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## Field screening of cumin germplasms against wilt incited by *Fusarium oxysporum* f. sp. *cumini*

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### Abstract

A field investigation was undertaken over two consecutive Rabi seasons (2022–23 and 2023–24) to evaluate fifty cumin (*Cuminum cyminum* L.) germplasm lines, including varieties and advanced breeding entries, for their response to *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *cumini*. The trials were conducted under natural wilt epiphytotic conditions at the Seed Spices Research Station, SDAU, Jagudan (Gujarat), in a randomized block design with two replications. Disease incidence was assessed at 30, 45 and 60 days after sowing from three randomly selected 1 m row sections per plot. Based on pooled data from both years, 47 out of 50 entries were found to be highly susceptible, exhibiting more than 30 per cent wilt incidence. However, three entries CUM 49, JC 20-07 and GP 7 consistently recorded lower disease incidence (ranging between 26.70% and 31.10%), classifying them as susceptible but relatively more tolerant compared to the rest. In contrast, entries such as Hairy Cumin, White Flower Cumin, JC 18-09, JC 18-10 and JC 18-11 showed complete susceptibility with cent per cent disease incidence across both years.

**Keywords:** Cumin, germplasm, screening, *Fusarium* wilt

### Introduction

Cumin (*Cuminum cyminum* L.) is a commercially important spice crop of the Apiaceae family, widely valued for its culinary, aromatic and medicinal properties. In the Indian systems of medicine, cumin finds a vital role through its essential and total oil components and various aqueous and alcoholic extracts (Meena *et al.*, 2022). Cumin seeds have an aromatic fragrance due to cuminol. Cumin is produced in India, Iran, Lebanon, Cypress, Egypt, Syria, China, Indonesia, Mexico and Iran (Meena *et al.*, 2018). 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, 2024). 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 may get compromised the durability of wilt-resistant cultivars, reducing their effectiveness. Given these considerations, the present study was undertaken to evaluate various germplasm/entries of cumin against *Fusarium* wilt incidence, with the aim of identifying sustainable alternatives.

## Materials and Methods

A total of fifty cumin (*Cuminum cyminum* L.) germplasm lines, including varieties and advanced entries, were obtained from the Seed Spices Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan (Dist. Mehsana) Gujarat for evaluation of their reaction to wilt disease caused by *Fusarium oxysporum* f. sp. *cumini*. The field investigation was conducted during the Rabi seasons of 2022-23 and 2023-24 at a wilt-infested field (inoculum load:  $10^8$  cfu/g soil) located at the Seed Spices Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan (Dist. Mehsana) Gujarat. The experiment was laid out in a Randomized Block Design (RBD) with two replications. Each treatment was accommodated in a gross plot of 3.0 m × 4.0 m and a net plot of 2.4 m × 3.0 m, maintaining an inter-row spacing of 30 cm. Disease incidence data were recorded at 30, 45 and 60 days after sowing from three randomly selected spots per plot, each comprising 1 m row length, to assess the relative resistance of the germplasm to wilt under natural epiphytotic conditions.

The screened germplasm/varieties/entries of cumin were categorized according to their reaction against the disease as per criterion (Choudhary *et al.* 2016): The categorization of cumin germplasm based on per cent disease incidence was as follows: entries showing 0 or less than 1 per cent incidence were classified as immune; those with 1-10 per cent incidence were considered resistant; moderately resistant entries exhibited 11-20 per cent incidence; susceptible entries

showed 21-30 per cent incidence; while those with more than 30 per cent disease incidence were categorized as highly susceptible.

## Results and discussion

### Per cent disease incidence

#### Year 2022-23

A field experiment was conducted during the year 2022-23 to evaluate the resistance or susceptibility of 50 cumin germplasms/entries/varieties against wilt disease caused by *Fusarium oxysporum* f. sp. *cumini* in wilt sick plot under natural field conditions. The per cent disease incidence was recorded at harvest to categorize the entries based on their response to the disease.

The results revealed that out of the 50 entries screened, only three entries exhibited relatively lower wilt incidence, falling into the susceptible category, with disease incidence less than 30 per cent. These were *viz.*, CUM 49 (26.70%), JC 20-07 (27.50%) and GP 7 (28.70%). Although these entries did not exhibit resistance or moderate resistance, their disease incidence remained comparatively lower than the rest, suggesting that they might possess certain genetic or physiological traits conferring partial tolerance to the wilt pathogen.

On the other hand, the majority of the germplasms (47 entries) recorded more than 30 per cent wilt incidence, categorizing them as highly susceptible. This highlights the widespread vulnerability of most of the screened entries to *Fusarium oxysporum* f. sp. *cumini* under field conditions. In particular, some entries *viz.*, Hairy Cumin, White Flower Cumin, JC 18-09, JC 18-10 and JC 18-11 were found to be completely infected with wilt, recording cent per cent disease incidence, indicating complete breakdown of defence mechanisms and total susceptibility.

#### Year 2023-24

The screening of 50 cumin germplasms /entries/ varieties against wilt disease caused by *Fusarium oxysporum* f. sp. *cumini* was carried out again in the year 2023-24 under field conditions. The per cent disease incidence was recorded at harvest, and the results showed a trend similar to that observed in the previous year (2022-23).

Among all the tested entries, only three showed less than 31.50 per cent disease incidence indicating

relatively lower susceptibility compared to the remaining entries. These were viz., CUM 49 (31.10%), JC 20-07 (30.00%) and GP 7 (30.80%). Although few of these entries still fell into the susceptible and highly susceptible category, their consistent performance with comparatively lower wilt incidence across consecutive years suggests their potential tolerance, which could be further explored and utilized in future breeding programs.

However, the remaining 47 entries recorded disease incidence well above the susceptible threshold, showing a highly susceptible reaction (HS) to the pathogen. Several entries, including Hairy Cumin, White Flower Cumin, JC 18-09, JC 18-10 and JC 18-11, again exhibited cent per cent disease incidence, confirming their complete vulnerability to *Fusarium oxysporum* f. sp. *cumini*.

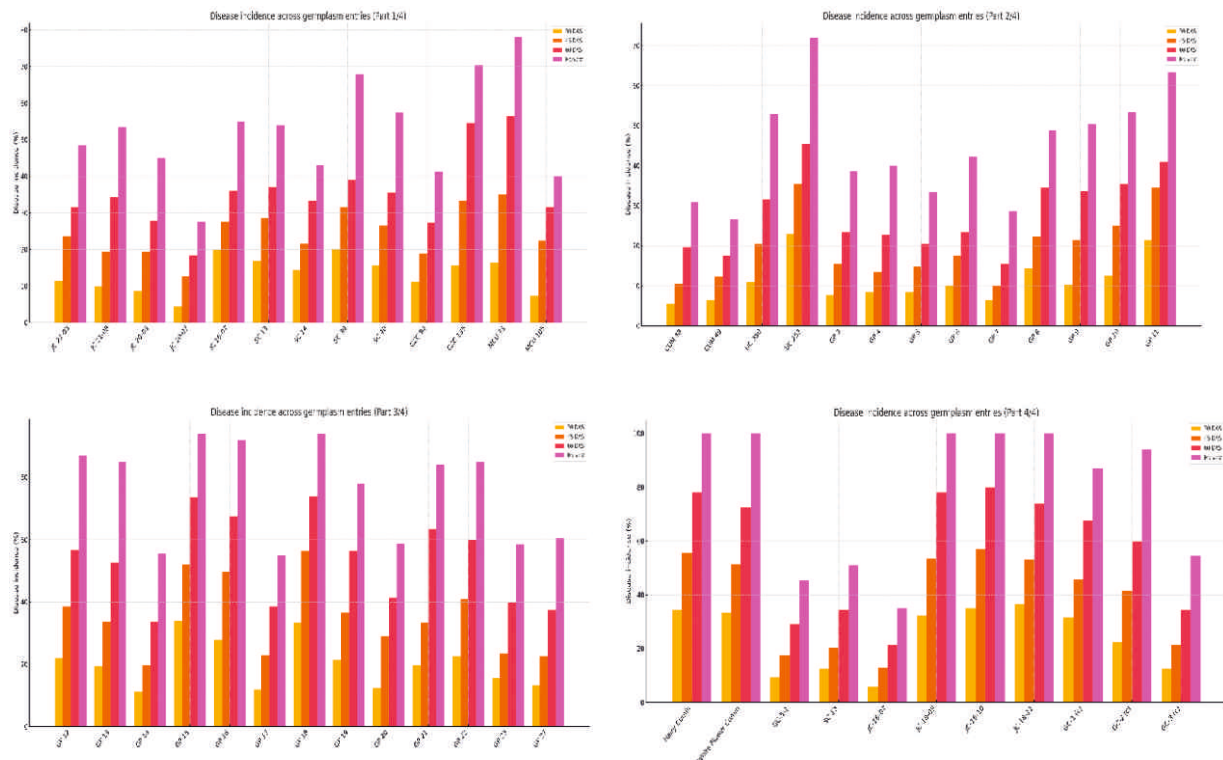
The consistency of these results over two consecutive years indicates that most of the currently available cumin germplasm lacks resistance against wilt. It also

highlights the stability of disease susceptibility or partial tolerance in the entries evaluated. The identification of the three moderately performing entries in both years (CUM 49, JC 20-07 and GP 7) suggests their relative advantage, though not yet resistant and reaffirms the pressing need for developing resistant varieties through selection, hybridization, or biotechnological interventions.

The present investigation on screening of 50 cumin germplasms/entries against *Fusarium oxysporum* f. sp. *cumini* during 2022–23 and 2023–24 revealed that none of the tested entries exhibited complete resistance. This finding is consistent with the observations of Deepak and Kant (2004), who also reported that none of the 25 cumin genotypes they evaluated showed complete resistance, although certain genotypes displayed higher levels of tolerance. Similarly, Arora *et al.* (2004) and Deepak *et al.* (2008) identified genotypes like UC-220 and EC-232684 as having higher resistance, but overall resistance in cumin has remained limited.

**Table 1.** Screening of cumin germplasms/entries against wilt disease of cumin (2022-23)

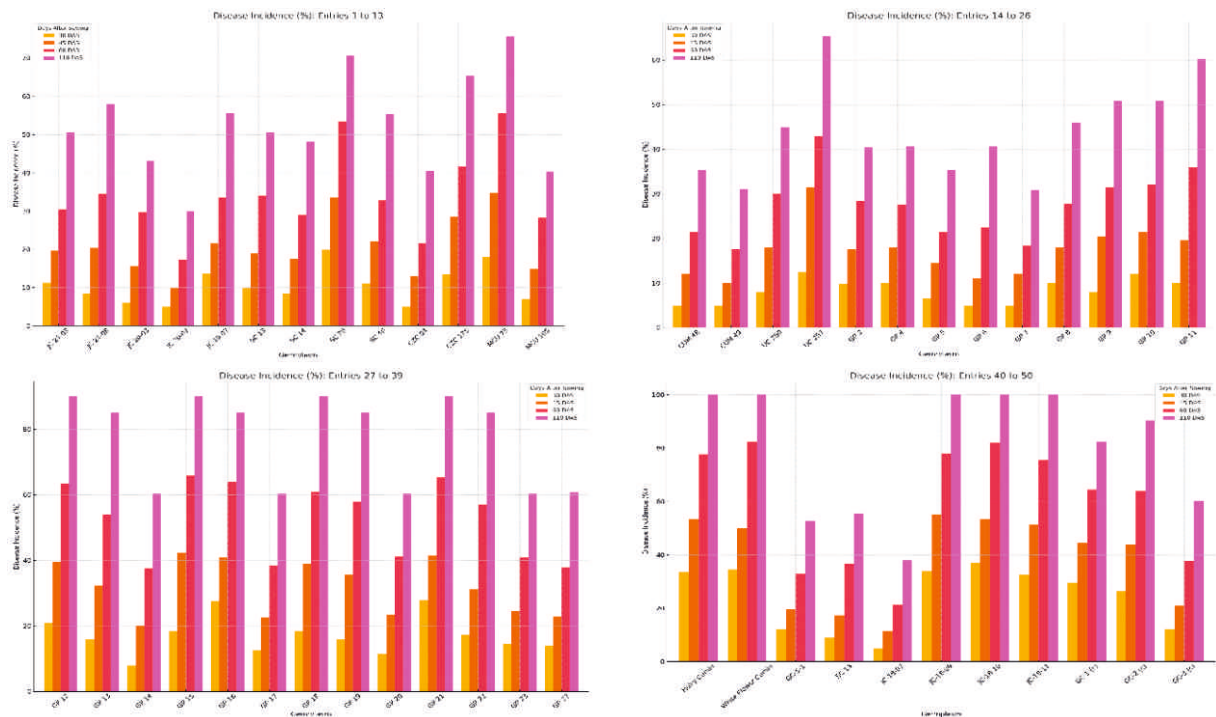
| Reaction                |                                                                                                                                                                                                                                                                                                                                                                                                  | Germplasm/<br>Entries |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Immune                  |                                                                                                                                                                                                                                                                                                                                                                                                  | --                    |
| Resistant               |                                                                                                                                                                                                                                                                                                                                                                                                  | --                    |
| Moderately<br>resistant |                                                                                                                                                                                                                                                                                                                                                                                                  | --                    |
| Susceptible             | JC 20-07, CUM 49, GP 7                                                                                                                                                                                                                                                                                                                                                                           |                       |
| Highly susceptible      | JC 21-03, JC 21-08, JC 20-03, JC 18-07, SC 13, SC 14, SC 39, SC 40, MCU 105, CZC 94, CZC 135, MCU 73, CUM 48, UC 350, UC 257, GP 3, GP 4, GP 5, GP 6, GP 8, GP 9, GP 10, GP 11, GP 12, GP 13, GP 14, GP 15, GP 16, GP 17, GP 18, GP 19, GP 20, GP 21, GP 22, GP 23, GP 27, Hairy Cumin, White Flower Cumin, GC-5-1, SC 13, JC-18-07, JC-18-09, JC-18-10, JC-18-11, GC-1 (c), GC-2 (c), GC-3 (c). |                       |



**Fig 1.** Screening of cumint germplasms/entries against wilt disease of cumint (2022-23)

**Table 2.** Screening of cumint germplasms/entries against wilt disease of cumint (2023-24)

| Reaction                | Germplasm/<br>Entries                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Immune                  | --                                                                                                                                                                                                                                                                                                                                                                                                               |
| Resistant               | --                                                                                                                                                                                                                                                                                                                                                                                                               |
| Moderately<br>resistant | --                                                                                                                                                                                                                                                                                                                                                                                                               |
| Susceptible             | JC 20-07.                                                                                                                                                                                                                                                                                                                                                                                                        |
| Highly susceptible      | JC 21-03, JC 21-08, JC 20-03, JC 18-07, SC 13, SC 14, SC 39, SC 40, MCU 105, CZC 94, CUM 49, CZC 135, MCU 73, CUM 48, UC 350, UC 257, GP 3, GP 4, GP 5, GP 6, GP 7, GP 8, GP 9, GP 10, GP 11, GP 12, GP 13, GP 14, GP 15, GP 16, GP 17, GP 18, GP 19, GP 20, GP 21, GP 22, GP 23, GP 27, Hairy Cumin, White Flower Cumin, GC -5-1, SC 13, JC -18-07, JC-18-09, JC-18-10, JC-18-11, GC-1 (c), GC-2 (c), GC-3 (c). |



**Fig 2.** Screening of cumini germplasms/entries against wilt disease of cumini (2023-24)

In the present study, three entries viz., CUM 49, JC 20-07 and GP 7 consistently showed disease incidence below 31.50 per cent, categorizing them as susceptible but relatively tolerant compared to the remaining highly susceptible entries. This aligns with the pattern observed by Talaviya *et al.* (2017), where only one line (JC-2000-9) was found completely resistant and others were either moderately resistant or highly susceptible. Our findings also corroborate those of Patel (2021), where a small number of genotypes exhibited moderate resistance, while most were either susceptible or highly susceptible.

Moreover, the presence of highly susceptible entries with 100 per cent disease incidence in both years, such as Hairy Cumin, White Flower Cumin, JC 18-09, JC 18-10 and JC 18-11, echoes the challenges noted in other spice crops. Choudhary *et al.* (2016) in fenugreek and Jat and Ahir (2017) in coriander also reported that a large proportion of tested genotypes showed high susceptibility under natural or artificial inoculation conditions.

The wide range of susceptibility observed in our study highlights the genetic variability present in cumini for *Fusarium* wilt resistance. This is further supported by

Nouraein *et al.* (2020) who found significant variability among 64 cumini accessions and identified ten accessions as highly resistant. Although such highly resistant lines were not observed in our screening, the identification of relatively tolerant entries viz., CUM 49, JC 20-07 and GP 7 could serve as promising candidates for future breeding efforts.

### Conflict of Interest

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

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