlation with minimum temperature (r=–0.721) and a highly significant positive correlation with maximum relative humidity (r=+0.847), while the effect of rainfall was not significant. The causal organism was linked as Alternaria brassicicola based on morpho-cultural features. A field trial with seven treatments (fungicides and biopesticides) showed that foliar spray of onion extract was most effective, with lowest disease intensity (12.90%) and highest reduction (75.25%) at 60 DAS, followed by neem oil (18.09%) and Mancozeb 75% WP (18.53%). The study concludes that Alternaria blight is a major constraint in radish production in Bundelkhand and that eco-friendly approaches like onion extract can be promising alternatives for disease management.

Key words : *Alternaria raphani*, Epidemiology, Pesticides, Biopesticides, Radish, *Raphanus sativus*, Disease Management.

Introduction

Radish (*Raphanus sativus*), a member of the Brassicaceae family, is a widely cultivated edible root vegetable valued for its crisp texture, peppery flavor, and diverse culinary uses such as in salads and pickles. In India, it is extensively grown in states with cooler climates, including Uttar Pradesh. The total radish production in India is approximately 3.145 million tonnes from an area of 3174 thousand hectares. Despite its popularity and simple cultivation requirements, radish crops are prone to several diseases, among which Alternaria blight, caused by *Alternaria* spp., is one of the most destructive. This disease significantly limits yield and quality. The causal pathogens —*A. brassicae*, *A. brassicicola*, *A. raphani*, and *A. alternata* are primarily seed-borne, leading to yield losses ranging from 5% to 47% in various regions of India. The disease appears as circular, dark brown spots on leaves, stems and pods, ultimately reducing seed quality and oil content.

Environmental conditions such as temperature and leaf wetness, which impact various stages of the fungal life cycle, strongly determine the development and severity of the disease. However, in the Bundelkhand region, limited information is available on the epidemiology and effective management of Alternaria blight of radish.

Materials and Methods

The present study was carried out at the Institute of Agricultural Sciences, Bundelkhand University, Jhansi

(U.P.) during the *Rabi* season of 2024–25.

Field Survey and Disease assessment

Fortnightly field surveys were conducted in major radish-growing areas of Jhansi, Hamirpur and Mahoba districts to assess the status of Alternaria blight. In each surveyed village, five fields were randomly selected.

Disease intensity was assessed using the 0 – 5 complaint standing scale as per Townsend and Heuberger (1943). The Percent Disease Intensity (PDI) was calculated using the formula:

$$PDI = \frac{\Sigma(\text{Individual Disease Ratings}) \times 100}{(\text{Total Plants Observed} \times \text{Maximum diseases Rating})}$$

Pathogen Isolation and identification

Radish leaves showing typical Alternaria blight symptoms were collected from the field. Small segments were cut from the margins of lesions, surface sterilized with 0.1% mercuric chloride for 30 seconds, rinsed thrice with sterile distilled water, and then placed on Potato Dextrose Agar (PDA) medium. The inoculated plates were incubated at 25 ± 1°C for 7–10 days. The emerging fungal colonies were purified and identified based on their morphological and cultural characteristics.

Epidemiological studies

To study the effect of weather parameters on disease development, the radish variety 'Korean White' was used. Observations on PDI were recorded weekly from the 52nd to the 11th Meteorological Standard Week (MSW).

Meteorological data on temperature, relative humidity, and rainfall were collected from Krishi Vigyan Kendra (KVK), Jhansi. Correlation and regression analyses were performed to determine the relationship between disease development and weather parameters.

Management Efficacy trial

A field trial was laid out in a Randomized Block Design (RBD) with three replications. The radish variety 'Korean White' was grown in plots of 2.0 m × 1.57 m. Seven treatments, including pesticides and bio pesticides, were applied as foliar sprays. compliances on PDI were recorded at 30, 45 and 60 Days After Sowing (DAS).

Preparation of Onion extract

Fresh onion bulbs (1 kg) were crushed into a fine paste using a grinder and mixed with 1 L distilled water. The admixture was kept at room temperature for 12 hours and then filtered through muslin cloth. The filtrate was adulterated with water to gain 80% concentration and used as foliar spray at 5–7 day intervals.

Commercial formulation of *T. harzianum* (10w CFU/g) was mixed in water @5 g/L and applied as foliar spray at 7-day intervals

Table 1 : Details of treatment.

Treatment Code	Treatment	Concentration
T_1	Mancozeb 75%WP	0.2%
T_2	Carbendazim 50%WP	0.1%
T_3	*Trichoderma harzianum*	5 g/L (10^7 CFU/g)
T_4	Neem oil (foliar spray)	3%
T_5	Onion extract (foliar spray)	80%
T_6	Propiconazole 25%EC	0.1%
T_7	Control (Water spray)	100%

Statistical analysis

The data recorded during the trial were subordinated to Analysis of Variance (ANOVA). The significance of treatment effects was tested at a 5% probability level, and Critical Difference (CD) values were calculated wherever the F-test was set up significant.

Results

The present study researched the status, symptomatology, epidemiology, and management strategies for Alternaria blight of radish in the Bundelkhand region.

Disease Status Based on Field Survey:checks conducted across Jhansi, Hamirpur and Mahoba section verified the wide circumstance of Alternaria blight in radish-growing regions.

Disease Severity and Incidence

The disease severity ranged from 12.75% to 33.62% (mean: 22.66%), while incidence ranged from 19.20% to 41.29% (mean: 28.08%).

Highest Infection Zone

The highest severity (33.62%) and incidence (41.29%) were recorded in Bijoli village, Babina block, Jhansi.

Lowest Infection Zone

The lowest severity (12.75%) was recorded in Pawai village, Sarila block, Hamirpur, and the lowest incidence (19.20%) in Bhadwara village, Kulpahar block, Mahoba.

Symptomatology and Pathogen identification

Initial symptoms appeared on older lower leaves as small brown spots with concentric rings and a yellow halo. As the disease progressed, the spots enlarged, coalesced, and spread to younger leaves, stems, and pods, leading to a blighted appearance.

The pathogen was insulated and linked as *Alternaria*

Table 2 : Disease Status in Bundelkhand Region.

District	Block	Disease Severity (%): Mean ± SE (Range)	Disease Incidence (%): Mean ± SE (Range)
Jhansi	Babina	26.15 ± 4.3 (15.9–33.6)	32.70 ± 4.5 (22.3–41.2)
	Bangra	25.68 ± 2.8 (19.7–31.8)	30.70 ± 3.1 (24.4–37.7)
	Mauranipur	24.06 ± 3.5 (17.4–32.1)	29.31 ± 4.0 (21.6–38.7)
Hamirpur	Sarila	17.23 ± 1.8 (12.7–20.5)	23.40 ± 1.5 (19.7–26.0)
	Rath	24.10 ± 2.3 (20.3–29.7)	29.11 ± 2.0 (25.5–34.0)
	Muskura	27.86 ± 2.2 (22.4–31.9)	33.69 ± 2.6 (27.3–35.5)
Mahoba	Kulpahar	17.03 ± 1.2 (14.5–20.0)	21.80 ± 1.4 (19.2–25.2)
	Jaitpur	16.34 ± 1.2 (13.8–19.1)	21.60 ± 1.1 (19.9–24.4)
	Kabrai	25.00 ± 1.6 (21.1–27.7)	29.85 ± 1.5 (26.31–32.9)
	Overall	**22.66 ± 1.17 (12.7–33.6)**	**28.08 ± 1.23 (19.2–41.2)**

Table 3 : The correlation between weather parameters and disease intensity (PDI) revealed.

Parameter	r-value	Correlation Type	Significance
Maximum Temperature	+0.195	Weak Positive	Not Significant
Minimum Temperature	–0.721	Strong Negative	**Highly Significant (1%)**
Max Relative Humidity	+0.847	Strong Positive	**Highly Significant (1%)**
Min Relative Humidity	–0.469	Moderate Negative	**Significant (5%)**
Rainfall	–0.197	Weak Negative	Not Significant

Note: While minimum temperature showed a negative correlation, maximum RH showed a strong positive correlation with disease intensity.

Table 4 : Efficacy of Treatments against Alternaria Blight at 60 DAS.

Treatment	Disease Intensity (%)	Disease Reduction (%)
Onion extract foliar spray	12.90	75.25
Neem oil foliar spray	18.09	65.29
Propiconazole 25% EC	18.33	64.83
Mancozeb 75% WP	18.53	64.45
Carbendazim 50% WP	30.80	40.90
Trichoderma harzianum	40.65	22.00
Control (Water spray)	52.12	–
SE(m)	**0.37**	
CD (0.05)	**1.14**	

brassicicola based on morphological and cultural characteristics on PDA.

- Colony: Circular, greyish-brown to brown
- Hyphae: Branched, septate, brown
- Conidia: Brown, ovoid, with 4–6 septa; size: 15–49 µm × 6–10 µm

Epidemiological Findings

The disease first appeared during the 1st Meteorological Standard Week (MSW) and progressively increased, reaching a peak PDI of 56.18% by the 11th MSW. The most rapid increase was observed during the 3rd MSW, under the following weather conditions:

- Maximum temperature: 17.94°C
- Minimum temperature: 6.0°C
- Relative humidity: Max 95%, Min 73%
- Rainfall: 0 mm

Correlation analysis

Regression analysis

The regression analysis revealed that the combined effect of the studied meteorological variables explained 95.94% of the variation in disease development, indicating a strong influence of weather on disease progression.

Efficacy of Management treatments

A field trial of seven treatments, including fungicides and biopesticides, showed all treatments were more effective than the untreated control in reducing disease intensity.

Performance at 60 Days After Sowing (DAS)

Most effective treatment

Onion extracts foliar spray recorded the lowest

disease intensity (12.90%) and the highest disease reduction (75.25%) over control.

Moderately effective treatments

Neem oil (18.09%), Propiconazole 25% EC (18.33%), and Mancozeb 75% WP (18.53%) were statistically at par and handed substantial control.

Least effective treatment

Trichoderma harzianum showed limited efficacy with 40.90% disease intensity.

Control plot

The untreated control displayed the highest disease intensity (52.12%).

These results clearly demonstrate that onion extract spray handed the most effective and eco-friendly control of Alternaria blight under field conditions.

Discussion

This study provides a comprehensive analysis of Alternaria blight in the Bundelkhand region, focusing on its prevalence, the environmental factors driving its progression, and potential management strategies.

Disease Status and Prevalence

The extensive surveys confirmed that Alternaria blight is a significant and widespread issue for radish farmers across all the surveyed districts of Bundelkhand, with disease severity reaching as high as 33.62%.

The observed variability in disease severity across different locations can be attributed to local weather conditions and the availability of inoculum sources, which is consistent with the findings of Dhaliwal and Singh (2020) in Punjab. The yield losses observed in this study, ranging from 5% to 47% are comparable to previous reports across India, further solidifying the disease's status as a major economic threat.

Epidemiological Factors

The study confirmed that weather parameters play a critical role in determining the development of Alternaria blight, with over 95% of the disease variation being explained by these factors.

The study revealed a complex relationship between disease development and weather parameters. A strong negative correlation was observed with minimum temperature, while a weak positive trend was seen with maximum temperature. This suggests that colder nights followed by warmer days, coupled with high relative humidity, might create a favorable microclimate for disease progression in the Bundelkhand region. While the negative correlation with minimum relative humidity was expected, the highly positive correlation with maximum relative humidity underscores its critical role in facilitating spore germination. The study found a complex relationship with humidity. Disease severity significantly increased with maximum relative humidity ($r=+0.847$), while a negative correlation was observed with minimum relative humidity ($r=-0.469$). This indicates that cold nights followed by highly humid days are most favorable for the disease's development. This discrepancy may be attributed to regional microclimatic conditions or the specific strain of Alternaria present in Bundelkhand.

Moreover, the non-significant impact of rainfall on disease development supports previous findings that rainfall does not always have a direct impact on disease progression.

These observations highlight the importance of regional epidemiological studies in understanding the local disease dynamics, as generalizations may not always apply due to varying climatic conditions.

Management strategies

The evaluation of different management strategies revealed promising results, particularly for eco-friendly alternatives. The superior performance of onion extract foliar spray, which resulted in the lowest disease intensity (12.90%), is a noteworthy finding. This efficacy can be attributed to the antifungal properties of compounds found in *Allium cepa* extracts, as reported by Sheikh and Agnihotri (2021), who found that onion extracts effectively inhibited spore germination of *Alternaria* species. In comparison, Mancozeb and Propiconazole, despite being effective, did not perform as well as the onion extract. This is consistent with numerous past studies, which have shown Mancozeb to be an effective treatment for *Alternaria* species, but with limitations in terms of environmental impact and potential resistance buildup.

The relatively poor performance of *Trichoderma harzianum* as a foliar spray in this study contrasts with earlier reports where it was effective when used as a seed treatment. This suggests that the mode of application plays a crucial role in the efficacy of biocontrol agents.

The success of onion extract as a cost-effective, accessible, and environmentally safe treatment makes it a strong contender for promoting sustainable Alternaria blight management in radish cultivation.

Summary and Conclusion

This study was conducted to assess the impact of Alternaria blight on radish (*Raphanus sativus*), a major root crop in India. The research provides valuable insights

into the disease status, epidemiology, and potential management strategies in the Bundelkhand region.

Prevalence : Surveys conducted during the 2024-25 winter season confirmed that Alternaria blight is widespread across the Jhansi, Hamirpur, and Mahoba districts of Bundelkhand. The mean disease severity was found to be 22.66%, with a mean incidence of 28.08%.

Symptoms : The disease manifests as characteristic brown to dark brown spots with concentric rings, typically starting on the lower leaves and progressively covering the entire plant, resulting in a blighted appearance.

Epidemiology : Weather parameters, particularly temperature and relative humidity, were found to significantly influence disease progression. Disease development is strongly influenced by local weather parameters, particularly a negative correlation with minimum temperature and a positive correlation with maximum relative humidity, which serve as key factors for predicting disease progression. Rainfall, however, did not significantly affect disease development.

Management : Among the seven treatments tested, onion extract foliar spray proved to be the most effective in managing Alternaria blight under field conditions. After 60 days of application, it resulted in the lowest disease intensity (12.90%), compared to the control plot (52.12%). The onion extract outperformed other treatments, including neem oil, Mancozeb, Propiconazole, Carbendazim and Trichoderma harzianum.

Based on the findings of this study, the following conclusions can be drawn:

- Alternaria blight is a widespread and economically significant disease affecting radish cultivation in the Bundelkhand region.

  Disease development is strongly influenced by local weather parameters, particularly temperature and relative humidity, which serve as key factors for predicting disease progression.
- While several chemical fungicides are effective in managing the disease, onion extract foliar spray offers the most effective, accessible and environmentally sustainable management strategy for farmers in the region.

Further research is required to standardize the preparation and application methods of onion extract, which could enhance its potential as a core component of integrated disease management programs in the region.

Conflict of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

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