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Field Evaluation of organic amendments for the eco - friendly management of cumin (*Cuminum Cyminum* L.) wilt caused by *Fusarium oxysporum* f. sp. *Cumini*

B. K. Prajapti^{1*} and N. R. Patel²

Abstract

A two-year field experiment (Rabi 2022–23 and 2023–24) was performed to assess the impact of organic amendments on cumin wilt caused by *Fusarium oxysporum* f. sp. *cumini*, using variety GC-4 under open-field conditions. Treatments included farmyard manure, castor cake, poultry manure, and neem cake (each @ 2 t/ha), with an untreated control, arranged in a randomized block design. Wilt incidence was monitored at 30, 45 and 60 days after sowing, along with seed yield, volatile oil content, 1000-seed weight and AUDPC. Neem cake recorded the lowest pooled wilt incidence (13.54%) and AUDPC, followed by poultry manure (16.15%) and significantly improved seed yield over control. No notable differences were observed in volatile oil content or seed weight among treatments. The results suggest that neem cake and poultry manure are effective, eco-friendly options for managing cumin wilt and improving yield sustainably.

Keywords: Cumin, *Fusarium* wilt, organic amendments, neem cake, poultry manure

Introduction

Cumin (*Cuminum cyminum* L.) is a commercially important spice crop of the Apiaceae family, widely valued for its culinary, aromatic, and medicinal properties. Cultivated predominantly during the Rabi season, it thrives in dry and cool climates, making the arid and semi-arid regions of Gujarat and Rajasthan ideal for its production (Didwania, 2019). Gujarat recorded the highest production of 518 MT from 5.30 lakh hectares during 2023–24, while Rajasthan leads in cultivated area (Anonymous, 2024a). Cumin productivity is frequently constrained by biotic stresses, particularly diseases and insect pests. Among them, *Fusarium* wilt-caused by *Fusarium oxysporum* f. sp. *cumini* is the most devastating, with the potential to cause yield losses of up to 80 per cent (Dar *et al.*, 2019). The disease is favoured by specific soil and environmental conditions and is widespread in major

cumin-growing regions. Over time, the emergence of new pathogenic races has compromised the durability of wilt-resistant cultivars, reducing their effectiveness. Chemical fungicides, though widely used, pose environmental and economic challenges, including soil and water contamination, resistance development and higher input costs. Hence, there is growing interest in sustainable, eco-friendly management strategies. Organic soil amendments have shown promise in improving soil health and suppressing soil-borne pathogens by enhancing microbial activity and nutrient availability. Given these considerations, the present study was undertaken to evaluate the impact of different organic amendments on cumin wilt incidence, with the aim of identifying sustainable alternatives to chemical control measures.

Material and Methods

A two-year field study was undertaken during the *Rabi* seasons of 2022-23 and 2023-24 to evaluate the impact of various organic manures on the incidence of cumin wilt, caused by *Fusarium oxysporum* f. sp. *cumini*. The experiment was conducted using the cultivar Gujarat Cumin 4 (GC 4) under open field conditions. Four types of organic amendments- farmyard manure, castor cake, poultry manure and neem cake- were incorporated into the soil at the rate of 2 t/ha prior to sowing. An untreated control was maintained for comparison.

The trial was arranged in a Randomized Block Design (RBD) with five treatments and four replications. Each gross plot measured 3.0 m × 4.0 m, with a net plot size of 2.4 m × 3.0 m, and an inter-row spacing of 30 cm was maintained throughout. This experimental layout enabled uniform application of treatments and effective assessment of disease incidence under field conditions. The study aimed to assess the efficacy of these organic inputs in reducing wilt incidence while promoting sustainable disease management in cumin cultivation.

Observations recorded:

Per cent disease incidence assessed at 30, 45, and 60 days after sowing from three randomly selected spots (1 m row length each) per plot

Area Under Disease Progress Curve (AUDPC) for wilt incidence

Seed yield (q/ha)

Volatile oil content (%)

1000-seed weight (g)

For volatile oil (%) analysis of cumin seeds, steam distillation method was used as described by Guenther (1972) and followed by Singh *et al.* (2006).

The Area Under Disease Progress Curve (AUDPC) was calculated to evaluate the effect of various treatments against cumin wilt disease incidence as per below mentioned method suggested by Shaner and Finney (1977):

$$AUDPC = \sum_{i=1}^{n-1} [2(Y_i + Y_{i+1}) \times (T_{i+1} - T_i)]$$

Where:

Y_i = Disease incidence (%) at the i^{th} observation

Y_{i+1} = Disease incidence (%) at the $(i+1)^{th}$ observation

T_i = Time (days after sowing) at the i^{th} observation

T_{i+1} = Time at the $(i+1)^{th}$ observation

n = Number of observations

Results and Discussion

Year 2022-23

The effect of different organic amendments on cumin wilt disease incidence was evaluated through soil application of farm yard manure (FYM), castor cake, poultry manure, neem cake and control (without amendment) before sowing during the year 2022-23.

At 30 days after sowing (DAS), the minimum disease incidence (6.93% PDI) was recorded with neem cake treatment, which was statistically at par with poultry manure (8.08% PDI), while the highest disease incidence was observed in the control treatment (26.95% PDI).

At 45 DAS, a slightly different trend was observed, with neem cake again showed the lowest disease incidence (11.24% PDI), followed by poultry manure (14.26% PDI), both significantly lower compared to the control (35.35% PDI).

At 60 DAS, the same pattern was evident, where neem cake recorded the lowest disease incidence (17.56% PDI) and it was at par with poultry manure (21.77% PDI), and both treatments showed significant reductions compared to the control (44.71% PDI).

Among the treatments, neem cake recorded the highest reduction in per cent disease incidence over control (60.72%) at 60 DAS, followed by poultry manure (51.31%).

Year 2023-24

The results for the year 2023-24 indicated that among the different organic amendments applied as soil treatments before sowing, neem cake proved to be the most effective in reducing cumin wilt incidence. At 30 days after sowing (DAS), the lowest disease incidence of 8.90 per cent was recorded with neem cake, which was statistically at par with poultry manure (10.18%), and both were significantly lower than the control (31.23%).

At 45 DAS, a similar trend was observed where neem cake treatment recorded 14.52 per cent PDI, which was at par with poultry manure (17.56%), in contrast to 38.51 per cent PDI in the control.

At 60 DAS, neem cake continued to show the lowest wilt incidence (20.75%), at par with poultry manure (23.88%) and both treatments were superior to the control (53.97%).

The highest reduction over control in per cent disease incidence was observed with neem cake (61.55%), followed by poultry manure (55.75%) and castor cake (38.30%).

Pooled results

Pooled analysis over both years (2022-23 and 2023-24) confirmed that neem cake (13.54% PDI) was the most effective amendment, followed by poultry manure (16.15%), both significantly reduced cumin wilt incidence compared to the control (38.51%).

The superior effectiveness of neem cake and poultry manure in reducing *Fusarium* wilt incidence in cumin may be attributed to their antifungal properties and soil health-enhancing effects. Neem cake contains bioactive compounds like azadirachtin and nimbin, which directly inhibit the growth of *Fusarium oxysporum* and suppress its multiplication in the soil. Additionally, neem cake improves soil microbial activities and organic matter, creating an unfavorable environment for pathogen survival.

Similarly, poultry manure enriches the soil with essential nutrients and organic matter, promoting the growth of beneficial microbes that compete with or antagonize soil-borne pathogens. The release of ammonia and other compounds during its

decomposition also contributes to pathogen suppression. The combined effect of improved soil health, enhanced microbial diversity, and direct antifungal action results in significant reduction of wilt incidence, as observed in the present study.

AUDPC study of different organic amendments on cumin wilt disease (2022-23)

The area under the disease progress curve (AUDPC) analysis revealed significant differences in cumin wilt disease incidence among different organic amendments. The lowest average AUDPC value of 359.36 was recorded in the treatment with neem cake, indicating its superior efficacy in reducing disease progression. This was followed by the treatment with poultry manure, which recorded an average AUDPC of 445.29. In contrast, the highest AUDPC value of 1070.33 was observed in the control, demonstrating the severe disease incidence in the absence of organic amendments.

AUDPC study of organic amendments on cumin wilt disease (2023-24)

The area under the disease progress curve (AUDPC) analysis revealed significant differences among the treatments in managing cumin wilt disease. The lowest average AUDPC value of 445.33 was recorded in the neem cake treatment, indicating its highest efficacy in disease suppression. This was followed by poultry manure, which recorded an AUDPC value of 523.41, demonstrating a considerable reduction in disease progression. In contrast, the control treatment exhibited the highest AUDPC value of 1217.19, highlighting the severity of disease incidence in the absence of organic amendments.

Effect of different treatments on volatile oil of cumin seeds

Among different organic amendments tested under field conditions, there was no significant difference among the treatments for volatile oil content in both the years. During both the years the volatile oil content ranged from 4.38 to 4.54 per cent.

This could be attributed to the genetic potential of the cumin variety GC-4, which is known for its stable volatile oil content. Additionally, uniform and healthy seeds were selected for the study from all treatments, it did not show any significant variation in volatile oil percentage.

Effect of different treatments on 1000 seed weight of cumin seeds

Among different organic amendments tested under field conditions, there was no significant difference among the treatments for 1000 seed weight in both the years. During both the years the 1000 seed weight ranged from 4.21 to 4.38 grams. This might be due to the fact that healthy and well-developed seeds were selected from all the treatments for recording observations, ensuring uniformity in seed quality across treatments.

Effect of different treatments on yield of cumin seeds

Among different organic amendments tested under field conditions during 2022-23, neem cake recorded the highest seed yield of 6.00 q/ha, which was at par with poultry manure (5.72 q/ha), as compared to control (2.92 q/ha).

In 2023-24, the same trend was observed with neem cake (5.78 q/ha) and poultry manure (5.40 q/ha), both showing superiority over control (2.67 q/ha).

Pooled over year data also showed a similar trend, where neem cake recorded the highest seed yield (5.89 q/ha), followed by poultry manure (5.56 q/ha), and the lowest yield was observed in control (2.79 q/ha).

This increase in yield with neem cake and poultry manure might be due to their ability to suppress soil-borne pathogens like *Fusarium oxysporum* f. sp. *cumini*, improve soil health, enhance nutrient availability, and promote overall plant vigour, ultimately leading to better seed formation and higher yield.

The effectiveness of neem cake in suppressing *Fusarium* wilt corroborates the findings of Choudhary *et al.* (2017), who reported maximum inhibition of *Fusarium oxysporum* f. sp. *cumini* through neem cake application due to its antifungal properties and growth-inhibitory compounds like azadirachtin. Similarly, Jat *et al.* (2017) and Patra *et al.* (2017) also demonstrated the efficacy of neem cake in reducing wilt disease incidence in coriander and chickpea, respectively, supporting its broad-spectrum antifungal effect in soil-borne disease management.

The efficacy of poultry manure observed in the present study can be attributed to its ability to enhance soil fertility, improve microbial activity, and produce ammonia and organic acids during decomposition, which suppress pathogenic propagules. Benjumea *et*

al. (2015) and Ureba *et al.* (2016) also reported reduced wilt severity and zero plant mortality with poultry manure application in asparagus and carnation crops, respectively. The current results align with these observations, indicating that poultry manure not only improves plant vigor but also creates an antagonistic soil environment unfavorable for *Fusarium* spp.

Moreover, the consistent performance of neem cake and poultry manure in lowering wilt incidence over both years suggests their potential role in sustainable disease management. This could be due to the combined effects of direct pathogen suppression and promotion of beneficial soil microflora, as also supported by the studies of Israel *et al.* (2005) and Lodha and Israel (2005), who documented significant reduction in pathogen populations with organic amendments. Overall, the findings confirm that integration of organic amendments like neem cake and poultry manure can play a vital role in eco-friendly and long-term management of cumin wilt disease under field conditions.

These results are in corroboration with the findings of Choudhary *et al.* (2017), who reported that neem cake offered maximum disease control (44.70%) against *Fusarium oxysporum* f. sp. *cumini*, resulting in healthier plants and better yield performance. Similarly, Jat *et al.* (2017) found that neem cake (5 q/ha) application led to minimum wilt incidence (21.45%) in coriander and higher yields.

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The present findings are in agreement with those of Jadon *et al.* (2025), who reported that organic amendments, particularly oilcakes and crop residues, significantly reduced cumin wilt by stimulating antagonistic soil microflora and improving soil physicochemical properties. The superior performance of neem cake observed in the present study may similarly be attributed to enhanced microbial activity and the creation of an unfavourable environment for

Fusarium oxysporum f. sp. *cumini*.

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Conflict of Interest

The authors declare that there is no conflict of interest associated with this publication.

Author Contributions

B. K. Prajapati: Conceptualization, methodology, investigation, data curation, formal analysis, writing an original draft.

N. R. Patel: Conceptualization, methodology, supervision, data curation, writing -review and editing.

Both authors have read and approved the final version of the manuscript.

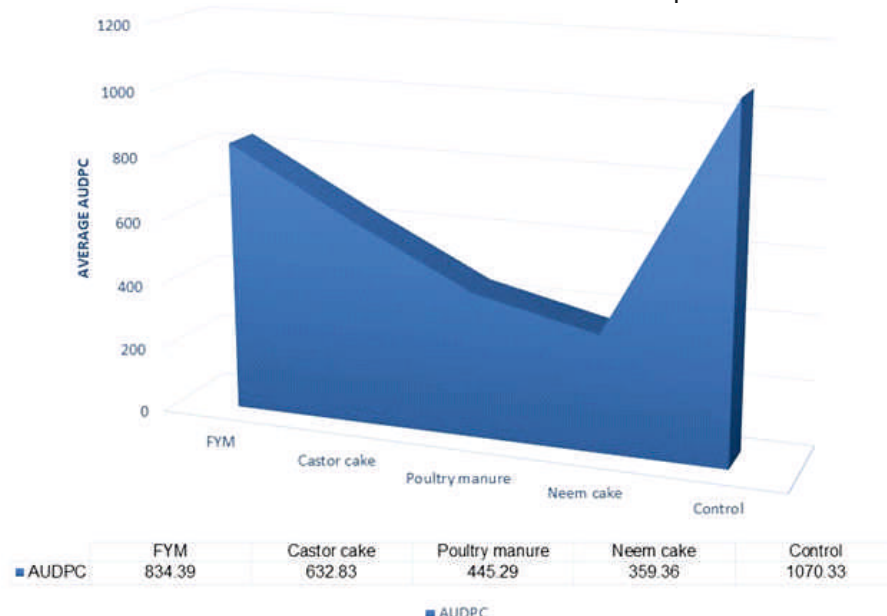


Fig 1: Area Under Disease Progress Curve (AUDPC) of different organic amendments on cumin wilt disease (2022-23)

Table 1. Effect of the different organic amendments on cumin wilt disease incidence and yield

Tr. No.	Treatment details	Per cent disease incidence (2022-23)				Per cent disease incidence (2023-24)				Pooled over year	Seed yield (q/ha)	
		30 DAS	45 DAS	60 DAS	ROC (%)	30 DAS	45 DAS	60 DAS	ROC (%)		2022-23	2023-24
1	FYM	26.18 ^b (19.48)	31.98 ^b (28.06)	36.47 ^b (35.35)	20.93	29.24 ^b (23.88)	35.87 ^a (34.36)	38.95 ^b (39.55)	26.72	33.11 ^b (30.18)	4.43 ^b	4.09 ^b
2	Castor cake	23.16 ^c (15.48)	27.04 ^c (20.68)	31.26 ^c (26.95)	39.72	25.62 ^c (18.71)	30.62 ^b (25.96)	35.23 ^c (33.30)	38.30	28.82 ^c (23.61)	4.54 ^b	4.27 ^b
3	Poultry manure	16.50 ^d (8.08)	22.17 ^{cd} (14.26)	27.80 ^d (21.77)	51.31	18.60 ^d (10.18)	24.77 ^c (17.56)	29.24 ^d (23.88)	55.75	23.18 ^d (16.15)	5.72 ^a	5.40 ^a
4	Neem cake	15.25 ^d (6.93)	19.58 ^d (11.24)	24.77 ^d (17.56)	60.72	17.35 ^d (8.90)	22.39 ^c (14.52)	27.09 ^d (20.75)	61.55	21.07 ^e (13.54)	6.00 ^a	5.78 ^a
5	Control	31.26 ^a (26.95)	36.47 ^a (35.35)	41.95 ^a (44.71)	-	33.96 ^a (31.23)	38.34 ^a (38.51)	47.26 ^a (53.97)	-	38.20 ^a (38.51)	2.92 ^c	2.67 ^c
	SEm _T	0.85	0.97	1.48	-	1.09	0.96	1.06	-	0.66	0.20	0.19
	P	-	-	-	-	-	-	-	-	0.51	-	-
	Y	-	-	-	-	-	-	-	-	0.42	-	-
	T x P	-	-	-	-	-	-	-	-	1.14	-	-
	T X Y	-	-	-	-	-	-	-	-	0.93	-	-
	P X Y	-	-	-	-	-	-	-	-	0.72	-	-
	T X P X Y	-	-	-	-	-	-	-	-	1.62	-	-
	CD at 5% _T	2.61	2.99	4.56	-	3.35	2.95	3.26	-	1.85	0.63	0.60
	T X Y	-	-	-	-	-	-	-	-	NS	-	-
	C.V. (%)	7.54	7.08	9.12	-	8.73	6.30	5.95	-	11.18	8.61	8.76

Note

- Figures outside the parentheses are arc sine transformed values and those inside the parentheses are retransformed values
- Treatment means followed by the same letter(s) are not significantly different by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance

Table 2. Effect of different organic amendments on 1000 seed weight (g) and volatile oil (%) in relation to wilt disease

Treat. No.	Treatment details	1000 seed weight (g)		Volatile oil (%)	
		2022 -23	2023 -24	2022 -23	2023 -24
1	FYM	4.28	4.38	4.46	4.38
2	Castor cake	4.29	4.29	4.51	4.46
3	Poultry manure	4.33	4.26	4.47	4.47
4	Neem cake	4.24	4.29	4.52	4.51
5	Control	4.26	4.21	4.45	4.46
SEm.	T	0.08	0.08	0.09	0.07
	Y	-	-	-	-
	Y x T	-	-	-	-
CD at 5%		NS	NS	NS	NS
C.V. (%)		3.93	3.71	4.02	3.17

Note: Treatment means followed by the same letter(s) are not significantly different by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance

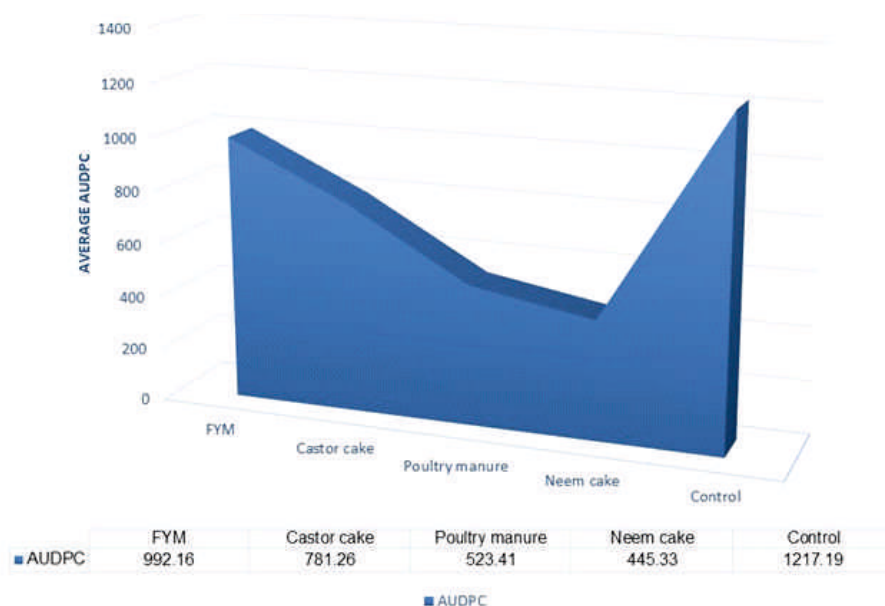


Fig 2: Area Under Disease Progress Curve (AUDPC) of different organic amendments on cumin wilt disease (2023-24)

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