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Screening for resistant sources in chickpea entries against *Fusarium* wilt

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Abstract
Wilt caused by *Fusarium oxysporum* f. sp. *ciceris* is a devastating disease of chickpea in India. In the present study 31 entries from ICRISAT were screened for 2014-15 and 2015-16 under field condition to identify genetic sources of resistance against this disease at Agriculture research station Kalaburagi. Disease reaction at different stages revealed considerable variation among the entries. At different stages percent mean disease incidence varied from 02.87 to 100 % and 12.86 to 100 % for two different years respectively. Among the entries, 10 entries were shown resistant (ICC 14199, ICCV 06302, ICCV 07104, ICC 07112, ICCV 07117, ICCV 08119, ICCV 98503, ICCV 08312, ICCV 08324, ICCV 08122), 18 were moderately resistant (ICC 11322, ICCV 08318, ICCV 08121, ICCV 08118, ICCV 08102, ICCV 08112, ICCV 08114, ICCV 08115, ICCV 07307, ICCV 07312, ICC 8522, ICC 14402, ICC 14402, ICCV 06302, ICC 07112, ICCV 08102, ICCV 08114, ICCV 08118), 18 were susceptible (ICCV 05534, ICCV 05532, ICCV 05530, ICC 14199, ICC 8522, ICCV07104, ICCV 07312, ICCV 07313, ICCV 08101, ICCV 08112, ICCV 08115, ICCV 08119, ICCV 08312, ICC 11322, ICCV 98503, ICCV 08318, ICC 14449, ICCV 04608) and 10 were highly susceptible (ICCV 08121, ICCV 08122, ICC 5003, ICCV 07307, ICCV 07117, ICCV 04608, ICC 14449, ICC 4951, ICC 5003, ICCV 07313). These entries may be exploited for the development of resistant cultivars against wilt and can be use for further development of resistant lines against *Fusarium* wilt in future.

Keywords: Chickpea, *Fusarium oxysporum* f. sp. *ciceris*, ICRISAT, Percent Wilt incidence and Disease reaction

Introduction
Chickpea (*Cicer arietinum* L.) is the most important pulse crop of India. It is an important source of human food and animal feed that also helps in the management of soil fertility particularly in dry lands (Singh & Saxena, 1996) [25]. It can be a promising alternative crop for rotation with barley, peas and wheat in dry land areas (Auld &Lee.1981). The productivity of chickpea in India is high as compared to world average, wilt disease is one of the factors responsible for its low yield. *Fusarium* wilt caused by *Fusarium oxysporum* Schlechtend Fr. *f. sp*. *Ciceris* (Padwick) Matuo & K. Sato, is the most important soil-borne disease of chickpea throughout the world and particularly in the Indian Subcontinent, the Mediterranean Basin, and California (Haware 1990, Jalali & Chand 1992, Nene & Reddy, 1987) [7, 12, 17]. Attacks of the *Fusarium* wilt pathogen can destroy the crop completely (Halila & Strange, 1996) [6] or cause significant annual yield losses. Annual chickpea yield losses due to *Fusarium* wilt were estimated at 10% in India (Singh & Dahiya.1973; Trapero-Casas & Jiménez-Díaz, 1985) [20, 22] and 40% in Tunisia (Bouslama, 1980) [4]. Early wilting causes more loss than late wilting, but seeds from late-wilted plants are lighter, rough and dull than those from healthy plants (Haware & Nene, 1980) [8]. The cheapest, economical and the most ideal way of managing chickpea wilt, is the use of resistant cultivars. Chemical control of wilt is not feasible and economical because of the soil as well as seed-borne nature of the pathogen. Fungal chlamydospores can survive in soil up to 6 years in the absence of the host plants (Haware *et al*., 1996) [9]. The most practical and cost-efficient method for management of *Fusarium* wilt of chickpea is the use of resistant cultivars (Nene & Haware 1980; Nene & Reddy 1987; Bakhsh *et al*., 2007) [8, 17, 3]. Present study was undertaken to evaluate the newly developed entries of chickpea for resistance against local isolates of wilt fungus in order to identify new genetic sources of resistance.

Material and Method
Thirty one entries obtained from ICRISAT were screened for their level of resistance/susceptibility against *Fusarium* wilt under field conditions at agricultural research station, Kalaburagi for 2014 and 2015 (Table 1 and 2). The sick plot was maintained since from 20 years by adding infected chickpea inoculum year after year by incorporating into soil.

Each of the test lines was sown in two replications. For susceptible check JG 62 was repeatedly sowned after every four test entries and resistant check WR 315. Data on the number of wilted plants in each replication for each test line were recorded at 30, 60 and 90 days after sowing. The data on wilted plants of test entries at different stages were recorded when killing of the susceptible check had occurred. The second stage data on wilted plants were recorded at the initiation of Physiological maturity. The wilt incidence of each test entry was calculated by the following formula:

$$\text{Percent Wilt incidence} = \frac{\text{Number of plants wilted}}{\text{Total number of plants}} \text{X } 100$$

The level of resistance and susceptibility of each test line was determined by using 1-9 rating scale given by ICRISAT where 1= Asymptomatic (0 % plants wilted), 3= Resistant (0-10% plants mortality), 5=moderately resistance (10.1-20% mortality), 7=susceptible (20.1-40% mortality) and 9= highly susceptible (more than 40% mortality). Experiment was planted in a Randomized block design having two replication. Each entry was planted in a 4 m X 4m plot. Row to row and plant to plant distances were maintained at 30 cm and 10 cm, respectively. A highly wilt susceptible genotype, JG 62 and resistant check WR 315 was repeatedly planted after every four test entries. At reproductive stage data on wilted plants of test entries were recorded at 100% mortality of the susceptible check.

Result and Discussion

The percent disease incidence of 31 chickpea entries was recorded at 30, 60 and 90 DAS (Table 1 and 2). The results revealed that disease reaction at different stages revealed considerable variation among the entries. At different stages percent mean disease incidence varied from 02.87 to 100 % and 12.86 to 100 % for two different years 2014-2015 and 2015-2016 respectively. Among the entries, 10 entries were resistant, 18 were moderately resistant, 21 were susceptible and 13 were highly susceptible during both years. The results showed that chickpea entries had significant genetic variation between genotypes for their disease reaction at two stages i.e., at seedling stage and reproductive stage. Our study revealed that at seedling stage majority of the genotypes were resistant whereas, at reproductive stage majority of the genotypes appeared to be susceptible. Variation in wilt resistance at two stages was also reported by (Muhammad Ansar *et al*., 2010 and Chaudhry *et al.*, 2006) [15, 5]. Most of the genotypes that showed resistant response at seedling stage appeared to be susceptible at physiological maturity stage. Although little information on the mechanism of resistance is available, a detailed research based on this material is needed to throw light on it.

Due to the prevalence of drought conditions in the Kalaburagi district, *Fusarium* wilt has gained importance in ARS Kalaburagi. Our results indicate that the incidence and the severity of the disease were higher in the field. One of the reasons might be that the crop often has the chances of disease escape as the wilt disease is temperature dependent and the level of inoculum may vary at different places. The resistance source of *Fusarium* wilt in chickpea germplasm is not uncommon and a number of other workers have also reported the occurrence against high level of resistance of *Fusarium* wilt (Ahmad & Sharma 1990; Reddy *et al.,* 1990; Iqbal *et al.,* 1993; Ahmad *et al.,* 1990; Iftikhar *et al.,* 1997; Yu & Su, 1997) [1, 11, 1, 10, 23].

Similar studies were made by Zote *et al.,* (1983) [25] who studied sources of resistance to chickpea wilt and reported that none of the 42 lines of *Cicer arietinum* tested in a wilt sick plot infested with *F. oxysporum f. sp. ciceri* were highly resistant, 4 developed less than 10% and 6 others less than 29% disease. While, Patel *et al.,* (1985) [18] studied the reaction of chickpea lines to *Fusarium* wilt and screened 34 supposedly resistant germplasm lines from ICRISAT and 3 promising varieties as potted plants for germination and for wilting at 40 and 80 days after sowing in soil infested with the Arnej isolate of *F. oxysporum f. sp ciceri*. Similarly, Zote *et al.,* (1986) [24] further studied that only 5 chickpea lines out of 15 tested for three successive years showed less than 10% wilt incidence. Khalid (1993) [14] evaluated 122 test lines against *Fusarium* wilt under field conditions and found 37 of them to be resistant while all the remaining test lines exhibited moderate resistance to highly susceptible reaction. Whereas, Kapoor *et al.,* (1991) evaluated 39 varieties for resistance to *F. oxysporum f. sp. ciceri.*

Most of the genotypes showing resistance reaction at seedling stage and some at reproductive stage may be utilized in breeding programme to develop resistant/tolerant varieties against *fusarium* wilt disease. Development of disease is slow in resistant lines and fast in susceptible lines. As the resistant lines at reproductive stage also became susceptible thus field screening at reproductive stage seems to be more reliable.

Table 1: Evaluation of Chickpea ICRISAT national nursery entries against wilt disease during Rabi-2014-2015

Sl. No.	Entry	Percent wilt			Disease Reaction
		R-I	R-II	Mean	
1	ICC 8522	20.83	15.38	18.11	M
2	ICC 14199	08.82	03.85	06.34	R
3	ICC 14402	07.14	19.23	13.19	M
4	ICC 14449	57.69	32.26	44.98	S
5	ICCV 04608	32.26	28.00	30.13	S
6	ICCV 05530	33.33	26.09	29.71	T
7	ICCV 05532	27.59	15.78	21.69	T
8	ICCV 05534	25.00	20.00	22.50	T
9	ICCV 06302	04.55	04.35	04.45	R
10	ICCV 07104	5.00	10.71	7.86	R
11	ICC 07112	08.33	03.13	05.73	R
12	ICCV 07117	09.09	05.56	07.33	R
13	ICCV 07307	13.33	07.69	10.51	M
14	ICCV 07312	14.29	10.00	12.14	M
15	ICCV 07313	63.64	41.67	52.65	HS
16	ICCV 08101	26.09	18.91	22.50	T
17	ICCV 08102	11.43	9.10	10.27	M
18	ICCV 08112	03.57	02.17	02.87	M
19	ICCV 08114	16.67	14.26	15.47	M
20	ICCV 08115	20.69	09.09	14.89	M
21	ICCV 08118	16.00	15.79	15.90	M
22	ICCV 08119	08.00	03.45	05.73	R
23	ICCV 08121	12.90	29.41	25.16	M
24	ICCV 08122	04.55	02.22	03.39	R
25	ICCV 08312	05.00	06.45	05.73	R
26	ICCV 08318	08.69	12.25	10.48	M
27	ICCV 08324	07.70	11.76	09.73	R
28	ICCV 98503	04.77	03.33	04.05	R
29	ICC 4951	100.00	100.00	100.00	HS
30	ICC 5003	100.00	100.00	100.00	HS
31	ICC 11322	17.24	08.33	12.77	M
	JG 62	100.00	100.00	100.00	HS
	WR 315	5.70	6.35	6.02	R

Table 2: Evaluation of Chickpea ICRISAT national nursery entries against wilt disease during Rabi 2015-16

Sl No.	Entry	Percent wilt			Disease Reaction
		R I	R II	Mean	
1	ICC 8522	43.48	33.33	38.41	S
2	ICC 14199	24.24	26.09	25.17	S
3	ICC 14402	10.34	15.38	12.86	MR
4	ICC 14449	60.00	50.00	55.00	HS
5	ICCV 04608	50.00	44.44	47.22	HS
6	ICCV 05530	33.33	25.93	29.63	S
7	ICCV 05532	32.00	28.00	30.00	S
8	ICCV 05534	23.08	29.41	26.25	S
9	ICCV 06302	18.75	16.67	17.71	MR
10	ICCV 07104	28.57	23.40	25.99	S
11	ICC 07112	15.00	16.67	15.84	MR
12	ICCV 07117	43.48	37.04	40.26	HS
13	ICCV 07307	42.86	37.50	40.18	HS
14	ICCV 07312	20.00	23.53	21.77	S
15	ICCV 07313	25.00	16.67	20.84	S
16	ICCV 08101	40.00	33.33	36.67	S
17	ICCV 08102	22.73	16.00	19.37	MR
18	ICCV 08112	36.84	40.00	38.42	S
19	ICCV 08114	16.67	14.29	15.48	MR
20	ICCV 08115	37.50	40.00	38.75	S
21	ICCV 08118	15.38	12.50	13.94	MR
22	ICCV 08119	21.43	20.00	20.72	S
23	ICCV 08121	44.83	36.36	40.60	HS
24	ICCV 08122	40.91	43.48	42.20	HS
25	ICCV 08312	16.67	26.92	21.80	S
26	ICCV 08318	30.77	26.32	28.55	S
27	ICCV 08324	25.00	14.81	19.91	MR
28	ICCV 98503	27.78	20.59	24.19	S
29	ICC 4951	100.00	100.00	100.00	HS
30	ICC 5003	90.00	92.86	91.43	HS
31	ICC 11322	29.03	31.71	30.37	S
	JG 62	100.00	100.00	100.00	HS
	WR 315	2.35	6.50	4.42	R

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