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STUDIES ON VARIABILITY AND SCREENING OF CHICKPEA GERMPLASM AGAINST *FUSARIUM OXYSPORUM* F. SP. *CICERI*

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ABSTRACT: Wilt symptoms in adult plants were quite common at flowering and pod stages. The affected plants showed characteristic wilting *viz.*, drooping of the petioles, rachis and leaflets.All the 50 isolates of *F. oxysporum* f. sp. *ciceri*exhibited a great variability in respect of colony diameter, colony characters and pigmentation and were categories into 5 groups (A, B, C, D and E) on the basis of colony characters and pigmentation. Ten isolates of group A recorded colony diameter ranging between 50.3-58.4 mm, 15 isolates of group B had colony diameter (36.4 to 52.8 mm), 17 isolates in group C had colony diameter (40.3-51.60 mm), 6 isolates in group D having colony diameter (46.6 to 57.9 mm) and 2 isolates in group E had colony diameters of 37.3 and 48.8 mm. The size of microconidia ranged between 2.8-4.2 × 1.7-2.4 µm to 6.1-6.6 × 4.1-4.5 µm, the maximum size being recorded in FOC-1 and the minimum in FOC-7; macroconidia ranged between 6.7-7.5× 1.9-2.6 µm and 14.4-17.6 × 5.4-5.7 µm, the maximum size was recorded in FOC-1 and the minimum in FOC-13 and Chlamydospore ranged between 3.7-3.8 µm-6.6-7.0 µm, the maximum size was recorded in FOC-1 and the minimum in FOC-7. Out of 82 genotypes screened, H-82-2, DCP-92-3, Avrodhi and Udaywere found resistant to Fusarium wilt.Virulence response of Foc isolates on chickpea differentials revealed that three different types of pathogenic groups existed in Jammu sub-tropics *i.e.*, highly virulent (FOC-3, FOC-28 and FOC-34), moderately virulent (FOC-1, FOC-25, FOC-32 and FOC-37), and least virulent (FOC-18, FOC-38 and FOC-43).

Key words: Chickpea wilt, *Fusarium oxysporum* f. sp. *ciceri*, variability, Screening, Virulence.

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INTRODUCTION

Chickpea *(Cicer arietinum* L.) is an important pulse crop, which belongs to leguminoceae [1]. The Kabuli and Desi chickpea is grown throughout the world with different names *i.e.*, Chickpea (UK), Garbanzo (Latin America), Bengal gram (India), Hommes Hamaz (Arab world), Shimbra (Ethiopia) and Nohud and Loblebi (Turkey). Chickpea is mainly used for human consumption as well as for animal feeds. It is consumed as whole seed, dal fried, boiled, salted or more generally, which is cooked. Fresh green leaves are used as vegetable. The grains also used as vegetable (chhole). Gram flour is mixed with wheat flour to improve the protein content of wheat flour and is used in making missi roti. The flour of dehusked gram called 'besan' is widely used in making pakodas, kadhi, namkeens and several snacks food. Exudation of leaves locally called 'amb'contain oxalic and malic acids, which possess medicinal value for bronchitis, cholera, constipation, diarrhea, digestive disorders, snake-bites, warts and blood purification. In India, chickpea is grown on 10.23 million productivity 967 kg/ha.

The production of chickpea in Maharashtra is 1.62 million tonnes with productivity 891 kg/ha which covered nearly 1.82 million ha of area. Maharashtra contributes about 16.42 per cent share in total production of country (Anonymous, 2014). It was observed to cause damage up to 61 per cent at seedling stage and 43 per cent at flowering stage [2]. Yield loss (10-15%)was reported in Maharashtra [3] and 2-20 per centin Bihar due to chick pea wilt (Anonymous, 2010).In general, the disease causes substantial yield loss which may reach even 100 per cent under favourable weather conditions [4]. Haware and Nene [5] reported that chickpea wilt at seeding stages results in the losses varying from 77 to 94 per cent while at late wilting stages losses are 24 to 65 per cent. Symptoms in a highly susceptible cultivar can develop within 25 days after sowing and podding stage.

MATERIALS AND METHODS

The field experiments of the present investigation on wilt of chickpea were conducted at Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha situated at 32.43° N latitude, 74.54° E longitude and 327 meters above sea level during *Rabi* 2016-17 and 2017-18 cropping seasons. The laboratory experiments were conducted in the Division of Plant Pathology, SKUAST- Jammu. Materials used and methodology adopted for field as well as laboratory experimentation are described as below:

Studies on variability of chickpea wilt pathogen, *F. oxysporum* f. sp. *ciceri*

Roots of infected plant samples showing typical and variable wilt symptoms were collected from different location (i.e) KVK Ghazipur, Pulse Research Samba, Pantnagar University during survey programme. Fifty isolates of pure single spore cultures were maintained on PDA. Morphological and cultural characters of the isolates *viz*. colony characters, colony diameter and sporulation were studied. Cultural variability among the 50 isolates was studied on the basis of cultural and morphological variability.

Cultural variability of F. oxysporum f. sp. *ciceri*

The variation in cultural characters among 50 *F. oxysporum* f. sp. *ciceri* isolates collected from different locations was studied on PDA medium. The cultural characters *viz*., colony diameter, growth pattern, mycelial colour and pigmentation were recorded. Mycelial disc (5mm) of 7 day old culture of different isolates was transferred to the centre of sterilized Petriplates containing PDA medium and incubated at 28±1°C for a week. Colony diameter was recorded by measuring the radial growth of the mycelium in mm after a week [6]. Reverse side of cultural plate of each fungal isolate was also observed to record pigmentation, if any.

Morphological variabilityof *F. oxysporum* f. sp. *ciceri*

The morphological variation among various isolates of *F. oxysporum* f. sp. *ciceri* was studied on artificial culture under *in vitro* conditions. Fifty monoconidialisolates of *F. oxysporum* f. sp. *ciceri* were grown on PDA medium in Petriplates andincubated at 28±1°Cfor ten days and observed the morphological characters such as length and width of microconidia and macroconidia, diameter of chlamydospores, shape, colour, number of spores and number of septation per macroconidia and microconidia were measured under a light microscope.

Screening of chickpea germplasm against *F. oxysporum* f. sp. *ciceri*

Chickpea germplasm/cultivars obtained from various sources were evaluated against *F. oxysporum* f. sp. *ciceri* (FOC-1 isolate) under field conditions in sick soil [7]. Eighty two chickpea cultivars/germplasm *viz*.H-82-2, DCP-92-3, AVRODHI, UDAY, SCS-15-D-1, SCS-15-D-2, SCS-15-D-3, SCS- 15-D-4, SCS- 15-D-5, SCS- 15-D-6, SCS-15-D-7, SCS-15-D-8, SCS-15-D-9, SCS-15-D-10, SCS-15-D-11, SCS-15-D-12, SCS-15-D-13, SCS-15-D-14, SCS-15-D-15, SCS-15-D-16, SCS-15-D-17, SCS-15-D-18, SCS-15-D-19, SCS-15-D-20, SCS-15-D-21, SCS-15-D-22, SCS-15-D-23, SCS-15-D-24, SCS-15-D-25, SCS-15-D-26, SCS-15-D-27, GNG-1501, GNG-496, RSG-963, CSJ-515, JG-14, JG-11, JG-63, J66-1, JKG-1, VIJAY, GNG-1581, RSG-973, JAKI-9218, RSG-974, RSGH-6, JG-16, CSJK-6, RSG-896, RSG-963, HC-1, RSG-943, RSG-888, PG-186, RSG-895, RSG-931, SAMRAI, CSJ-515, CSJK-31, KWR-108, RSG-807, C-235, C-606, C-923, CSJ-303, CSJ-313, BG-3013, H-07-163, GAURAV, BDNG-K-798, BDN-9- 3, BDNG-797, H-208, PG-114, PG-186, PKC-2, PG-183, PG-4, PKC-1, PG-3, JG-62 and L-550 procured from different sources were screened in field under artificial epiphytotic conditions during *Rabi* 2016-17 and 2017-18 cropping seasons at Research Farm of SKUAST-J, Chatha. Sowing was done in a Randomized Block design (RBD) with the plot size of 2 × 2 m with spacing of 75 cm between rows and 25cm between plants. Recommended agronomic practices and insect pest control measures were followed [8]. Twelve plants of each germplasm/ variety were randomly selected and tagged for recording observation on disease intensity at 60, 75 and 90 days after sowing. For creating disease pressure, 10-day old culture of *F.oxysporum* f. sp.*ciceri* multiplied on chickpea seed was inoculated during sowing. The disease incidence was recorded using 1-5 disease rating. Host plant reaction based on the basis of disease incidence (%) following 0-5 scale as proposed by Nene *et al.* [9].

Host Plant Reaction based upon Percent Disease Incidence

Grade	Infection type	Disease incidence	Disease reaction
0	No appearance of infection	0% mortality	Highly Resistant
1	Very slight to slight infection, one or two to few scattered lesions on lower leaves	1-10% mortality	Resistant
2	Light infection, moderate number of lesions on lower leaves only	10.1-20% mortality	Moderate Resistant
3	Heavy infection, lesion abundant on lower extending to upper leaves	20.1-30% mortality	Moderate Susceptible
4	Heavy infection, lesion abundant on lower and middle leaves, extending to upper leaves	30.1-50% mortality	Susceptible
5	Very heavy infection, lesions abundant all leaves, plants prematurely dry or killed by the disease	Above 50% mortality	Highly Susceptible

Analysis of data

The data of various experiments were subjected to statistical analysis with the help of computer software SPSS. The data was subjected to appropriate transformations, wherever needed as suggested by Gomez and Gomez [10] before analysis.

RESULTS

The results based on doctoral research investigations titled "Studies on variability and management of *Fusarium oxysporum* f. sp. *ciceri* (Padw.) Synd. & Hans. causing chickpea wilt" are presented here under the following heads:

Variability study of *Fusarium oxysporum* f. sp. *ciceri* isolate

Variability among the isolates of *F. oxysporum* f. sp. *ciceri* was recorded with respect to cultural and morphological characters. A total number of 50 isolates of *F. oxysporum* f. sp. *ciceri* was obtained from 27 different locations of three districts surveyed. Isolations and purification were made as per method described in Chapter 3 under the heading 3.2.4. Fifty isolates of *F. oxysporum* f. sp. *ciceri* obtained from different locations have satisfied Koch's postulates and were named FOC-1 to FOC-50 (Table 4). All the isolates under study exhibited considerable variability with respect to colony diameter, colony character, pigmentation, size of macroconidia, microconidia and chlamydospores on PDA medium at 25±1°C.

Culture variation within isolates of *Fusarium oxysporum* f. sp. *ciceri* on PDA

All the 50 representative isolates of chickpea wilt pathogen F. oxysporum f. sp. ciceri, when grown in sterilized Petri plates on autoclaved PDA medium, exhibited a great variability in respect of colony diameter, colony characters and pigmentation after 7days of incubation at 25±1℃. The isolates of *F. oxysporum* f. sp. *ciceri* were categories into 5 groups (A, B, C, D and E) on the basis of colony characters and pigmentation (Plate 3). Ten isolates (FOC-6, FOC-10, FOC-15, FOC-16, FOC-18, FOC-25, FOC-26, FOC-27, FOC-49, FOC-50) in group A recorded colony diameter ranging between 50.3-58.4 mm and showed colony characters with pale white mycelial colour, floccose, serrated margin with appressed growth (Table 1); 15 isolates (FOC-1, FOC-2, FOC-7, FOC-13, FOC-17, FOC-19, FOC-24, FOC-35, FOC-38, FOC-39, FOC-40, FOC-41, FOC-44, FOC-47 and FOC-48 in group B having colony diameter between 36.4 to 52.8 mm showed colony characters with creamish white mycelial colour, floccose, serrated margin with fluffy growth; 17 isolates (FOC-4, FOC-5, FOC-8, FOC-9, FOC-11, FOC-14, FOC-20, FOC-21, FOC-22, FOC-28, FOC-30, FOC-31, FOC-33, FOC-36, FOC-37, FOC-42 and FOC-45) in group C having colony diameter between 40.3-51.6 mm, showed purple pink colony character with felted, serrated margin with partially appressed growth; 6 isolates (FOC-12, FOC-23, FOC-29, FOC-32, FOC-43 and FOC-46) in group D having colony diameter ranging between 46.6 to 57.9 mm showed colony character with pinkish mycelial colour, felted, serrated margin with partial appressed growth and 2 isolates (FOC-3 and FOC-34) in group E were colony diameters of 37.3 and 48.8 mm, respectively showed colony character as bright white mycelial colour, floccose, serrated margin with fluffy growth.

Morphological variation in isolates of *Fusarium oxysporum* f. sp. *ciceri* on PDA

The mycelia of all isolates of *F. oxysporum* f. sp. *ciceri,* when grown on PDA culture medium, were septate, hyaline having round or oval microconidia, with one or no septation. The size of microconidia ranged between 2.8-4.2 × 1.7-2.4 µm to 6.1-6.6 × 4.1-4.5 µm, the maximum size being recorded in FOC-1 and the minimum in FOC-7.

Macroconidia were sickle shaped having 1-5 septation with pointed or blunt ends, profusely branched and highly varied in width. Size of macroconidia ranged between 6.7-7.5× 1.9-2.6 µm and 14.4-17.6 × 5.4-5.7 µm, the maximum size was recorded in FOC-1 and the minimum in FOC-13 (Table 2).

Table No. 1: Culture variation within isolates of *Fusarium oxysporum* f. sp. *ciceri* on Potato Dextrose Agar medium

Isolate	Colony diameter (mm)	Group	Colony Character	Pigmentation
FOC-6	54.0	A	Pale white mycelial colour, floccose, serrated margin with appressed growth	Pale white
FOC-10	52.5			
FOC-15	51.6			
FOC-16	55.5			
FOC-18	57.4			
FOC-25	58.4			
FOC-26	55.4			
FOC-27	57.4			
FOC-49	52.2			
FOC-50	50.3			
FOC-1	43.6	**B**	Creamish white mycelial colour, floccose, serrated margin with fluffy growth	Creamish white
FOC-2	40.9			
FOC-7	41.3			
FOC-13	47.0			
FOC-17	41.1			
FOC-19	44.1			
FOC-24	50.9			
FOC-35	46.9			
FOC-38	44.3			
FOC-39	47.0			
FOC-40	48.1			
FOC-41	49.1			
FOC-44	52.8			
FOC-47	36.4			
FOC-48	48.3			
FOC-4	43.1	C	Purple pink mycelial colour, felted, serrated margin with partial appressed growth	Purple pink
FOC-5	45.8			
FOC-8	40.3			
FOC-9	40.4			
FOC-11	48.9			
FOC-14	47.6			
FOC-20	49.8			
FOC-21	42.8			
FOC-22	45.6			
FOC-28	47.8			
FOC-30	48.8			
FOC-31	47.3			
FOC-33	45.6			
FOC-36	49.8			
FOC-37	46.1			
FOC-42	51.1			
FOC-45	51.6			
FOC-12	56.9	D	Pinkish mycelial colour, felted, serrated margin with partial appressed growth	Pinkish
FOC-23	57.9			
FOC-29	50.1			
FOC-32	56.8			
FOC-43	50.4			
FOC-46	46.6			
FOC-3	37.3	E	Bright white mycelial colour, floccose, serrated margin with fluffy growth	Bright white
FOC-34	48.8			

The size of Chlamydospore ranged between 3.7-3.8 µm-6.6-7.0 µm, the maximum size was recorded in FOC-1 and the minimum in FOC-7.These results are again in agreement with those reported by Thaware *et al.* [6] who studied8 isolates of *F. oxysporum* f. sp. *ciceri* (FOC-1 to FOC-8) and recorded different dimensions and septation of microconidia and macroconidia that varied from 12.70×3.50µm to 17.20×3.50 µm; 20.35×7.00 µm to 30.50×7.00µm, respectively. Many other workers have also reported that the size of macroconidia, microconidia and chlamydospore falling in the range obtained in present investigations [7, 11, 12, 13, 14]. Similarly, Kadam [15] revealed that macroconidia were typically sickle shaped, curved, fusoid, varied in the size from 17.5µm to 49 µm and septation was between 2 to 5, while, size of microconidia was 23.22 × 6.18µm. Round chlamydospores were found in FOC-11 (Sangali), FOC-14 (Washim) and FOC-15 (Yawatmal), while other FOC isolates were oval to spherical.

Disease incidence of *Fusarium oxysporum* f. sp. *ciceri* isolates on chickpea differentials

All the 10 Focisolates, regardless of their geographical location, proved pathogenic and produced characteristic wilt symptoms. Internal discoloration of the root vascular system was conspicuous in wilted plants. Since the Indian isolates are producing only the typical wilting rather than the yellowing syndrome, the virulence was analysed on the basis of wilt incidence. Virulence analysis of Focisolates on 10 chickpea differential cultivars revealed high variability in wilt incidence, ranging from 0 to 90 per cent. All the isolates caused more than 20 per cent mean wilt incidence irrespective of the chickpea cultivars evaluated (Table 3). Among the Foc isolates tested on different chickpea differentials,FOC-3,FOC-28and FOC-34 isolate were recorded mean disease incidence of 41.40, 41.40, and 40.60 per cent, respectively and were highly virulent. These were followed byFOC-37,FOC-1,FOC-25 and FOC-32 with mean disease incidence of 35.70, 34.90, 34.80 and 34.30 per cent, respectively. The least virulent group comprising of FOC-18, FOC-38 and FOC-43 exhibiting disease incidence of 25.50, 25.50 and 23.90 per cent, respectively. Among the chickpea cultivars, Chaffa and JG-62 showed highest wilt incidence. Chickpea cultivars, C-104, JG-74, BG 212, WR 315and GPF 2 showed less than 20 per cent wilt incidence, irrespective of the fungal isolates.

Virulence response of *F. oxysporum* f. sp. *ciceri* on chickpea differentials

Virulence response of chickpea differentials to the wilt pathogen *F. oxysporum* f. sp. *ciceri* revealed that differentials *viz*., WR-315 and GPF-2 exhibited resistant reaction, whereas JG-62 and Chaffa showed susceptible reaction against all the isolates of Foc (Table 4). Whereas, C-104 and CPS-1 and DCP-92-3 were susceptible to all isolates, but exhibited resistant response to three isolates of Foc isolates *viz*., FOC-18, FOC-38 and FOC-43, whereas BG-212, KWR-108 and JG-74 exhibited resistant response to all the isolates under investigation, but were susceptible to FOC-3, FOC-28 and FOC-34.

Isolate Foc 18, Foc 38 and Foc 43 of Foc were resistant response to the entire chickpea differentials except of Chaffa and JG-62. Chickpea cultivars *viz.*,JG-74, BG-212, WR-315, KWR-108 and GPF-2 exhibited as resistance reaction to Foc37,Foc 1,Foc-25 and Foc 32 isolates. Fusarial wilt isolates, Foc-3, Foc-28 and Foc-34 were regarded as highly virulent groups and showed susceptible reaction to most of chickpea differentials except for WR-315 and GPF-2. It is concluded from the study that three different types of pathogenic groups existed in Jammu sub-tropics *i.e*., highly virulent (Foc-3, Foc-28 and Foc-34), moderately virulent (Foc-1, Foc-25, 32 and Foc-37), and least virulent (Foc-18, Foc-38 and Foc-43). Virulence analysis in *F. oxysporum* f. sp. *ciceri* was also reported by many researchers [16,17,18,19] studied pathological variability among the six isolates of *F. oxysporum* f. sp. *ciceri* of chickpea collected from different locations. Wilt incidence induced by isolates ranged from 59.9 to 100 per cent in JG-62, a variety highly susceptible to wilt. Two isolates from Rahuri and Hisar were highly virulent as evident from abundant sporulation, while others were moderately virulent showing poor sporulation. Sharma *et al*. [20] studied 48 isolates of *F. oxysporum* f. sp. *Ciceri* collected from different chickpea growing regions in India were evaluated for genetic variations, out of which 41 isolates were found pathogenic and seven non-pathogenic and the pathogenic isolates differed in their virulence. However, they concluded that there was no apparent correlation between geographical origin and virulence of the isolates. Mandhare *et al.* [21] reported morphological, pathogenic and molecular characterization of *F. oxysporum* f. sp. *ciceri* isolates from Maharashtra, India and the pathogenicity of each isolate was confirmed using wilt susceptible chickpea genotype JG-62.

Screening of chickpea germplasm against *F. oxysporum* f. sp. *ciceri*

In order to find out the sources of resistance in chickpea forFusariumwilt, 82 chickpea germplasm, collected from Pulse Research Sub Station, SKUAST-J, Samba, K.V.K., Ghazipur and G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) were evaluated during *Rabi* 2016-17 and 2017-18 under field conditions by the standard procedure. Under natural epiphytotic conditions, all the 82 chickpea entries exhibited different reactions against *F. oxysporum* f. sp. *ciceri* during *Rabi* 2016-2017 and 2017-18. However, four germplasm*viz.*, H-82-2, DCP-92-3, Avrodhi and Uday were found resistant with mean disease intensity of 3.34, 4.13, 4.47 and 5.16 per cent, respectively during *Rabi* 2016-17 and 3.69, 4.38, 5.35 and 5.32 per cent, respectively during *Rabi* 2017-18, 27 germplasm*viz*., SCS-15-D-1, SCS-15-D-2, SCS-15-D-3, SCS-15-D-4, SCS-15-D-5, SCS-15-D-6, SCS-15-D-7, SCS-15-D-8, SCS-15-D-9, SCS-15-D-10, SCS-15-D-11 SCS-15-D-12, SCS-15-D-13, SCS-15-D-14, SCS-15-D-15, SCS-15-D-16, SCS-15-D-17, SCS-15-D-18, SCS-15-D-19, SCS-15-D-20, SCS-15-D-21, SCS-15-D-22, SCS-15-D-23, SCS-15-D-24, SCS-15-D-25, SCS-15-D-26, SCS-15-D-27 were found moderately resistant with mean disease intensity in the range of 11.83-14.83 per cent; 12.66-15.50 per cent, respectively during *Rabi* 2016-17 and 2017-18 (Table 5 and 6).

Thirty seven germplasm*viz.*, GNG-1501, GNG-496, RSG-963, CSJ-515, JG-14, JG-11, JG-63, J66-1, JKG-1, VIJAY, GNG-1581, RSG-973, JAKI-9218, RSG-974, RSGH-6, JG-16, RSG-963, HC-1, RSG-943, RSG-888, PG-186, RSG-895, C-606, C-923, CSJ-303, CSJ-313, BG-3013, HO7-163, GAURAV, BDNG-K-798, BDN-9-3, BDNG-797, H-208, PKC-1, CSJK-6, CSJ-515, CSJK-31 were found moderately susceptible with mean disease intensity 14.16 to 18.60 per cent during *Rabi* 2016-17 and 14.68 to 18.50 per cent during *Rabi*2017-18; 14 germplasm*viz*., RSG-896, RSG-931, SAMRAI, KWR-108, RSG-807, PG-114, PG-186, PKC-2, PG-183, PG-3, PG-4, JG-62, C-235 and L-550, were found susceptible to wilt with mean disease incidence of 19.59-29.90 during 2016-17 and 20.00-30.16 during *Rabi* 2017-18.Our results are in line with the findings of Bajwa *et al*. [22] found that out of 32 genotypes only one line was resistant and other 31 lines were susceptible to *F. oxysporum* f. sp. *ciceris*. Kumar *et al.* [23] screened 101 genotypes of chickpea against Fusarium wilt out of which 57 were resistant, 28 were tolerant while 16 showed as susceptible to *F. oxysporum* f. sp. *ciceris* at seedling stage. At reproductive stage, 31 genotypes were resistant, 26 were tolerant and 44 were susceptible to the disease. Mirzapour *et al.* [24] evaluated 18 genotypes/cultivars against chickpea wilt and observed disease incidence of 0-46.6 per cent at seedling stage and it varied from 0-100 per cent at reproductive stage. Benzohra-Belaidi [25] screening chickpea genotype accessions for resistance to two races of *F. oxysporum* f. sp. *ciceris*, the causal pathogen of chickpea wilt disease to evaluate the resistance of 13 chickpea genotype accessions to *F. oxysporum* f. sp. *ciceris* and reported that 3 chickpea genotypes (Flip4107, Kadri and Flip 97-555) had an important resistance and other 10 genotypes (PPC25, Bouazza, INRAA199, P505, Col15-24, Col15-07, ILC1929, ILC482, Flip9393, Flip3701c) were susceptible to Fusarium wilt. Thaware *et al.* [6] observed that all the 50 chickpea entries exhibited different reactions against *F. oxysporum* f. sp. *ciceri*. However, 6 test entries were found highly resistant, 31 were resistant, 8 were moderately resistant, 2 were moderately susceptible and 3 were highly susceptible. Patil *et al.* [26] observed that out of seven isolates, I-19 and I-28 showed resistant reaction, I-20, I-13 and I-1 showed moderately resistant, whereas I-4 and I-80 showed susceptible reaction on chickpea Cv. JG-315. All the isolates showed susceptible reaction to JG-62 which matched our findings.

Table 2: Morphological variation of conidia of different isolates of *Fusarium oxysporum* f. sp. *ciceri*

Isolate	Size of microconidia (µm)				Size of macroconidia (µm)				Chlamydospore Diameter (µm)	
	L×B	Range	Mean	No. of septa	L×B	Range	Mean	No. of septa	Mean	Range
FOC-1	6.3×4.4	6.1-6.6× 4.1-4.5	6.3×4.3	0-1	16.9×5.6	14.4-17.6× 5.4-5.7	16.3×5.5	1-5	6.8	6.6-7.0
FOC-2	5.1×3.7	4.7-5.3× 3.5-3.9	5.0×4.1	0-1	13.5×5.1	12.6-13.9× 4.6-5.5	13.33×5.0	1-3	4.2	4.1-4.4
FOC-3	5.5×3.9	5.4-5.7× 3.7-4.2	5.5×3.9	0-1	13.5×4.8	12.8-13.8× 4.2- 5.1	13.37×4.7	1-4	5.4	5.2-5.6
FOC-4	4.9×3.4	4.6-5.2× 3.1-3.5	4.9×3.3	0-1	11.2×4.4	10.4-11.8× 3.7-4.8	11.13×4.3	1-3	4.9	4.8-5.0
FOC-5	4.8× 3.2	4.7-4.9× 3.0-3.5	4.8×3.2	0-1	10.5×4.2	9.9-10.9× 3.6-4.8	10.43×4.2	1-2	4.7	4.5-4.7
FOC-6	5.2× 3.7	5.0-5.4× 3.5-3.9	5.2×3.7	0-1	11.0×5.1	10.5-11.4× 4.5-5.5	10.96×5.0	1-4	5.6	5.5-5.7
FOC-7	4.2× 2.1	2.8-4.2× 1.7-2.4	3.0×2.0	0	9.1×3.1	8.4-9.6× 2.7- 3.4	9.03×3.0	1-3	3.8	3.7-3.8
FOC-8	5.2× 3.8	4.8-5.3× 3.6-4.1	5.1×3.8	0-1	14.1×4.8	13.6-14.6× 4.3-5.2	14.10×5.0	1-3	5.1	5.0-5.3
FOC-9	4.8× 3.3	4.6-5.0× 3.1-3.5	4.8×3.3	0-1	12.8×4.8	12.4-13.1× 4.4-5.2	12.76×4.8	1-2	4.8	4.6-5.2
FOC-10	3.3× 2.2	3.1-3.5× 2.0-2.5	3.3×2.2	0	8.9× 2.2	8.4-9.3× 1.7-2.6	8.86×2.1	1-2	5.4	5.3-5.5
FOC-11	4.9× 3.3	4.6-5.2× 3.1-3.4	4.9×3.2	0-1	12.8×4.0	12.5-13.2× 3.6-4.3	12.83×3.9	1-3	5.2	5.1-5.3
FOC-12	3.9× 2.4	3.7-4.2× 2.1-2.5	3.9×2.3	0	8.9×2.5	8.6-9.3× 1.8-2.9	8.93×2.4	1-2	5.8	5.6-5.9
FOC-13	3.1× 2.1	3.1-4.5× 1.8-2.4	4.2×2.1	0	7.2× 2.2	6.7-7.5× 1.9-2.6	7.13×2.2	1-3	5.1	4.9-5.2
FOC-14	4.5× 2.5	4.3-4.7× 2.3-2.6	4.5×2.4	0-1	13.2×3.5	12.7-13.7× 3.1-3.8	13.20×3.4	1-2	4.9	4.7-5.0
FOC-15	3.9× 2.0	3.7-4.2× 1.9-2.2	3.9×2.0	0	11.1×4.0	10.6-11.6× 3.7-4.3	11.10×4.0	1-4	5.7	5.6-5.7
FOC-16	3.8× 2.0	3.5-4.1× 1.9-2.3	3.8×2.0	0	10.9×2.0	10.5-11.4× 1.7- 2.4	10.93×2.0	1-3	5.9	5.8-6.1
FOC-17	5.1× 3.5	4.8-5.4× 3.0-3.6	5.1×33	0-1	14.3×5.1	13.9-14.7× 4.7-5.5	14.30×5.1	1-5	5.0	4.8-5.1
FOC-18	5.5× 3.7	5.2-5.7× 3.6-3.9	5.4×3.7	0-1	14.2×5.5	13.8-14.6× 5.2-5.7	10.86×5.4	1-3	6.0	5.7-6.2
FOC-19	5.9× 3.7	5.6-6.0× 3.6-3.9	5.8×3.7	0-1	11.2×4.8	10.7-11.5× 4.3-5.2	11.13×4.7	1-5	4.2	4.0-4.3
FOC-20	5.5× 3.4	5.4-5.6× 3.2-3.6	5.5×3.4	0-1	14.0×5.5	13.7-14.3× 5.2-5.6	14.00×5.4	1-5	5.4	5.3-5.4
FOC-21	3.4× 2.1	2.9-3.4× 1.8-2.3	3.1×2.0	0-1	11.3×3.1	11.1-11.5× 2.7-3.6	11.30×3.1	1-5	4.9	4.8-5.2
FOC-22	5.2× 2.1	4.9-5.4× 2.0-2.3	5.1×2.1	0-1	13.5×3.8	13.2-13.8× 3.5-4.2	13.50×3.8	1-4	4.7	4.7-4.9
FOC-23	5.3× 2.2	5.1-5.5× 2.0-2.5	5.3×2.2	0-1	10.5×3.1	10.1-10.7× 2.7-3.6	10.43×3.1	1-4	5.1	5.0-5.3
FOC-24	4.1× 2.0	3.8-4.4× 1.8-2.3	4.1×2.0	0-1	9.1× 2.9	8.6-9.4× 2.7-3.3	9.03×2.9	1-3	5.3	5.1-5.3
FOC-25	4.8× 2.3	4.6-5.1× 2.0-2.5	4.8×2.2	0-1	14.2×4.8	13.8-14.5× 4.5-5.3	13.86×4.8	1-4	5.9	5.8-6.0

FOC-26	4.2× 2.0	4.0-4.5× 1.8-2.3	4.2×2.0	0-1	12.8×4.2	12.5-13.1× 3.8-4.5	12.80×4.1	1-3	5.7	5.6-5.9
FOC-27	3.9× 2.1	3.6-4.2× 2.0-2.4	3.9×2.1	0	8.9× 2.6	8.6-9.3× 2.4-2.9	8.93×2.6	1-2	5.1	5.0-5.3
FOC-28	4.2× 2.1	4.0-4.5× 1.9-2.4	4.2×2.1	0	12.2×4.2	11.8-12.5× 3.7-4.5	12.16×4.1	1-3	5.0	4.9-5.2
FOC-29	3.5× 2.0	3.2-3.6× 1.9-2.2	3.4×2.0	0	13.6×3.5	13.3-13.9× 3.3-3.9	13.60×3.9	1-4	6.2	6.0-6.3
FOC-30	5.1× 3.2	4.8-5.3× 3.0-3.5	5.0×3.2	0-1	11.9×4.9	11.4-12.3× 4.5-5.2	11.86×4.8	1-3	5.3	5.3-5.5
FOC-31	5.2× 3.3	5.0-5.4× 3.1-3.4	5.2×3.2	0-1	11.7×4.5	11.6-12.4× 4.1-4.7	11.90×4.4	1-2	4.9	4.7-5.1
FOC-32	5.1× 3.3	4.9-5.3× 3.0-3.5	5.1×3.2	0-1	14.1×5.1	13.6-14.4× 4.8-5.4	14.03×5.1	1-3	6.3	5.8-6.3
FOC-33	5.8× 3.7	5.4-6.0× 3.5-3.9	5.7×3.7	0-1	11.3×4.8	11.1-11.6× 4.3-4.9	11.33×4.6	1-3	4.2	4.1-4.4
FOC-34	3.6× 2.0	3.4-3.7× 1.9-2.2	3.5×2.0	0	10.9×3.6	10.4-11.4× 3.4-3.8	10.90×3.6	1-2	5.2	5.1-5.4
FOC-35	4.1× 2.2	3.9-4.4× 2.0-2.3	4.1×2.1	0-1	10.1×3.7	9.7-10.4× 3.4-3.9	10.06×3.6	1-3	4.8	4.8-5.2
FOC-36	5.2× 3.1	5.1-5.4× 2.9-3.4	5.2×3.1	0	11.2×4.6	10.7-11.4× 4.3-4.9	11.10×4.6	1-4	4.5	4.4-4.7
FOC-37	4.9× 2.8	4.7-5.2× 2.7-3.0	4.9×2.8	0-1	13.1×4.6	12.7-13.3× 4.2-4.7	13.03×4.5	1-4	4.3	4.2-4.4
FOC-38	5.5× 3.2	5.3-5.7× 3.0-3.3	5.5×3.1	0-1	14.1×5.0	13.7-14.5× 4.7-5.3	14.10×5.0	1-3	3.9	3.7-3.9
FOC-39	5.9× 3.7	5.7-6.0× 3.6-3.9	5.8×3.7	0-1	11.2×4.9	10.7-11.4× 4.7-5.3	11.10×4.9	1-3	4.2	4.1-4.3
FOC-40	5.3× 3.4	5.1-5.4× 3.1-3.5	5.2×3.3	0-1	11.3×5.0	11.1-11.4× 4.7-5.3	11.26×5.0	1-3	4.7	4.6-4.9
FOC-41	4.2× 2.1	4.0-4.3× 2.0-2.4	4.1×2.1	0	10.2×4.2	9.9-10.4× 3.9-4.5	10.16×4.2	1-3	5.1	5.1-5.4
FOC-42	3.4× 2.1	2.9-3.4× 1.8-2.3	3.1×2.0	0	9.3× 3.1	9.0-9.4× 2.7-3.5	9.23×3.1	1-4	5.3	5.1-5.3
FOC-43	3.4× 2.1	3.1-3.5× 2.0-2.3	3.3×2.1	0	10.4×3.4	10.0-10.5× 3.1-3.6	10.30×3.3	1-5	6.0	5.8-6.0
FOC-44	4.8× 2.5	4.5-4.9× 2.3-2.7	4.7×2.5	0-1	11.1×4.7	10.6-11.4× 4.5-4.9	11.03×4.7	1-2	3.9	3.9-4.3
FOC-45	3.9× 2.1	3.6-4.0× 2.0-2.4	3.8×2.1	0	10.9×3.9	10.4-11.3× 3.7-4.1	10.86×3.9	1-2	5.8	5.6-5.9
FOC-46	4.9× 2.1	4.6-5.0× 2.0-2.5	4.8×2.2	0-1	11.2×4.5	10.9-11.4× 4.3-4.7	11.16×4.5	1-2	5.9	5.8-6.1
FOC-47	5.9× 3.5	5.7-6.0× 3.4-3.7	5.8×3.5	0-1	12.1×5.2	12.0-12.4× 5.0-5.4	12.16×5.2	1-3	4.4	4.3-4.5
FOC-48	5.5× 3.1	5.3-5.7× 2.8-3.3	5.5×3.0	0-1	13.2×5.5	13.1-13.4 ×5.3-5.8	13.23×5.5	1-5	4.9	4.7-4.9
FOC-49	5.2× 3.0	4.9-5.4× 2.9-3.2	5.1×3.0	0-1	10.1×3.8	9.9-10.4× 3.5-4.0	10.13×3.7	1-5	6.2	6.0-6.3
FOC-50	4.8× 2.5	4.7-5.1× 2.3-2.7	4.6×2.5	0-1	11.2×4.8	11.0-11.5 × 4.4-4.9	11.23×4.7	1-5	5.7	5.6-5.9

Table 3: Disease incidence of *Fusarium oxysporum* f. sp. *ciceri* isolateson chickpea differentials

Isolate	Per cent disease incidence in chickpea differential										Mean
	C-104	JG-74	CPS-1	BG-212	WR-315	KWR-108	GPF-2	DCP-92-3	Chaffa	JG-62	
FOC-1	24	19	59	0	0	11	0	79	69	88	34.9
FOC-3	30	28	80	35	0	60	0	46	75	60	41.4
FOC-18	0	0	10	20	15	15	20	20	85	70	25.5
FOC-25	24	18	59	0	0	11	0	78	69	89	34.8
FOC-28	30	28	80	35	0	60	0	46	75	60	41.4
FOC-32	23	18	58	0	0	10	0	78	68	88	34.3
FOC-34	29	27	79	34	0	59	0	45	74	59	40.6
FOC-37	25	20	60	0	0	12	0	80	70	90	35.7
FOC-38	0	0	10	20	15	15	20	20	85	70	25.5
FOC-43	0	0	8	18	13	13	18	18	83	68	23.9
Mean	18.5	15.8	50.3	16.2	4.3	26.6	5.8	51.0	75.3	74.2	

0-20%= Resistant; 20-100%= Susceptible

Table 4: Virulence response of *Fusarium oxysporum* f. sp. *ciceri*isolates on chickpea differentials

Isolate	Disease reaction of different isolates of *F. oxysporum* f. sp. *ciceri* on chickpea differentials									
	JG-62	Chaffa	WR-315	GPF-2	C-104	CPS-1	DCP-92-3	BG-212	KWR-108	JG-74
FOC-1	S	S	R	R	S	S	S	R	R	R
FOC-3	S	S	R	R	S	S	S	S	S	S
FOC-18	S	S	R	R	R	R	R	R	R	R
FOC-25	S	S	R	R	S	S	S	R	R	R
FOC-28	S	S	R	R	S	S	S	S	S	S
FOC-32	S	S	R	R	S	S	S	R	R	R
FOC-34	S	S	R	R	S	S	S	S	S	S
FOC-37	S	S	R	R	S	S	S	R	R	R
FOC-38	S	S	R	R	R	R	R	R	R	R
FOC-43	S	S	R	R	R	R	R	R	R	R

Table 5: Evaluation of chickpea germplasm against wilt caused by *F. oxysporum* f. sp. *ciceri* under field conditions

S. No.	Germplasm	Disease incidence (%)							
		60 DAS*		75 DAS*		90 DAS*		Mean	
		2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
1	H-82-2	1.05	1.41	2.79	3.17	6.19	6.49	3.34	3.69
2	DCP-92-3	1.82	2.01	3.52	3.81	7.07	7.33	4.13	4.38
3	AVRODHI	2.10	2.07	4.00	5.50	8.12	8.50	4.74	5.35
4	UDAY	2.20	2.35	5.30	5.40	8.00	8.21	5.16	5.32
5	SCS-15-D-1	8.00	8.50	15.00	15.50	19.50	20.00	14.16	14.69
6	SCS-15-D-2	7.50	8.50	13.50	14.00	17.50	18.00	12.83	13.50
7	SCS-15-D-3	8.00	9.00	14.50	15.00	18.50	19.00	13.66	14.38
8	SCS-15-D-4	7.00	8.00	14.50	15.00	18.00	18.50	13.16	13.83
9	SCS-15-D-5	6.50	7.50	13.50	14.00	17.50	18.00	12.50	13.16
10	SCS-15-D-6	7.50	8.50	16.00	16.50	20.00	20.00	14.50	15.00
11	SCS-15-D-7	8.00	9.00	17.00	17.50	19.50	20.00	14.83	15.50
12	SCS-15-D-8	7.50	8.50	14.00	14.50	17.00	17.50	12.83	13.50
13	SCS-15-D-9	6.00	7.00	15.50	16.00	18.50	19.50	13.30	14.16
14	SCS-15-D-10	5.50	6.50	15.50	15.00	17.50	18.50	12.80	13.39
15	SCS-15-D-11	6.00	7.00	13.00	13.50	16.50	17.50	11.83	12.69
16	SCS-15-D-12	7.50	8.00	14.50	15.00	18.00	19.00	13.35	14.00
17	SCS-15-D-13	7.00	7.50	15.50	16.00	18.50	19.50	13.60	14.37
18	SCS-15-D-14	6.00	6.50	16.00	16.50	19.00	20.00	13.64	14.39
19	SCS-15-D-15	6.00	7.00	16.50	17.00	18.50	19.50	13.66	14.50
20	SCS-15-D-16	5.50	6.00	16.50	17.00	19.00	19.50	13.66	14.16
21	SCS-15-D-17	5.00	5.50	14.50	15.00	17.50	18.50	12.39	13.00
22	SCS-15-D-18	5.00	5.50	14.00	14.50	17.00	18.00	12.00	12.68
23	SCS-15-D-19	5.50	6.00	14.00	14.50	17.00	17.50	12.16	12.66
24	SCS-15-D-20	6.00	6.50	14.50	15.00	17.50	18.50	12.66	13.34
25	SCS-15-D-21	5.50	6.00	15.50	16.00	19.00	20.00	13.35	14.67
26	SCS-15-D-22	5.00	5.50	13.00	13.50	19.00	19.50	12.39	12.83
27	SCS-15-D-23	5.00	5.50	13.50	14.00	18.50	19.50	12.34	13.67
28	SCS-15-D-24	5.50	6.00	14.00	14.50	19.50	20.00	13.00	13.50
29	SCS-15-D-25	6.00	6.50	14.50	15.00	19.50	20.00	13.37	13.83
30	SCS-15-D-26	6.50	7.00	14.50	15.00	19.50	20.00	13.50	14.00
31	SCS-15-D-27	6.50	7.00	14.50	15.00	19.50	20.00	13.56	14.00
32	GNG 1501	5.00	5.50	14.50	15.00	24.00	25.00	14.59	15.16
33	GNG 496	5.50	6.00	16.00	16.50	24.50	25.50	15.34	16.00
34	RSG 963	5.50	6.00	16.50	17.00	26.50	27.50	16.17	16.83
35	CSJ 515	6.00	7.00	16.50	17.00	26.00	27.00	16.19	17.00
36	JG 14	7.50	8.00	14.00	14.50	22.50	23.00	14.64	15.16
37	JG 11	7.00	7.50	15.00	15.50	23.00	23.50	15.43	15.50
38	JG 63	6.50	7.00	14.00	14.50	22.00	23.50	14.16	15.00

39	J66- 1	6.50	7.00	14.50	15.00	23.50	24.50	14.83	15.50
40	JKG-1	5.50	6.00	15.50	16.00	24.50	25.00	15.16	15.66
41	VIJAY	5.50	6.00	16.50	17.00	22.00	22.50	14.66	15.16
42	GNG 1581	6.00	6.50	16.50	17.00	24.50	25.00	15.67	16.16
43	RSG 973	6.50	7.00	16.50	17.00	26.00	26.50	16.39	16.83
44	JAKI-9218	6.50	7.00	16.00	16.50	27.00	27.50	16.50	17.00
45	RSG- 974	6.50	7.00	16.50	17.00	25.50	26.00	16.16	16.69
46	RSGH- 6	6.50	7.00	16.50	17.00	26.50	27.00	16.59	17.00
47	JG-16	7.00	7.50	14.50	15.00	27.00	28.00	16.16	16.83
48	RSG-963	7.00	8.00	16.50	17.00	24.50	23.50	16.00	16.16
49	HC-1	6.50	7.00	14.50	15.00	23.00	22.00	14.64	14.68
50	RSG-943	7.50	8.00	15.50	16.00	26.00	26.00	16.34	16.60
51	RSG-888	6.50	7.00	15.00	15.50	26.50	25.50	16.70	16.00
52	PG-186	6.00	6.50	15.00	15.50	26.50	25.50	15.83	15.83
53	RSG-895	5.50	6.50	14.50	15.00	26.00	25.00	15.34	15.50
54	C-606	6.50	7.00	18.00	18.50	26.50	25.50	17.34	17.00
55	C-923	7.50	7.50	17.00	17.50	27.00	26.00	17.16	17.00
56	CSJ-303	6.50	7.00	15.00	15.50	23.50	24.00	15.90	15.50
57	CSJ-313	5.50	6.00	15.00	15.50	24.50	25.50	15.69	15.65
58	BG-3013	6.00	6.50	15.50	16.00	24.50	25.00	15.34	15.83
59	H07-163	5.50	6.00	15.50	16.00	25.50	26.00	15.50	16.00
60	GAURAV	9.50	9.50	19.00	19.50	25.50	26.50	18.60	18.50
61	BDNG-K-798	6.00	6.50	17.00	17.50	24.50	25.00	15.83	16.33
62	BDN-9-3	6.50	6.50	17.00	17.50	26.00	26.50	16.57	16.83
63	BDNG-797	7.00	7.50	17.00	18.00	25.50	26.50	16.59	17.38
64	H 208	6.00	6.50	16.00	16.50	28.00	27.50	16.65	16.83
65	PKC-1	6.00	6.50	15.50	16.50	25.00	24.50	15.50	15.83
66	CSJK-6	6.50	7.00	15.00	16.50	26.00	28.50	15.83	17.33
67	CSJ-515	6.00	5.50	14.50	15.00	24.00	25.00	14.83	15.16
68	CSJK-31	6.50	6.00	15.00	15.50	26.00	26.50	15.83	16.00
69	RSG-896	7.50	8.00	21.00	22.50	34.50	35.00	21.00	21.83
70	RSG-931	8.50	8.50	23.50	24.00	34.00	34.50	22.00	22.37
71	SAMRAI	8.50	9.00	23.50	24.00	32.00	32.50	21.30	21.83
72	KWR-108	9.50	9.50	24.50	25.00	32.00	34.00	22.00	22.83
73	RSG-807	9.00	9.50	24.50	25.00	38.00	38.50	21.50	22.00
74	C-235	10.00	10.50	29.50	31.50	47.50	48.50	29.90	30.16
75	PG-114	8.50	8.00	15.50	16.50	34.50	35.50	19.59	20.00
76	PG-186	7.50	8.00	16.50	17.00	37.00	37.50	20.34	20.83
77	PKC-2	7.50	8.00	18.50	19.50	39.00	40.00	21.69	22.50
78	PG-183	7.50	8.50	19.00	20.50	41.50	42.50	22.69	23.83
79	PG-4	7.50	8.00	21.00	21.50	40.50	42.00	23.56	23.83
80	PG-3	6.50	7.50	20.50	22.00	36.00	37.50	21.89	22.39
81	JG 62	10.50	10.00	27.50	29.00	48.50	49.50	28.83	29.50
82	L 550	8.50	9.50	25.50	27.50	47.00	48.00	27.90	28.37

Table 6: Screening of chickpea germplasm for resistance to Fusarium wilt during *Rabi* seasons of2016-17 and 2017- 18

Disease Incidence (%)	Chickpea germplasm (*Rabi* 2016-17)	Chickpea germplasm (*Rabi* 2017-18)	Disease reaction
1-10	H-82-2, DCP-92-3, Avrodhi, Uday	H-82-2, DCP-92-3, Avrodhi, Uday	Resistant (R)
10.1-20	SCS-15-D-1, SCS-15-D-2, SCS-15-D-3, SCS-15-D-4, SCS-15-D-5, SCS-15-D-6, SCS-15-D-7, SCS-15-D-8, SCS-15-D-9, SCS-15-D-10, SCS-15-D-11 SCS-15-D-12, SCS-15-D-13, SCS-15-D-14, SCS-15-D-15, SCS-15-D-16, SCS-15-D-17, SCS-15-D-18, SCS-15-D-19, SCS-15-D-20, SCS-15-D-21, SCS-15-D-22, SCS-15-D-23, SCS-15-D-24, SCS-15-D-25, SCS-15-D-26, SCS-15-D27,	SCS-15-D-1, SCS-15-D-2, SCS-15-D-3, SCS-15-D-4, SCS-15-D-5, SCS-15-D-6, SCS-15-D-7, SCS-15-D-8, SCS-15-D-9, SCS-15-D-10, SCS-15-D-11 SCS-15-D-12, SCS-15-D-13, SCS-15-D-14, SCS-15-D-15, SCS-15-D-16, SCS-15-D-17, SCS-15-D-18, SCS-15-D-19, SCS-15-D-20, SCS-15-D-21, SCS-15-D-22, SCS-15-D-23, SCS-15-D-24, SCS-15-D-25, SCS-15-D-26, SCS-15-D27,	Moderately resistant (MR)
20.1-30	GNG 1501, GNG496, RSG 963, CSJ515, JG 14, JG 11, JG 63, J66-1, JKG-1, VIJAY, GNG 1581, RSG973, JAKI 9218, RSG- 974, RSGH-6, JG-16, RSG-963, HC 1, RSG-943, RSG-888, PG-186, RSG-895, C 606, C 923, CSJ 303, CSJ 313, BG 3013, HO7-163, GAURAV, BDNG-K-798, BDN-9-3, BDNG-797, H 208, PKC-1,CSJK-6, CSJ-515, CSJK- 31	GNG 1501, GNG496, RSG 963, CSJ515, JG 14, JG 11, JG 63, J66-1, JKG-1, VIJAY, GNG 1581, RSG973, JAKI 9218, RSG- 974, RSGH-6, JG-16, RSG-963, HC-1, RSG-943, RSG-888, PG-186, RSG-895, C 606, C 923, CSJ 303, CSJ 313, BG 3013, HO7-163, GAURAV, BDNG-K-798, BDN-9-3, BDNG-797, H 208, PKC-1,CSJK-6, CSJ-515, CSJK-31	Moderately susceptible (MS)
30.1-50	RSG-896, RSG-931, SAMRAI, KWR-108, RSG-807, PG-114, PG-186, PKC-2, PG-183, PG-4, PG-3, JG 62, L550, C235	RSG-896, RSG-931, SAMRAI, KWR-108, RSG-807, PG-114, PG-186, PKC-2, PG-183, PG, PG-3, JG 62, L550, C235	Susceptible (S)
>50	Nil	Nil	Highly susceptible (HS)

Disease Reaction	:	**Per cent wilt (mortality)**
Resistant (R)	:	0-10% mortality
Moderately resistant (MR)	:	10.1-20% mortality
Moderately susceptible (MS)	:	20.1-30% mortality
Susceptible (S)	:	30.1-50% mortality
Highly susceptible (HS)	:	above 50% mortality

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