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Evaluation of Fungicides and Botanicals for the Management of Alternaria Leaf Blight in Fenugreek (*Trigonella foenum-graecum* L.)

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Abstract

Alternaria leaf blight, caused by *Alternaria alternata*, is an emerging foliar disease of fenugreek (*Trigonella foenum-graecum* L.) in major cultivation regions, including Rajasthan, India. Field experiments were conducted to assess the influence of sowing dates and to evaluate the bioefficacy of selected fungicides and plant extracts. Sowing date had minimal effect on disease severity; however, earlier sowing contributed to higher yields. Among the fungicides tested, propiconazole and difenoconazole were the most effective in suppressing the disease, while neem oil and garlic extract were the most effective among the botanicals.

Keywords: *Alternaria* leaf blight, biocontrol, disease management, fenugreek, fungicides, *Trigonella foenum-graecum*

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an important leguminous crop widely cultivated in India as a spice, leafy vegetable, and medicinal purpose (Malhotra and Vashishtha, 2008; Singh *et al.*, 2007). Rajasthan is one of the major fenugreek-growing areas in the country, contributing significantly to national production. However, fenugreek cultivation is threatened by several biotic stresses, among which foliar diseases are prominent in reducing both yield and quality (Sharma *et al.*, 2010; Khare *et al.*, 2014; Sharma *et al.*, 2024). Among these, *Alternaria* leaf blight, caused by *Alternaria alternata*, has emerged as a serious concern (Sharma *et al.*, 2019; Solanki *et al.*, 2022). This fungal disease is characterized by distinct symptoms: it begins with small necrotic spots that evolve into larger lesions featuring concentric rings and a surrounding light yellow zone. As the disease progresses, these lesions coalesce, leading to the blighting of the apical portions of leaflets. In severe stages, the affected leaves curl inward, become brittle, and eventually wither and die, resulting in substantial defoliation and crippling losses in crop productivity (Solanki *et al.*, 2022). Systematic studies on the management of

Alternaria leaf blight in fenugreek are limited. The growing concern over fungicide resistance and environmental safety also necessitates exploring eco-friendly alternatives, such as plant-based extracts and resistant cultivars. This study was therefore undertaken to evaluate disease management strategies, including the effects of sowing dates, chemical fungicides, and botanical control options, to develop effective and sustainable management approaches for this economically important disease.

Materials and Methods

To study the effect of sowing dates, fenugreek (var. AFg-3) was sown on three dates: third week of October (early), first week of November (normal), and third week of November (late) in a Randomized Block Design (RBD) with three replications over two seasons. Per cent Disease Index (PDI) was recorded at different growth stages, and seed yield was recorded at harvest. Eight fungicides (five systemic: propiconazole, difenoconazole, azoxystrobin, picoxystrobin, hexaconazole; and three contact: chlorothalonil, copper oxychloride, mancozeb) and selected plant extracts i.e. Garlic extract (5%, 10%), Neem Seed

Kernel Extract (5%, 10%), Neem oil (2%), and *Trichoderma asperellum* (2%, 5%) were evaluated under field conditions using RBD with three replications over two seasons. Sprays were applied at the initiation of symptoms and repeated at 15-day intervals. Disease was recorded 15 days after the final spray, and seed yield was recorded at harvest.

All collected data from field experiments were subjected to appropriate statistical analysis.

Results and Discussion

Effect of Sowing Date

Fenugreek sown on three different dates, i.e. 3rd week of October, 1st week of November, and 3rd week of November, showed minimal variation in disease severity. The Per cent Disease Index (PDI) ranged from 39.0 to 40.2, indicating that sowing date had no significant effect on disease incidence (Fig. 1). However, yield was notably lower in the late-sown crop (3rd week of November) as compared to the 1st week of November. These results suggest that while disease pressure from *A. alternata* remains relatively constant across sowing dates, yield optimization favours sowing in the 1st week of November.

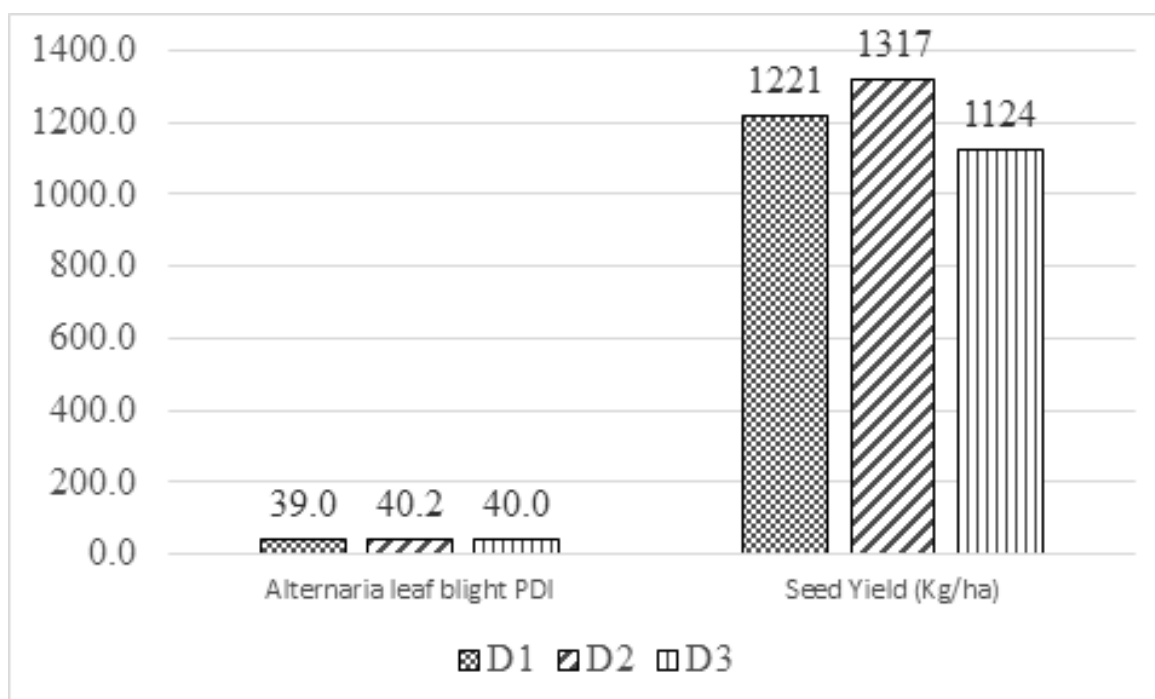


Fig. 1. Effect of sowing time on leaf blight (PDI) and seed yield of fenugreek

Bioefficacy of Fungicides

In vitro screening of eight fungicides showed significant inhibition of *A. alternata* growth. Field trials confirmed that all eight tested fungicides significantly reduced disease severity compared to the untreated control (48.4% PDI). Propiconazole (29.2% PDI) and difenoconazole (30.0% PDI) were the most effective in reducing blight incidence, while the highest seed yields were recorded with azoxystrobin and picoxystrobin treatments (Table 1). Systemic fungicides exhibited superior performance, likely due to their curative and protective modes of action. The efficacy of propiconazole and difenoconazole against *A. alternata* is in agreement with previous findings in cumin and other crops (Sharma *et al.*, 2013; Patel *et al.*, 2017). Nevertheless, the risk of resistance development highlights the importance of rotating fungicides and integrating them with non-chemical options.

Bioefficacy of Plant Extracts

Plant extracts, including garlic extract, neem oil, and *Trichoderma asperellum*, showed significant antifungal activity both *in vitro* and under field conditions. Among botanical treatments, neem oil and garlic extract consistently reduced disease severity and enhanced yield compared to the untreated control (Table 2). The antifungal efficacy of neem oil and garlic is attributed to the presence of bioactive compounds such as azadirachtin, allicin, and sulfur-containing metabolites,

which interfere with fungal cell walls and metabolism (Jamiolkowska, 2020; Ann Rose *et al.*, 2023). While their efficacy was slightly lower than that of synthetic fungicides, they offer an environmentally friendly alternative for integrated disease management and organic farming systems.

Conclusion

This study conclusively revealed that sowing date was not a significant factor in disease severity, however, planting in the first week of November optimized yield. Effective disease management options include chemical control using Propiconazole and Difenoconazole, which significantly reduced the disease index. Furthermore, the strong antifungal activity of Neem oil and Garlic extract provides viable, environmentally friendly alternatives for integrated management.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Table 1. Effect of different fungicides on leaf blight of fenugreek

Treatments	Leaf blight PDI	Seed Yield (Kg/ha)
Propiconazole	29.2 d	1790 a
Difenaconazole	30.0 cd	1794 a
Azoxystrobin	31.7 bcd	1875 a
Picoxystrobin	32.5 bcd	1931 a
Haxaconazole	34.6 b	1813 a
Chlorothalonil	32.1 bcd	1760 a
Copper oxychloride	38.8 a	1851 a
Mancozeb	33.3 bc	1819 a
Control	48.40	1148 b

Different letters indicate significant differences by Fisher's LSD at $P \leq 0.05$.

Table 2. Effect of organic treatments on leaf blight of fenugreek

Treatments	Leaf blight PDI	Seed Yield (Kg/ha)
Neem oil 2%	28.0 ^c	1786 ^{abc}
Garlic extract 5%	29.2 ^c	1774 ^{abc}
Garlic extract 10%	27.9 ^c	1883 ^{ab}
<i>Trichoderma asperillum</i> 2%	33.5 ^{bc}	1626 ^c
<i>Trichoderma asperillum</i> 5%	31.7 ^{bc}	1905 ^{ab}
NSKE 5%	37.8 ^{ab}	1723 ^{bc}
NSKE 10%	36.0 ^b	1940 ^a
Control	43.9 ^a	1415 ^d

Different letters indicate significant differences by Fisher's LSD at $P \leq 0.05$.

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