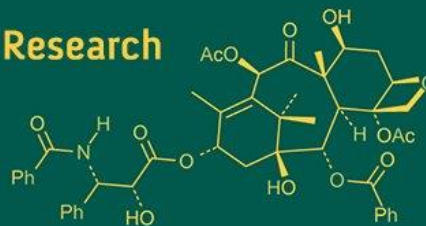
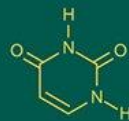
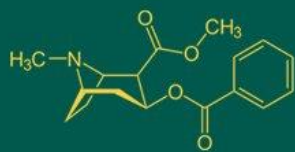


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(5): 455-458
www.biochemjournal.com
Received: 10-02-2026
Accepted: 13-03-2026

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Screening for Fusarium wilt Resistance in Chickpea (*Cicer arietinum* L.) through Artificial Inoculation

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i5Sf.8405>

Abstract

Chickpea (*Cicer arietinum* L.) is a globally important grain legume cultivated across more than 50 countries in the world. In spite of significant improvement in productivity of chickpea, still it is severely constrained by several stresses, one among them is wilt, incited by *Fusarium oxysporum* f. sp. *ciceri*. The present study was conducted to identify resistant genotypes under controlled greenhouse conditions. A total of forty two chickpea genotypes, along with two checks, WR 315 (R) and JG 62 (S), were screened through artificial inoculation with pathogen infested sorghum medium at 8% (w/w). The experiment was laid out in a completely randomized design with two replications and disease incidence was recorded based on plant mortality. None of the genotypes exhibited immune reaction. Four genotypes, namely DCPV 21-23, DCPV 21-85, DCPV 21-131 and WR 315 significantly showed resistant (R) reaction with low disease incidence. Eleven genotypes were classified as moderately resistant (MR), while the other genotypes fell under moderately susceptible (MS) to highly susceptible (HS) categories. Highly susceptible reactions were observed in some genotypes including Annigeri, and JG 62, confirming adequate disease pressure during screening. The study revealed considerable variability among genotypes, indicating the scope for isolation of resistant sources. The identified resistant and moderately resistant genotypes can be effectively utilized in breeding programmes aimed at developing fusarium wilt-resistant chickpea cultivars.

Keywords: Chickpea, Fusarium wilt, genotypes, resistance, screening

Introduction

Chickpea (*Cicer arietinum* L.) is a self-pollinated, diploid ($2n = 16$) cool-season grain legume of significant global importance (Varshney *et al.*, 2013)^[13]. It is broadly classified into two major groups, *desi* and *kabuli*, which differ in morphological, physiological and genetic attributes, including seed characteristics, stress tolerance and adaptation patterns (Jimenez-Diaz *et al.*, 2015)^[7]. Chickpea is valued for its high nutritional content, serving as an affordable source of protein, dietary fiber and essential micronutrients, particularly in developing countries (Gaur *et al.*, 2012)^[3]. It also contributes to sustainable agriculture through symbiotic nitrogen fixation, improving soil fertility under rainfed and marginal conditions (Narayan *et al.*, 2024)^[8]. Chickpea is widely cultivated across diverse agro-ecological regions (Hattiholi *et al.*, 2024)^[4], while India is a leading producer globally, with about 10.24 million hectares area under cultivation (73.78% of the world area) and production of 11.68 million tonnes (73.45%) (DAC&FW, 2024-25)^[2].

Chickpea, despite being a valuable source of nutrition and income, is highly vulnerable to a range of biotic and abiotic stresses that considerably hamper its productivity. Important yield limiting factors include fungal diseases such as Ascochyta blight and Fusarium wilt, pod borer infestation and unfavorable environmental conditions like drought and cold stress (Sankar *et al.*, 2024)^[10]. *Fusarium oxysporum* f. sp. *ciceris* is the causal agent of Fusarium wilt in chickpea, which poses a major constraint to its productivity (Haware *et al.*, 1978)^[6]. Under congenial environmental conditions, the disease can lead to yield losses approaching 100 percent (Pande *et al.*, 2011)^[9]. Disease incidence has been reported to reach up to 61 percent during the vegetative stage and around 43 percent at the flowering stage, indicating its severe impact across crop growth phases.

Yield losses are more pronounced when infection occurs at early growth stages, with early wilt accounting for approximately 77-94% reduction, compared to 24-65% under late wilt conditions. Furthermore, infection during the reproductive phase, particularly from flowering to pod development, can result in drastic reductions in seed weight, with losses reported as high as 90%, underscoring the destructive nature of the disease. Several high yielding varieties such as Annigeri, JG 62, that are preferred by farmers are susceptible to *Fusarium* wilt. Hence, the cultivation of wilt-resistant varieties of chickpea is the best way to overcome yield and production losses. In view of this, present investigation was carried out to isolate the potential wilt resistant chickpea genotypes to aid in disease resistance broadly in chickpea.

Materials and Methods

Isolation and multiplication of pathogen

Diseased portion was washed under running tap water. Small infected tissue pieces were cut using a sterile blade, surface sterilized with 1% sodium hypochlorite and rinsed thrice in sterile distilled water. The tissues were aseptically placed on Potato Dextrose Agar (PDA) plates and incubated at 27±1 °C. Fungal growth was monitored and pure cultures were obtained using the hyphal tip method and maintained on PDA slants. Pathogenicity of the isolated fungus was confirmed by inoculating susceptible host plants and observing characteristic disease symptom development. For long-term maintenance, the cultures were periodically sub-cultured at monthly intervals and preserved on PDA slants at 4 °C (Sharma *et al.* 2010)^[11].

Screening of Chickpea Genotypes under Controlled Conditions

Forty two chickpea genotypes were screened for response to *Fusarium oxysporum* f. sp. *ciceri* infestation under controlled greenhouse conditions. The experiment was laid out in a completely randomized design (CRD) with two replications during *rabi* 2024-25. Two standard checks, WR 315 (R) and JG 62 (HS), were included to validate the screening procedure. The experiment was conducted using pots filled with sterilized soil to ensure uniform growth conditions. The pathogen inoculum was prepared on sorghum meal medium in conical flasks. The substrate was sterilized on two consecutive days to eliminate contaminants. A mycelial disc of 5 mm from a 7 day old actively growing culture of *F. oxysporum* f. sp. *ciceri* was aseptically transferred into each flask and incubated for 15 days at suitable temperature conditions, with intermittent shaking to ensure uniform colonization. The fully colonized substrate was mixed thoroughly and incorporated into the soil in each pot at an inoculum level of 8% (w/w). Five seeds were sown per pot. Prior to sowing, seeds of each genotype were surface sterilized with 1% sodium hypochlorite for 1 minute, followed by repeated washing with sterile distilled water for 2 times. Observations on wilt incidence were recorded periodically based on plant mortality. The percent disease incidence (PDI) was calculated using the following formula:

$$\text{PDI} = \frac{\text{Number of wilted plants}}{\text{Total number of plants observed}} \times 100$$

Based on the percent disease incidence, genotypes were categorized into different reaction groups following the scale

proposed by Haware and Nene (1982)^[5] with slight modifications (Table. 1).

Table 1: Disease rating scale

Sl. No.	Disease reaction category	Disease incidence (%)
1.	Resistant	0-10
2.	Moderately resistant	10.1-20
3	Moderately susceptible	20.1-30
4	Susceptible	30.1-50
5.	Highly susceptible	50.1-100

Based on the disease reaction, genotypes were categorized into resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible genotypes.

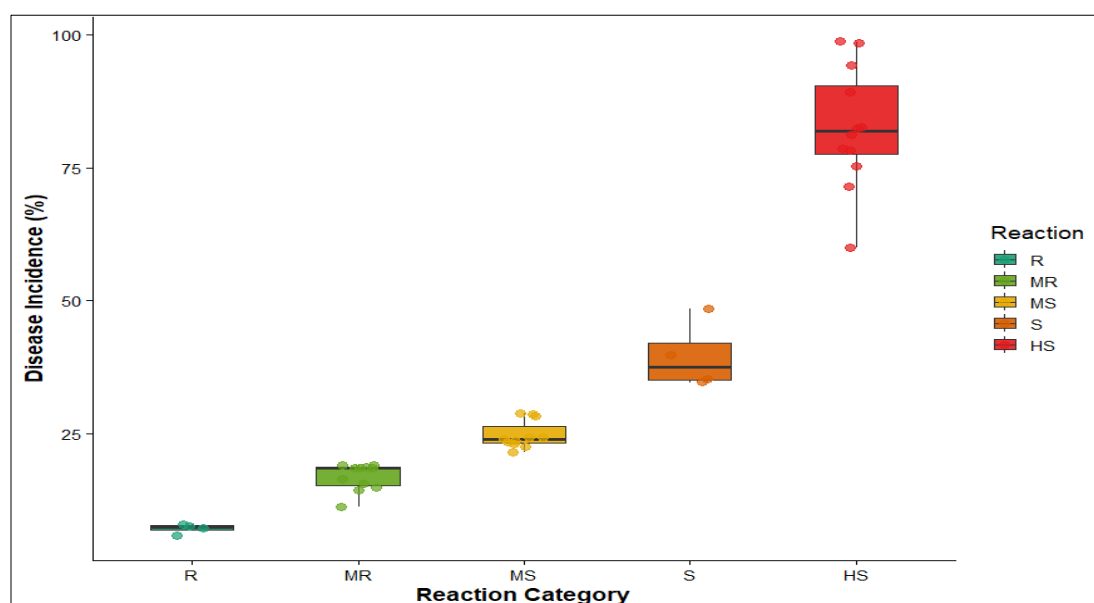
Results and Discussion

Among the forty two chickpea genotypes screened under artificial inoculation condition, None of them were immune. Four genotypes namely, DCPV 21-85, DCPV 21-23, DCPV 21-131 and WR 315 exhibited resistant reaction. Eleven genotypes, viz., BGD 133, DIBG 205, M-71, VCD-21-05, DCPV 21-111, DCPV 21-49, ICC 4958, SA-1, BGD 111-1, ADL 72, VCD 22-05 were categorized as moderately resistant, indicating partial resistance under artificial inoculation conditions. About eleven genotypes were grouped under the moderately susceptible category, including BGD 7050, BGD 9123, BGD 9124, DIBG 207 DCPV 21-3, DCPV 21-12, DCPV 21-2, DCPV 21-37, DCPV 21-75, DCPV 21-100, Jaki 9218 suggesting moderate levels of disease tolerance but not adequate resistance for direct cultivation under wilt-prone conditions. Four genotypes were classified as susceptible, showing considerable disease incidence. Twelve genotypes were grouped as highly susceptible, which recorded very high wilt incidence (Table. 2). The susceptible check JG 62 exhibited severe disease incidence which indicates the presence of sufficient disease pressure, thereby confirming disease resistance of identified genotypes.

The study revealed significant variability among the test genotypes for wilt disease reaction indicating the presence of diverse reaction levels. There were genotypes viz DCPV 21-23, DCPV 21-85, DCPV 21-131 and WR 315 which showed resistant reaction, suggesting their potential as reliable sources of resistance. Moderately resistant genotypes exhibiting superior yield performance may be recommended for cultivation, while also serving as valuable genetic sources in breeding programmes focused on the development of durable and broad-spectrum disease resistant chickpea cultivars. The genotypes categorized as moderately susceptible to highly susceptible, including popular cultivars like Annigeri and JG 62, exhibited the vulnerability under wilt conditions (Fig. 1) and cultivation of such entries under wilt prone fields should be curtailed. The clear differentiation of genotypes under controlled inoculation confirms the effectiveness of the screening method. Similar findings were obtained by Ashwini *et al.* (2024)^[1], where 25 genotypes were screened for wilt resistance under greenhouse conditions. Takalakki *et al.* (2025)^[11] identified 10 germplasm lines and 7 advanced breeding lines resistant to wilt under artificial sick plot condition. The present findings were aligned with results of Yadav *et al.* (2023)^[13]. The identified resistant and moderately resistant genotypes can be utilized in breeding programmes for developing fusarium wilt resistant chickpea varieties.

Table 2: Reaction of chickpea genotypes to Fusarium wilt (*Fusarium oxysporum* f. sp. *ciceri*) under controlled conditions

S. No	Genotype/Pedigree	DI (%)	Reaction
1	BGD 7050	23.57	MS
2	BGD 9123	23.84	MS
3	BGD9124	23.11	MS
4	BGD 133	18.50	MR
5	DIBG 205	16.50	MR
6	DIBG 207	28.56	MS
7	M-71	18.45	MR
8	M-97	98.70	HS
9	M-112	89.25	HS
10	DCPV 21-9	48.50	S
11	DCPV 21-23	05.70	R
12	VCD-21-05	19.02	MR
13	DCPV 21-7	39.75	S
14	DCPV 21-85	07.23	R
15	DCPV 21-111	11.20	MR
16	DCPV 21-3	28.30	MS
17	DCPV 21-17	35.20	S
18	DCPV 21-42	60.00	HS
19	DCPV 21-166	71.50	HS
20	DCPV 21-2	82.50	HS
21	DCPV 21-12	22.54	MS
22	DCPV 21-49	15.61	MR
23	DCPV 14-21-2	24.22	MS
24	DCPV 14-21-37	21.53	MS
25	DCPV 14-21-75	24.32	MS
26	DCPV 14-21-100	23.42	MS
27	DCPV 14-21-131	7.54	R
28	Annigeri	78.2	HS
29	ICC 4958	18.95	MR
30	JG 11	34.6	S
31	JAKI 9218	28.8	MS
32	BGD 111-1	18.75	MR
33	SA-1	14.23	MR
34	ADL 72	18.50	MR
35	ADL-18	75.3	HS
36	ADL-45	94.3	HS
37	JG 62	98.4	HS
38	WR 315	7.8	R
39	DBC 24-1	78.6	HS
40	VCD 22-05	14.9	MR
41	ICCV 231109	82.5	HS
42	ICCV 231143	81.2	HS

**Fig 1:** Distribution of disease incidence (%) of chickpea genotypes against *Fusarium oxysporum* f. sp. *ciceri*

Conclusion

Fusarium wilt remains a major constraint in chickpea production due to its destructive nature and widespread occurrence. In the present study, genotypes exhibiting resistant and moderately resistant reactions to *Fusarium oxysporum* f. sp. *ciceri* were isolated, which can be a valuable sources of resistance. These genotypes can be utilized both for direct deployment in wilt prone areas based on yield performance and as donors in breeding programmes aimed at developing resistant cultivars. Upon generating the molecular insights on resistance and tagging the markers for resistance aids in enhancing the efficiency of crop improvement through marker assisted selection. In addition, regular screening of diverse germplasm along with continuous monitoring of pathogen variability will be crucial for achieving durable and broad based resistance in chickpea.

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