

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(6): 1089-1093
www.biochemjournal.com
Received: 15-04-2026
Accepted: 19-05-2026

Dikkar MG

Ph.D. Research Scholar,
Department of Plant
Pathology, Post Graduate
Institute, Dr. Panjabrao
Deshmukh Krushi Vidyapeeth,
Akola, Maharashtra, India

Mane SS

Director of Research, Post
Graduate Institute, Dr.
Panjabrao Deshmukh Krushi
Vidyapeeth, Akola,
Maharashtra, India

Bramhankar SB

Associate Professor,
Department of Plant
Pathology, Post Graduate
Institute, Dr. Panjabrao
Deshmukh Krushi Vidyapeeth,
Akola, Maharashtra, India

Ingle ST

Associate Professor,
Department of Plant
Pathology, Post Graduate
Institute, Dr. Panjabrao
Deshmukh Krushi Vidyapeeth,
Akola, Maharashtra, India

Shinde MP

Ph.D. Research Scholar,
Department of Entomology,
Post Graduate Institute, Dr.
Panjabrao Deshmukh Krushi
Vidyapeeth, Akola,
Maharashtra, India

Corresponding Author:**Dikkar MG**

Ph.D. Research Scholar,
Department of Plant
Pathology, Post Graduate
Institute, Dr. Panjabrao
Deshmukh Krushi Vidyapeeth,
Akola, Maharashtra, India

Spatial distribution and epidemiology of chickpea wilt in major chickpea-growing regions of Maharashtra, India

Dikkar MG, Mane SS, Bramhankar SB, Ingle ST and Shinde MP

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i6Sm.8771>

Abstract

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in India; however, its productivity is significantly constrained by Fusarium wilt caused by *Fusarium oxysporum* f. sp. *ciceri*. The present study was conducted to investigate the incidence and distribution of chickpea wilt in major chickpea-growing districts of Maharashtra and to determine the influence of soil physicochemical properties on disease occurrence. A roving survey was carried out during 2020-21 in twenty-two districts of M.S. and wilt incidence was assessed based on the proportion of affected plants in representative fields. Diseased plant samples were collected, and the pathogen was isolated and identified using standard laboratory techniques.

The survey revealed considerable variation in wilt incidence among districts, ranging from 6.81 to 18.10 percent, indicating an uneven distribution of the disease across the state. The highest wilt incidence was recorded in Akola (18.10%), followed by Parbhani (17.32%), Dharaashiv (17.07%) and Amaravati (16.89%), whereas the lowest incidence was observed in Gadchiroli (6.81%) district. Analysis of soil properties showed that districts with alkaline soils and higher clay content generally exhibited greater wilt incidence. In contrast, electrical conductivity showed little association with disease development. The observed differences in disease incidence were also influenced by cropping history, soil fertility status and prevailing environmental conditions.

The study demonstrates that chickpea wilt is widely prevalent in Maharashtra and that its occurrence is strongly influenced by local soil and agro-climatic factors. The findings provide useful baseline information for identifying wilt-prone areas and developing effective integrated disease management strategies for sustainable chickpea production.

Keywords: Chickpea, Fusarium wilt, *Fusarium oxysporum* f. sp. *ciceri*, disease incidence, soil properties, survey, Maharashtra

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated worldwide and is a valuable source of protein, carbohydrates, vitamins, and minerals, especially in developing countries (Jukanti *et al.*, 2012) [9]. In addition to its nutritional value, chickpea improves soil fertility through biological nitrogen fixation, making it an important component of sustainable farming systems. India is the leading producer of chickpea, contributing nearly 65 percent of the global cultivated area and 68 percent of total production (Reddy and Mishra, 2010) [18]. Maharashtra is among the major chickpea-growing states in the country. Despite its importance, chickpea productivity is greatly affected by several diseases, among which Fusarium wilt, caused by *Fusarium oxysporum* f. sp. *ciceri*, is one of the most serious. The disease is widespread across major chickpea-growing regions of the world and can cause yield losses ranging from 10-40 percent, reaching up to 100 percent under favourable conditions (Nene *et al.*, 1984; Jalali and Chand, 1992) [12, 6]. The pathogen survives in soil and seed for long periods and infects plants at different growth stages, resulting in yellowing, vascular discoloration, wilting, and eventual plant death (Pande *et al.*, 2007; Jiménez-Fernández *et al.*, 2011) [15, 8]. In India, the incidence of Fusarium wilt varies with agro-climatic conditions, cropping practices, and pathogen populations (Singh *et al.*, 2007; Dubey *et al.*, 2010) [20, 3].

Considering the importance of chickpea cultivation in Maharashtra and the potential impact of wilt disease, a systematic survey was undertaken to assess the incidence and distribution of *Fusarium* wilt in major chickpea-growing areas and to generate baseline information for future disease management and resistance breeding programmes.

Material and Method:

Survey and Assessment of Wilt Incidence

A roving survey was conducted during the Rabi season (2021-2022) to assess the occurrence and distribution of chickpea wilt in major chickpea-growing areas of Maharashtra State. Efforts have been made to collect the wilt samples from 22 districts of Maharashtra and inspected for wilt disease incidence. The incidence of chickpea wilt was recorded based on the number of wilted plants observed in each field and expressed as percentage disease incidence using the following formula:

$$\text{Wilt incidence (\%)} = \frac{\text{Number of wilted plants}}{\text{Total number of plants observed}} \times 100$$

Plants exhibiting typical wilt symptoms such as yellowing, drooping, vascular discoloration and complete wilting were collected from different surveyed locations in sterile paper bags and transported to the laboratory for further studies.

Isolation of the Pathogen

Wilted chickpea plants collected during the survey were used for isolation of the pathogen. Small pieces of infected root and stem tissues from the collar region were washed thoroughly under running tap water and surface sterilized with 1 percent sodium hypochlorite solution for 1-2 min, followed by three washings with sterile distilled water. The sterilized tissue bits were dried on sterile blotting paper and aseptically transferred onto Potato Dextrose Agar (PDA) medium plates. The inoculated plates were incubated at 27 ± 2 °C for 5-7 days. Emerging fungal colonies were purified by hyphal tip/single spore isolation and maintained on PDA slants for further identification and studies.

Results and Discussion

The present investigation was conducted during 2020-25. The study evaluated that the occurrence of chickpea wilt, pathogen characterization, screening of antagonistic microorganisms, and efficacy of bioagents and pesticides under laboratory, pot culture, and field conditions. Their effects on wilt incidence, plant growth, and yield were assessed to develop effective integrated disease management strategies for chickpea wilt.

A roving survey was conducted during the cropping season in twenty-two major chickpea growing districts of Maharashtra and assessed the incidence of chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceris*. In each district, five representative fields were selected, and wilt

incidence was recorded based on the proportion of wilt-affected plants to the total number of plants observed at each location. (Table 1).

The results clearly indicated substantial spatial variation in wilt incidence across the surveyed districts, ranging from 6.81 to 18.10 percent, confirming that chickpea wilt is endemic but unevenly distributed across the state. Similar spatial heterogeneity in wilt distribution has been reported earlier by Nikam *et al.*, (2011) ^[14] and Sontakke *et al.*, (2020) ^[21] in different chickpea-growing regions of Maharashtra.

Among all the districts, the highest wilt incidence i.e. (18.10%) was recorded in Akola district, followed by Parbhani (17.32%), Dharashiv (17.07%), Amaravati (16.89%), Hingoli (16.46%) and Jalna (16.29%). These districts represent major chickpea production belts characterised by continuous chickpea cultivation, intensive cropping and favourable soil environments, which are known to promote inoculum build-up and disease expression (Haware and Nene, 1980; Nikam *et al.*, 2020) ^[5, 14].

Moderate levels of wilt incidence were observed in Aurangabad (15.63%), Washim (15.11%), Nanded (14.48%), Latur (13.78%), Solapur (13.40%) and Ahmednagar (13.57%) districts, indicating intermediate disease severity. Comparable levels of incidence have been reported from Marathwada and adjoining regions by Patra *et al.*, (2017) ^[17] and Sontakke *et al.*, (2020) ^[21].

In contrast, comparatively lower wilt incidence (<10%) was recorded in Gadchiroli (6.81%), Gondia (7.78%), Chandrapur (7.81%), Beed (8.12%), Jalgaon (9.13%), Yavatmal (9.66%) and Bhandara (9.73%). Lower disease incidence in these districts may be attributed to less intensive chickpea cultivation, lighter soil texture and relatively cooler or forest-influenced agro-ecologies, as also suggested by Nathawat *et al.*, (2020) ^[11].

The observed variation in wilt incidence among districts may also be associated with differences in soil physicochemical properties, cropping history, cultivar susceptibility and prevailing environmental conditions. Higher disease incidence in the central and Marathwada regions could be attributed to repeated cultivation of chickpea in the same fields, leading to the gradual accumulation of *Fusarium oxysporum* f. sp. *ciceris* inoculum in the soil. Furthermore, warm temperatures and moisture stress during the reproductive stage are known to favour disease development and wilt expression. Similar regional variations in chickpea wilt incidence and disease severity have been reported by Pande *et al.*, (2012) ^[16], Sharma and Ghosh (2016) ^[19], Dubey *et al.*, (2010) ^[3], Jiménez-Díaz *et al.*, (2015) ^[7] and Mahesh *et al.*, (2019) ^[10], who highlighted the combined influence of pathogen population density, environmental factors and host susceptibility on disease occurrence.

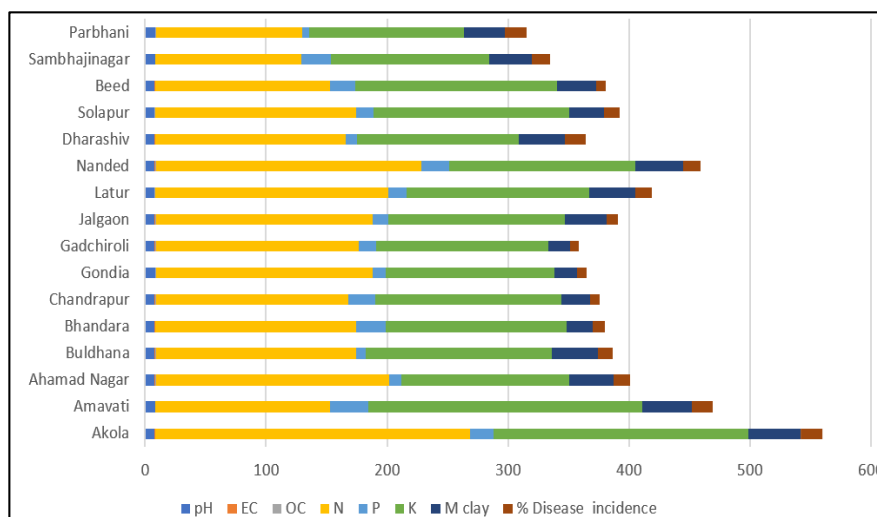
Table 1: Location wise Percent Mean Wilt Incidence (%) in major chickpea growing 22 districts, each districts five locations, of Maharashtra

S. No.	District	Sample (5 locations)	H	I	Average Percent of Wilt Incidence in each district
1	Akola	Mean	94.4	17	18.01
2	Washim	Mean	107.2	16.2	15.11
3	Buldhana	Mean	93.4	11.4	12.21
4	Hingoli	Mean	94.8	15.6	16.46
5	Amaravati	Mean	88.8	15	16.89
6	Nagpur	Mean	101.4	10.4	10.26
7	Wardha	Mean	101.6	11.6	11.42
8	Bhandara	Mean	96.6	9.4	9.73
9	Gondia	Mean	105.4	8.2	7.78
10	Yavatmal	Mean	105.6	10.2	9.66
11	Jalna	Mean	105.6	17.2	16.29
12	Sambhajinagar	Mean	89.6	14	15.63
13	Ahilyanagar	Mean	91.4	12.4	13.57
14	Jalgaon Kh.	Mean	91.4	12.4	9.17
15	Chandrapur	Mean	92.2	7.2	7.88
16	Gadchiroli	Mean	94	6.4	6.81
17	Parbhani	Mean	91.2	15.8	17.32
18	Dharashiv	Mean	90.2	15.4	17.07
19	Beed	Mean	118.2	9.6	8.12
20	Latur	Mean	90	12.4	13.78
21	Solapur	Mean	100	13.4	13.4
22	Nanded	Mean	100.8	14.6	14.48

- H-Healty Plant
- I-Infected Plant

Table 2: Physicochemical soil properties (pH, EC, OC, macronutrients and clay%) and their associated chickpea wilt disease incidence (%) across major chickpea growing districts of Maharashtra

S. No.	District	pH	EC	OC	N	P	K	M clay	% Disease incidence
1	Akola	7.48	0.46	0.58	260	19.7	211	42.80	18.1
2	Amavati	7.95	0.28	0.32	144	31.9	227	40.89	16.89
3	Ahamad Nagar	7.92	0.65	0.43	193	10	139	36.40	13.57
4	Buldhana	7.78	0.53	0.37	166	7.6	154	38.00	12.21
5	Bhandara	7.70	0.36	0.37	165.7	24.7	150	21.30	9.73
6	Chandrapur	7.90	0.59	0.33	158.9	22.8	154	23.40	7.81
7	Gondia	8.00	0.57	0.4	179.2	10.6	140	18.60	7.78
8	Gadchiroli	7.80	0.49	0.52	168	13.9	143	17.90	6.81
9	Jalgaon	7.67	0.72	0.4	179	13.6	146	34.50	9.13
10	Latur	7.55	0.36	0.43	193	14.9	151	38.00	13.78
11	Nanded	7.9	0.44	0.49	219.5	23.1	154	39.45	14.48
12	Dharashiv	7.65	0.52	0.35	157	9.7	134	38	17.07
13	Solapur	7.5	0.32	0.37	166	14.4	162	28.60	13.40
14	Beed	7.82	0.41	0.32	144	21.4	167	32.00	8.12
15	Sambhajinagar	7.95	0.26	0.27	121	24.1	131	35.00	15.63
16	Parbhani	8.01	0.49	0.27	121	5.7	128	34.30	17.32

**Fig 1:** Physicochemical soil properties (pH, EC, OC, macronutrients and clay %) and their associated chickpea wilt disease incidence (%) across major chickpea growing districts of Maharashtra

Relationship between Soil Physicochemical Properties and Wilt Incidence

To elucidate the influence of soil environment on wilt development, physicochemical properties of soils collected from the surveyed districts were analysed, including soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), phosphorus (P), potassium (K) and clay content. (Table 2 & Figure).

1. **Soil pH:** Soil pH ranged from 7.48 to 9.97. Districts with alkaline soils (>8.0), such as Parbhani, Jalna, Washim and Hingoli, recorded higher wilt incidence, whereas Gadchiroli and Chandrapur with near-neutral pH exhibited lower disease incidence. Similar findings were reported by Haware and Nene (1980) [5].
2. **Electrical Conductivity:** Electrical conductivity varied from 0.26 to 0.78 dS m⁻¹, indicating non-saline conditions across all districts. No consistent relationship was observed between EC and wilt incidence (Nikam *et al.*, 2011) [14].
3. **Organic Carbon:** Organic carbon content ranged from 0.27 to 0.58 percent. Districts with relatively higher OC, such as Akola and Wardha, recorded moderate wilt incidence, whereas Parbhani and Sambhajinagar with lower OC showed comparatively moderate disease incidence. Similar observations were reported by Alabouvette *et al.* (2009) [22].
4. **Available Nitrogen:** Available nitrogen ranged from 121 to 260 kg ha⁻¹. Lower nitrogen levels in Parbhani and Sambhajinagar were associated with higher wilt incidence, although high nitrogen alone did not consistently suppress the disease, as observed in Akola (Haware *et al.*, 1996) [23].
5. **Available Phosphorus:** Available phosphorus ranged from 5.7 to 31.9 kg ha⁻¹. Districts showing phosphorus imbalance, such as Parbhani (deficiency) and Amaravati and Washim (excess), recorded moderate to high wilt incidence. Similar observations were reported by Patra *et al.*, (2017) [17].
6. **Clay Content:** Clay content ranged from 17.9 to 42.8 percent. Higher clay content was observed in Akola, Amaravati and Latur, which also recorded comparatively higher wilt incidence, indicating the favourable role of heavy clay soils in wilt development.

Conclusion

The present survey confirmed that chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceri* is widely distributed in the major chickpea-growing districts of Maharashtra, with disease incidence varying from 6.81 to 18.10 percent. The variation in wilt incidence among districts indicates the significant influence of local soil and environmental conditions on disease development. Higher wilt incidence was generally observed in districts with alkaline soils and greater clay content, while electrical conductivity showed little influence on disease occurrence. Overall, the study highlights the importance of soil characteristics, cropping practices, and environmental factors in the epidemiology of chickpea wilt. The findings provide useful baseline information for identifying disease-prone areas and formulating effective integrated management strategies for sustainable chickpea production.

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