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Screening of chickpea (*Cicer arietinum* L.) genotypes for resistance to wilt disease caused by *Fusarium oxysporum* f. sp. *ciceri*

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Abstract
Chickpea (*Cicer arietinum* L.) is one of the important pulse crops, in India. Among fungal diseases, wilt caused by *Fusarium oxysporum* f. sp. *ciceri* Butler has been observed to be predominant and most destructive in major chickpea growing areas. Use of resistant varieties is the only ecofriendly and economically feasible approach for management of this disease. Therefore, present study was undertaken to search the resistant genotypes against wilt disease under glass house conditions during *Rabi* 2018-19. Out of 40 genotypes, 4 genotypes were found highly resistant namely Vishal, BCP-49, BCP-10 and BCP-60, 14 genotypes were found resistant namely Avarodhi, KWR-108, K-850, Pusa-362, Vijay, Digvijay, Krupa, AKG-70, PG-8108, BCP-92, BCP-51, BCP-24, BCP-52 and BCP-124, 10 moderately resistant namely Pant G-186, KGW-292, Uday (KP-75), KPG-59, PUSA-256, IPCK-2004-29, BDNG-9-3, BDNG-801, BCPK-3 and AKG-2009, 3 moderately susceptible namely KGW-385, KGW-374 and Virat, 3 susceptible Pusa-372, Radhey and C-104 and 6 highly susceptible Chaffa, CPS 1, JG-74, JG-62, BDNGK-807 and AKG-1207.These highly resistant genotypes may be utilized as donor for breeding varieties resistant to wilt disease.

Keywords: Chickpea, Screening, Genotype, *Fusarium oxysporum* f. sp. *Ciceri*

Introduction
Chickpea (*Cicer arietinum* L.) commonly known as Gram or Bengal gram or Egyptian pea belongs to the subfamily, Papilionaceae (family- Leguminosae) with chromosome number, 2n = 2x = 16. It is an important Rabi season pulse crop in India. Pulses are basic ingredient in the diet of a vast majority of Indian population as they provide a perfect mixture of high biological value when supplemented with cereals. It has carbohydrates 27.42 gram, protein 8.86 gram and fat 2.59 gram per 100 gram of chickpea. Chickpea is high in protein, low in fat and sodium, cholesterol free and is excellent source of both soluble and insoluble fiber, as well as complex carbohydrates, vitamin and minerals especially calcium, phosphorus, iron and magnesium (Roy *et al*., 2010) [13].

Germinated seeds are recommended to cure scurvy disease in human being. Being a pulse crop, it is a good source of protein constituting about 99 per cent in grains on dry weight basis, which is very cheap and hence referred as “Poor man’s meat” (Muehlbauer and Rajesh, 2008) [12].

Chickpea is the third most important pulse crop, after dry bean and peas, produced in the world. It accounts for 20 per cent of the world pulses production. Major producers of chickpea include India, Pakistan and Mexico. India is the largest producer, with about 8 million tons, accounting of about 69 to 71 per cent of total world production.

The area, production and productivity of chickpea among the major pulses in India is estimated to be 9.93 mha; 9.53 mt. and 960 kg/ha respectively. It is grown in Madhya Pradesh, Rajasthan, Uttar Pradesh, Jharkhand, Maharashtra, Bihar, Punjab, Haryana, Andhra Pradesh and Chhattisgarh. However, six major states *viz*., Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh altogether contribute 91 per cent of the production and 90 per cent of the area. The area, production and productivity of chickpea in U.P. is estimated to be 6.11 Lakh ha; 6.84 Lakh tons and 1119.48 kg/ha (Anonymous 2018) [1].

In spite of the excluding efforts made by different agencies to boost up its production, the total production and productivity per unit area is very less. Among the various factors responsible for yield, one of the major factors is the wilt of chickpea caused by different pathogens.

The pathogen of the disease is soil borne and can survive in the soil for at least six years in the absence of host. It is one of the major disease of chickpea at national level; the yield losses encountered was reported about 60 per cent (Singh and Gupta, 2007) [14].

F. oxysporum f. sp. *ciceri* infects chickpea at seedling stage as well as at flowering and pod forming stage with more incidence at flowering and podding stage if the crop is subjected to sudden temperature rise and water stress (Choudhary *et al*., 2007) [3]. Losses of chickpea from Fusarium wilt have been reported to vary from 10 to 15 per cent (Jalali and Chand, 1991) [74] but losses of up to 70 per cent have been reported in some years in Northern India and Pakistan. Four races (1 to 4) of Fusarium wilt have been identified from India (Haware and Nene, 1982) [5].

Therefore, in view of the seriousness of the disease and importance of the crop, present studies were undertaken screening of varieties/cultivars of chickpea for disease under pot culture experiment.

Methods and Material

Screening of chickpea germplasm consisting of released varieties/cultivars, were carried out under artificial conditions to find out the source of resistance to wilt of chickpea caused by *Fusarium oxysporum* f. sp. *ciceri.*

In Rabi season 2018-2019 varieties/cultivars of chickpea were grown in Glass house compound, Department of Plant Pathology, C. S. Azad University of Agriculture and technology, Kanpur. Each variety under test was sown in earthen pots in three replications. In order to ensure epidemics of the disease, the inoculum of the test fungus was added in the soil of earthen pots (45x20cm) before sowing. After fifteen days of sowing, the total number of plants in each earthen pot was counted and wilting was recorded with an interval of a month. To avoid error in counting, the counted wilted plants were up rooted.

The varieties were categorized into six reactions (I), Highly Resistant (HR), Resistant (R), Moderately Resistant (MR), Moderately Susceptible (MS), Susceptible (S), and Highly susceptible (HS).

Table 1: Grade, Show Levels of per cent and Reactions

Grade	Levels of per cent	Reactions
1	0.0 -1.0	Highly Resistant (HR)
2	1.1-10.0	Resistant (R)
3	10.1 -25.0	Moderately resistant (MR)
4	25.1-50.0	Moderately Susceptible (MS)
5	50.1-75.0	Susceptible (S)
6	> 75.0	Highly susceptible (HS)

Experimental Findings

Chickpea varieties/cultivars were tested in the glass house compound, Department of Plant Pathology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur for their resistance to Fusarium wilt under artificial conditions during *Rabi* season of 2018-2019. The results as obtained are presented in Table 6.

It is evident from the Table-6 that out of 40 varieties/cultivars of chickpea tested under artificial conditions, 4 varieties/ cultivars were free and highly resistant from infection namely Vishal, BCP-49, BCP-10, and BCP-60, 14 varieties/cultivars were found resistant namely Avarodhi, KWR-108, K-850, Pusa-362, Vijay, Digvijay, Krupa, AKG-70, PG-8108, BCP-92, BCP-51, BCP-24, BCP-52 and BCP-124, 10 moderately resistant namely Pant G-186, KGW-292, Uday (KP-75), KPG-59, PUSA-256, IPCK-2004-29, BDNG-9-3, BDNG-801, BCPK-3 and AKG-2009, 3 moderately susceptible namely KGW-385, KGW-374 and Virat, 3 susceptible Pusa-372, Radhey and C-104 and 6 highly susceptible Chaffa, CPS 1, JG-74, JG-62, BDNGK-807 and AKG-1207.

Discussion

Use of resistant varieties is the best source to avoid the occurrence of the disease. Keeping this point in view, 40 varieties/cultivars of chickpea were tested for their resistance against *Fusarium oxysporum* f. sp. *ciceri* in the glass house compound under artificial conditions. Out of these 4, varieties/cultivars were free and found highly resistant, 14 resistant, 10 moderately resistant, 3 moderately susceptible, 3 susceptible and 6 highly susceptible. Mishra *et al.* (1976) [11], Haware and Nene (1980) [4], Iqbal *et al.* (2010) [6], Korde (2011) [9], Kumar *et al.* (2013) [10], Thaware *et al.* (2015, 2017) [15, 16] and Bagde *et al.* (2018) [2] also reported various degree of resistance and susceptibility in chickpea germplasm which matched with the present finding.

Conclusion

Screening of the 40 varieties/cultivars of chickpea were carried out under conditions of artificial epiphytotic in the wilt sick soil, out of which 4 varieties/cultivars were found highly resistant *viz.*, Vishal, BCP-49, BCP-10, and BCP-60, 14 were resistant, 10 were moderately resistant, 3 were moderately susceptible, 3 varieties/cultivars were susceptible and 6 varieties/cultivars were highly susceptible.

Table 2: Reaction of varieties/cultivars against *Fusarium oxysporum* f. sp. *ciceri* under artificial conditions in pot culture experiment

Grade	Reaction	No. of Varieties	Varieties/ Cultivars
1	Highly Resistant (0-1% wilted plant)	4	Vishal, BCP-49, BCP-10, and BCP-60
2	Resistant (1-10% wilted plants)	14	Avarodhi, KWR-108, K-850, Pusa-362, Vijay, Digvijay, Krupa, AKG-70, PG-8108, BCP-92, BCP-51, BCP-24, BCP-52 and BCP-124
3	Moderately resistant (11-25% wilted plants)	10	Pant G-186, KGW-292, Uday (KP-75), KPG-59, PUSA-256, IPCK-2004-29, BDNG-9-3, BDNG-801, BCPK-3 and AKG-2009,
4	Moderately susceptible (26-50% wilted plants)	3	KGW-385, KGW-374 and Virat
5	Susceptible (51- 75% wilted plants)	3	Pusa-372, Radhey and C-104
6	Highly susceptible (more than 75% wilted plants)	6	Chaffa, CPS 1, JG-74, JG-62, BDNGK-807 and AKG-1207

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