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Fungicidal Management of Alternaria Blight in Rapeseed (*Brassica rapa* L.)

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ABSTRACT

Alternaria blight caused by *Alternaria* spp. is a major bio-bottleneck to rapeseed production in Nepal. Field experiments were conducted during the winter seasons of 2023 and 2024 at the Oilseed Research Program (ORP), Nawalpur, Sarlahi to evaluate the comparative efficacy of fungicides against Alternaria blight and their influence on yield of rapeseed. The trials were laid out in a randomized complete block design with seven treatments viz. Mancozeb 75% WP @ 2.5 g/L, Azoxystrobin 23% EC (Amistar) @ 1 g/L, Tebuconazole 25% EC (Folicur) @ 1 g/Ll, Fenamidone 50% SC (Reason) @ 1 g/L, Trifloxystrobin 50% WG (Flint) @ 0.5 g/L, Chlorothalonil 50% SC (Bravo) @ 3 g/L including control (Water spray) and three replications using the variety Nawalpur Tori 4. All allocated fungicidal treatments were applied as two foliar sprays at 60 and 75 days after sowing following the onset of disease. Fungicide application significantly ($P<0.05$) reduced disease severity and improved yield in both years. Fenamidone @1 g/L of water (Reason 50%SC) consistently gave the lowest percent disease index (27.98–29.50%) and the highest grain yield (1178–1213 kg/ha), followed by Tebuconazole @ 1g/l of water (Folicur (25% EC). The untreated control exhibited the highest disease severity and lowest yield. The results confirm the effectiveness of Fenamidone for managing Alternaria blight and enhancing rapeseed productivity.

Keywords: Alternaria blight, Fungicide, Management, Rapeseed

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INTRODUCTION

Rapeseed is a key oilseed crop in Nepal, contributing substantially to domestic edible oil production and supporting rural livelihoods. It is widely cultivated during the winter season under both rainfed and irrigated conditions, especially in the Terai and inner Terai regions (Subedi 2023). Despite its importance, rapeseed productivity in Nepal remains below its potential, largely due to biotic stresses, among which diseases are a major limiting factor (Subedi et al 2023). Alternaria blight, caused primarily by *Alternaria brassicae* and *A. brassicicola*, is one of the most destructive diseases of rapeseed and other *Brassica* crops globally (Kolte 1985). The disease affects leaves, stems, siliqua, and seeds, resulting in premature defoliation, reduced photosynthetic area, poor seed filling, and deterioration of seed quality (Ansari et al 1989). Under favorable environmental conditions, moderate temperatures (18-25 °C), high relative humidity (> 80%), and frequent dew or rainfall (Humpherson-Jones and Maude 1983), alternaria blight can cause yield losses of 10–47%, and in severe epidemics, losses may exceed 50% (Shrestha et al 2010). In Nepal, the disease is particularly prevalent during humid winters and in late-sown crops, where prolonged leaf wetness accelerates disease development. Management through host resistance has been limited by the lack of stable resistant varieties and high pathogen variability. Cultural practices alone often fail to provide sufficient control under high disease pressure. Therefore, fungicidal application remains one of the most practical strategies to manage Alternaria blight (Singh et al 2013). Various systemic and protectant new generation fungicides, including strobilurins, triazoles, have been reported to reduce disease severity and improve yield by maintaining healthy foliage during critical growth stages. However, their performance can vary across locations, seasons, and climatic conditions, highlighting the need for site-specific evaluations. This study was conducted at a single location over two consecutive seasons, which may limit the extrapolation of the results across diverse agro-ecological conditions and disease pressure levels. In addition, the evaluation focused on short-term fungicidal efficacy without assessing residual effects, resistance development, or economic returns over multiple cropping cycles. In this context, the present study was conducted at the Oilseed Research Program,

Nawalpur, Sarlahi during the winter seasons of 2023 and 2024 to evaluate the comparative efficacy of selected fungicides against Alternaria blight of rapeseed and to assess their effects on disease reduction and yield under field conditions.

MATERIALS AND METHODS

Field experiments were conducted during the winter seasons of 2023 and 2024 at the Oilseed Research Program (ORP), Nawalpur, Sarlahi, Nepal, to evaluate the efficacy of fungicides against Alternaria blight in rapeseed. The experimental site was located in the central Terai region at 27°03′86″ north latitude and 85°35′52″ east longitude, at an elevation of 144 meters above mean sea level. The site was characterized by a subtropical climate with cool, humid winters conducive to Alternaria blight development, and soils are predominantly fertile alluvial sandy loam to silty loam with good drainage and moderate organic matter content. The soil pH ranges between 4.5-6.0 and the status of Nitrogen is low, while Phosphorus is high and Potassium is medium (ORP 2020). The trials were laid out in a randomized complete block design (RCBD) with seven treatments and three replications. Each plot measured 6 m² (3 m × 2 m) with 30 cm row spacing and 5 cm plant spacing after thinning. The variety Nawalpur Tori 4, popular among the farmers but susceptible to the alternaria blight disease was used in all experiments. The source of this variety was breeding unit of ORP, Sarlahi. Seeds were sown at recommended seed rates, and fertilizers were applied at 80:40:20 kg/ha NPK following standard ORP protocols (ORP 2020). Other agronomic practices, including irrigation, weed management, and pest control, were applied uniformly across all plots. Seven fungicidal treatments collected from the nearby agrobhets were evaluated: Mancozeb 75% WP @ 2.5 g/L, Azoxystrobin 23% EC (Amistar) @ 1 g/L, Tebuconazole 25% EC (Folicur) @ 1 g/L, Fenamidone 50% SC (Reason) @ 1 g/L, Trifloxystrobin 50% WG (Flint) @ 0.5 g/L, Chlorothalonil 50% SC (Bravo) @ 3 g/L, and an untreated water-sprayed control. All treatments were applied as foliar sprays at 60 and 75 days after sowing, following the onset of disease, with recommended spray volumes and concentrations.

Data were recorded on plant height, siliqua per plant, seeds per siliqua, thousand-seed weight, and grain yield (kg/ha). Disease severity was scored using a 0–5 scale (Conn et al 1990).

Rating scale	Description of scale	Category of host reaction
0	No visible symptom	HR
1	1-10% leaf or pod covered with small pin head spots	R
2	11-25% leaf or pod area covered with small spots on leaf and superficial pinhead spots on pods	MR
3	26-50% leaf or pod area covered with bigger spots with initiation of coalescence on leaves and deep lesions on pods	MS
4	51-75% leaf or pod area covered with bigger commonly coalescing spots on leaves and deep lesions on pods	S
5	76-100% leaf or pod area covered giving blighting appearance	HS

Percent disease index (PDI) was calculated following Wheeler (1969) as:

$$\text{PDI}\ (\%) = \frac{\Sigma\,(n \times v)}{N \times V} \times 100 \quad \ldots\ldots\ldots\ldots (\text{Eq.1})$$

where n = number of plants in each disease category, v = numerical grade, N = total plants assessed, and V = maximum disease grade. All data were analyzed using ANOVA in Genstat Discovery 18th edition, and treatment means were compared using LSD at 5% probability. Data from each year were analyzed separately to assess annual variation in disease severity and yield response.

RESULTS AND DISCUSSION

Fungicidal effect on crop performance in 2023

Statistically significant differences ($p < 0.05$) were observed among treatments for plant height, siliqua per plant, seeds per siliqua, percent disease index (PDI), grain yield, and thousand-seed weight (TSW) (Table 1). Fenamidone @ 1 g/L (Reason 50% SC) consistently recorded the lowest disease severity (PDI 27.98%) and the highest grain yield (1213.33 kg/ha), followed by Tebuconazole @ 1 g/L (Folicur 25% EC) with PDI 32.45% and grain yield 1080 kg/ha. The untreated control exhibited the highest disease severity (PDI 68.95%) and the lowest grain yield (893.33 kg/ha). Mancozeb, Azoxystrobin, Trifloxystrobin, and Chlorothalonil showed intermediate disease suppression and yield benefits.

Table 1. Evaluation of fungicides against Alternaria blight disease of rapeseed at ORP during 2023.

Treatments	PHT (cm)	SIL /P	S /SIL	PDI %	GY (kg/ha)	TSW (g)
Mancozeb75%WP (2.5 g/L of water)	76.00	26.80	11.07	48.92	1040.00	3.86
Azooxystrobin @ 1g/L of water (Amistar (23%EC)	72.00	31.60	11.13	42.18	1040.00	4.03
Tebuconazole @ 1g/L of water (Folicur (25% EC)	70.80	35.80	12.87	32.45	1080.00	3.87
Fenamidone @1 g/L of water (Reason 50%SC)	69.27	42.80	11.53	27.98	1213.33	4.01
Trifloxystrobin @ 0.5 g/L of water (Flint (50% WG)	72.40	35.53	10.80	54.08	960.00	3.75
Chlorothalonil @ 3 gL of water (Bravo (50%SC)	69.73	33.13	10.80	32.72	1080.00	3.44
Control (water Spray)	66.47	37.00	10.80	68.95	893.33	3.72
Grand mean	70.95	34.67	11.29	43.90	1043.81	3.81
Min	66.47	26.80	10.80	27.98	893.33	3.44
Max	76.00	42.80	12.87	68.95	1213.33	4.03
P-value	0.019	<.001	<.001	<.001	0.001	0.022
LSD (0.05)	4.56	3.38	0.39	2.63	110.50	0.32
CV,%	3.60	5.50	2.00	3.40	6.00	4.70

PHT (cm)- Plant height in centimeter, SIL /PL- Siliqua per plant, S /SIL- Seed per siliqua, GY- Grain yield, kg/ha- kilogram per hectare, PDI- percent disease index, DI- disease intensity, TSW-thousand seed weight, g- gram, WP- wettable powder, EC- emulsifiable concentrate, L- litre, ml- milliliter, LSD-Least significant difference, CV- Coefficient of variation

These results indicate that systemic and newer-generation fungicides, particularly strobilurins and triazoles, effectively reduced Alternaria blight severity and maintained foliage health, resulting in higher productivity. The performance of Fenamidone aligns with its known broad-spectrum activity against *Alternaria* spp., confirming its suitability for integrated disease management in rapeseed.

Fungicidal effect on crop performance in 2024

In 2024, significant differences were observed for plant height, PDI, and grain yield ($p < 0.05$), while siliqua per plant and seeds per siliqua showed no significant variation (Table 2). Fenamidone @ 1 g/L again showed the lowest PDI (29.50%) and high grain yield (1178.00 kg/ha), followed closely by Tebuconazole @ 1 g/L (PDI 30.42%, yield 1133.00 kg/ha). The control plot recorded the highest disease severity (PDI 46.47%) and the lowest yield (850.00 kg/ha). Other fungicides, including Azoxystrobin, Mancozeb, and Trifloxystrobin, provided moderate disease suppression.

Table 2. Evaluation of fungicides against Alternaria blight disease of rapeseed at ORP during 2024.

Treatments	PHT (cm)	SIL /P	S /SIL	PDI %	GY (kg/ha)	TSW (g)
Mancozeb75%WP (2.5 g/L of water)	72.13	24.43	9.33	45.67	988.00	3.23
Azooxystrobin @ 1gL of water (Amistar (23%EC)	57.13	29.20	8.67	40.37	1100.00	3.21
Tebuconazole @ 1g/L of water (Folicur (25% EC)	68.53	33.53	10.50	30.42	1133.00	3.67
Chlorothalonil @ 3 g/Lof water (Bravo (50%SC)	64.27	39.73	9.30	29.50	1178.00	3.69
Trifloxystrobin @ 0.5 g/L of water (Flint (50% WG)	68.47	32.30	8.33	44.45	928.00	3.41
Fenamidone @1 g/L of water (Reason 50%SC)	64.27	50.47	8.50	33.65	1128.00	3.45
Control (water Spray)	61.73	34.67	8.43	46.47	850.00	3.15
Grand Mean	65.22	34.90	9.01	38.65	1013.86	3.54
Min	57.13	24.43	8.33	29.50	850.00	3.15
Max	72.13	50.47	10.50	46.47	1178.00	3.69
P-Value	<0.001	0.35	0.04	<0.001	0.005	0.006
LSD(0.05)	2.05	23.00	1.38	1.58	197.50	0.85
CV,%	1.80	37.00	8.30	2.30	10.90	30.80

PHT (cm)- Plant height in centimeter, SIL /P- Siliqua per plant, S /SIL- Seed per siliqua, GY- Grain yield, kg/ha- kilogram per hectare, PDI- percent disease index, DI- disease intensity, TSW-thousand seed weight, g- gram, WP-wettable powder, EC- emulsifiable concentrate, L- litre, ml- milliliter, LSD-Least significant difference, CV- Coefficient of variation

These results demonstrate consistent performance of Fenamidone and Tebuconazole across years, confirming their reliability for Alternaria blight management under field conditions. Reduced disease intensity in treated plots contributed to maintenance of leaf area, better pod filling, and ultimately higher yield, highlighting the importance of timely foliar application of effective fungicides.

The present findings are consistent with earlier reports highlighting the effectiveness of both systemic and combination fungicides against Alternaria blight. Chakrabarty et al (2025) reported that a ready-mix formulation of tebuconazole (50%) + trifloxystrobin (25%) WG achieved the highest reduction in disease severity on leaves (54.1%) and pods (55.7%), resulting in maximum seed yield (1187 kg/ha) with a 78.5% yield advantage over the untreated check. Earlier studies by Ansari et al (1990) demonstrated that foliar application of Dithane M-45 (0.2%) followed by Dithane Z-78 effectively controlled *Alternaria brassicae* in rapeseed and significantly increased yield. Rakesh et al (2018) observed that propiconazole (0.05%) sprayed at 60 DAS reduced disease severity by

62.8% on leaves and 35.4% on pods, while metalaxyl (4%) + mancozeb (64%) at 0.5 g /L provided moderate control (38.2%) on leaves. The superior efficacy of mancozeb against Alternaria blight has also been confirmed by Jha et al (2013) and Meena et al (2014). Supporting evidence from vegetable crops showed that tebuconazole, trifloxystrobin + tebuconazole, and propiconazole significantly reduced Alternaria leaf spot severity in cabbage compared to other fungicides (Tu et al 2015). Similarly, Rahman et al (2020) reported that double spraying of Contaf 5 EC (0.1%) at 45 and 55 DAS effectively minimized Alternaria leaf blight and improved yield attributes of mustard variety BARI Sharisha-14 under field conditions.

Both Fenamidone and Tebuconazole act against *Alternaria brassicae* and *A. brassicicola*, which are necrotrophic ascomycete pathogens. By targeting key physiological processes (sterol biosynthesis for tebuconazole and respiration for fenamidone), these fungicides reduce pathogen establishment, lesion expansion, and sporulation under conducive conditions (Haq et al 2020). Although much of the published literature focuses on triazoles and strobilurins or their combinations in *Alternaria* management, several studies report that systemic fungicides, especially tebuconazole alone or in combination with strobilurins, significantly inhibit *Alternaria* growth and symptom development in crucifers (Biswas and Ghosh 2018). For example, in vitro studies show that triazoles such as tebuconazole provide high mycelial growth suppression against *A. brassicae*, outperforming many contact fungicides (Gupta et al 2025). In field studies of related crop systems, fungicide applications that include systemic and QoI chemistries (e.g., tebuconazole mixed with strobilurins) have shown considerable reductions in disease severity and positive yield responses compared to untreated controls, supporting the practical effectiveness of these groups in *Alternaria* disease management.

CONCLUSION

The result of this study demonstrates that foliar application of systemic and new-generation fungicides significantly reduces Alternaria blight severity and improves yield in rapeseed under field conditions. Among the evaluated treatments, Fenamidone (Reason 50% SC) and Tebuconazole (Folicur 25% EC) consistently provided the lowest disease severity and highest grain yield across both years, indicating their strong efficacy against *Alternaria brassicae* and *A. brassicicola*. The reduction in percent disease index in treated plots contributed to improved plant growth, siliqua formation, and seed filling. Regular monitoring, timely application, and rotation with fungicides of different modes of action are recommended to maintain effectiveness and reduce the risk of resistance development.

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AUTHORS' CONTRIBUTION

Subash Subedi: Writing - original draft, Writing - review and editing, Conceptualization, Methodology development, Formal analysis, Data curation, and Visualization
Santosh K. Sah: Conduction of experiment, Data collection
Saraswati Neupane: Writing - review and editing, Validation
Jiban Shrestha: Writing - review and editing

CONFLICTS OF INTERESTS

The author (s) declare that they don't have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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