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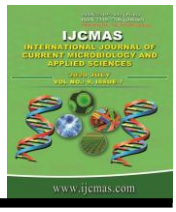

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Screening Chickpea (*Cicer arietinum* L.) for Resistance to Wilt (*Fusarium oxysporum* F.sp. *Ciceri*) under Field Condition

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A B S T R A C T

Several biotic and abiotic constraints significantly reducing the chickpea area and production over last two decades. Among biotic stresses, fusarium wilt caused by *Fusarium oxysporum* f. sp. *ciceri* (Foc) is the major soil-borne fungus affecting chickpea production globally. This Fusarium wilt disease affects chickpea not only quantitatively but also qualitatively. The development of resistant varieties is the most effective method to manage this disease and to stabilizing its productivity. Hence, present investigation was undertaken to evaluate the resistance of 129 chickpea national crossing program (NCP) lines against Fusarium wilt in a wilt sick plot facility made available at zonal agricultural research station (ZARS), Kalaburagi during post-rainy season of 2018, A total of 34 lines recorded low Per cent disease incidence (PDI) rate and thus designated as resistant lines. All the lines were further categorized into moderately resistant (34 lines), moderately susceptible (26 lines), susceptible (29 lines) and highly susceptible (6 lines) based on their PDI records. The resistant lines identified during the study can be further used in developing resistance cultivars directly or can be released as a variety. NCP F_2 -1(1), NCP F_2 -1(7), NCP F_2 -2 (6), NCP F_2 -2(11), NCP F_2 -2(12), NCP F_2 -2(14), NCP F_2 -3(10), NCP F_2 - 4(34) with 0.00 PDI could be the best for further use.

Introduction

Chickpea (*Cicer arietinum* L.), is the second most important food legume crop of the world, while it stands first among pulses in India. Chickpea seeds are used for both human and animal consumption, serves as an important source of dietary protein (Jendoubi, *et al.*, 2017). For the people of developing country (especially in South Asia), it is a cheap source of protein (20-23%), high levels of carbohydrates (60.7%) and dietary fibres (17.4%). Globally chickpea is cultivated in an area of 12.00 mha, with a production of 10.90 mt and an average yield of 913 kg /ha. India is the largest producer of chickpea accounting for about 68% of world chickpea production.

In India, is cultivated in an area of 8.25 mha, with a production of 7.33 mt and productivity of 896 kg/ha. Karnataka ranks fifth in the cultivation of chickpea with an area of 10.41 lakh ha, production of 6.74 lakh tonnes and productivity of 718 kg/ha (Anon., 2015).

In Karnataka, Kalaburgi ranks first followed by Vijayapur, Bidar, Gadag, and Raichur. During past three decades, a significant change in the scenario of chickpea area and production in India was noticed. It was mainly due to the infestation of major diseases.

Hence, an effort was made to evaluate 129 chickpea lines during *rabi* 2018 at Zonal Agricultural Research Station, kalaburagi, Karnataka, to elucidate information on disease reaction of these lines and to identify promising chickpea genotypes for disease resistance which attributes to good seed yield.

So far, the chickpea crop is infested by 172 pathogens (67 fungi, 22 viruses, 3 bacteria, 80 nematodes and phytoplasma) all over the world (Nene *et al.,* 1996). Among them, some of the pathogens have the potential to devastate the crop. One among such disease is Fusarium wilt.

The disease manifests as mortality of young seedlings i.e. whole seedling collapses (within 25 to 30 days after sowing) leads to wilting or death of plants and retain their dull-green colour (slightly yellowish-green)while stem retain green colour where as normal healthy plants turn to straw colour. wilt can be confused with other diseases, if not examined carefully.

In adult plants i.e. at flowering stages, the phytotoxin produced by the pathogen causes wilting and leaf burning. The roots of the wilted plants do not show any external rotting symptoms but when split vertically, dark brown discoloration of internal xylem vessels was observed (Nene *et al.,* 1991).

Haware and Nene, (1980) were reported that the early wilting reduced the seed number/ plant which causes significant yield losses than late wilting.

The seeds harvested from wilted plants are lighter, wrinkled and duller than those from healthy plants. The yield losses due to wilting vary between 10% and 100% depending on the agro-climatic conditions (Grewal and Pal, 1970).

Materials and Methods

The study consists of 129 chickpea National Crossing Programme (NCP) lines including resistant (WR 315) and susceptible (JG 62) checks and these were screened for wilt disease resistance in 30 year old wilt sick plot available at zonal agricultural research station Kalaburagi during rabi-2018.

The experiment was conducted in randomized block design with two replications. Each line was planted in a two rows of 2 m length with 30 cm and 10 cm as inter and intra-row spacing. The data on disease incidence was recorded on 30, 45 and 60 days after sowing to calculate PDI (per cent disease incidence).

Then the lines were scored according to their PDI and were categorized into resistant, moderately resistant, moderately susceptible, Susceptible and highly susceptible. The pattern of disease symptom of all the lines observed during the investigation was same.

A young seedling turns to yellowing within 3 weeks of sowing called as early wilt, which was the unique pattern of disease symptom of all the lines observed during the investigation. Since, it was mainly observed during the vegetative stage i.e. infected plant show typical wilting i.e. drooping of whole plant. Thus seedlings will be died with green stem. While, late wilt will be confirmed through their roots where the external appearance of roots shows no sign of rotting, when its split vertically, xylem vessels show brown to black discoloration throughout the vein and plants are difficult to uproot.

The level of resistance and/or susceptibility of each line was determined by using 1-9 rating scale (Anonymous, 2014) (Table 3). Percent disease incidence was calculated using the formulae given below:

$$\text{Percent disease incidence (PDI)} = \frac{\text{Number of wilted plants}}{\text{Total number of plants}} \times 100$$

Results and Discussion

The study was attempted during rabi 2018 in order to check the disease reaction of 129 chickpea NCP lines against wilt. Among studied lines, 34 lines were resistant, 34 lines moderately resistant, 26 lines moderately susceptible, 29 lines susceptible and 6 lines were found highly susceptible. The resistant check (WR 315) and susceptible check (JG 62) were sown along with our 129 NCP lines for comparative evaluation of resistance and susceptibility of new NCP lines. The resistant lines recorded PDI 1- 10 %, moderately resistant lines 11-20%, moderately susceptible lines 21-30 %, susceptible lines 31-50% and highly susceptible lines 51-100%. The resistant and susceptible check lines recorded the PDI 5.35 %, 100% respectively.

The disease free lines i.e resistant and moderately resistant lines can be used in breeding programs to incorporate the resistant genes. Further, it was found that the resistant lines are well adopted for local climate and can be used to develop disease resistance.

Table.1 Reaction of chickpea advanced breeding lines against wilt disease caused by *Fusarium oxysporum* f.sp. *ciceris* under wilt sick plot

Treatments	Percent Wilt	Scale	Disease reaction
NCP F2-1 (1)	0.00	1	Resistant
NCP F2-1 (2)	9.52	1	Resistant
NCP F2-1 (3)	15.63	3	Moderately resistant
NCP F2-1 (4)	14.29	3	Moderately resistant
NCP F2-1 (5)	6.45	1	Resistant
NCP F2-1 (6)	5.56	1	Resistant
NCP F2-1 (7)	0.00	1	Resistant
NCP F2-1 (8)	12.50	3	Moderately resistant
NCP F2-1 (9)	3.70	1	Resistant
NCP F2-1 (10)	7.69	1	Resistant
NCP F2-1 (11)	8.00	1	Resistant
NCP F2-1 (12)	12.12	3	Moderately resistant
NCP F2-1 (13)	11.54	3	Moderately resistant
NCP F2-1 (14)	18.18	3	Moderately resistant
NCP F2-1 (15)	25.00	5	Moderately susceptible
NCP F2-2 (1)	16.13	3	Moderately resistant
NCP F2-2 (2)	10.00	1	Resistant
NCP F2-2 (3)	2.94	1	Resistant
NCP F2-2 (4)	5.71	1	Resistant

NCP F2-2 (5)	10.34	1	Resistant
NCP F2-2 (6)	0.00	1	Resistant
NCP F2-2 (7)	16.00	3	Moderately resistant
NCP F2-2 (8)	10.00	1	Resistant
NCP F2-2 (9)	3.23	1	Resistant
NCP F2-2 (10)	4.55	1	Resistant
NCP F2-2 (11)	0.00	1	Resistant
NCP F2-2 (12)	0.00	1	Resistant
NCP F2-2 (13)	6.90	1	Resistant
NCP F2-2 (14)	0.00	1	Resistant
NCP F2-2 (15)	4.35	1	Resistant
NCP F2-2 (16)	3.45	1	Resistant
NCP F2-2 (17)	7.14	1	Resistant
NCP F2-2 (18)	13.79	3	Moderately resistant
NCP F2-2 (19)	12.00	3	Moderately resistant
NCP F2-2 (20)	14.29	3	Moderately resistant
NCP F2-2 (21)	9.38	1	Resistant
NCP F2-2 (22)	14.81	3	Moderately resistant
NCP F2-3 (1)	21.74	5	Moderately susceptible
NCP F2-3 (2)	16.00	3	Moderately resistant
NCP F2-3 (3)	17.65	3	Moderately resistant
NCP F2-3 (4)	26.09	5	Moderately susceptible
NCP F2-3 (5)	18.52	3	Moderately resistant
NCP F2-3 (6)	38.89	7	Susceptible
NCP F2-3 (7)	17.14	3	Moderately resistant
NCP F2-3 (8)	19.05	3	Moderately resistant
NCP F2-3 (9)	16.00	3	Moderately resistant
NCP F2-3 (10)	0.00	1	Resistant
NCP F2-4 (1)	30.00	5	Moderately susceptible
NCP F2-4 (2)	45.83	7	Susceptible
NCP F2-4 (3)	21.21	5	Moderately susceptible
NCP F2-4 (4)	42.31	7	Susceptible
NCP F2-4 (5)	13.51	3	Moderately resistant
NCP F2-4 (6)	22.22	5	Moderately susceptible
NCP F2-4 (7)	8.33	1	Resistant
NCP F2-4 (8)	23.81	5	Moderately susceptible
NCP F2-4 (9)	21.88	5	Moderately susceptible
NCP F2-4 (10)	66.67	9	Highly susceptible

NCP F2-4 (11)	43.75	7	Susceptible
NCP F2-4 (12)	25.00	5	Moderately susceptible
NCP F2-4 (13)	42.31	7	Susceptible
NCP F2-4 (14)	28.00	5	Moderately susceptible
NCP F2-4 (15)	55.56	9	Highly susceptible
NCP F2-4 (16)	41.18	7	Susceptible
NCP F2-4 (17)	35.00	7	Susceptible
NCP F2-4 (18)	33.33	7	Susceptible
NCP F2-4 (19)	81.82	9	Highly susceptible
NCP F2-4 (20)	27.78	5	Moderately susceptible
NCP F2-4 (21)	16.00	3	Moderately resistant
NCP F2-4 (22)	18.75	3	Moderately resistant
NCP F2-4 (23)	27.27	5	Moderately susceptible
NCP F2-4 (24)	66.67	9	Highly susceptible
NCP F2-4 (25)	34.62	7	Susceptible
NCP F2-4 (26)	22.22	5	Moderately susceptible
NCP F2-4 (27)	9.38	1	Resistant
NCP F2-4 (28)	22.22	5	Moderately susceptible
NCP F2-4 (29)	52.38	7	Highly susceptible
NCP F2-4 (30)	26.09	5	Moderately susceptible
NCP F2-4 (31)	11.54	3	Moderately resistant
NCP F2-4 (32)	47.06	7	Susceptible
NCP F2-4 (33)	33.33	7	Susceptible
NCP F2-4 (34)	0.00	1	Resistant
NCP F2-4 (35)	12.00	3	Moderately resistant
NCP F2-5 (1)	7.41	1	Resistant
NCP F2-5 (2)	45.16	7	Susceptible
NCP F2-5 (3)	44.00	7	Susceptible
NCP F2-5 (4)	29.63	5	Moderately susceptible
NCP F2-5 (5)	20.83	3	Moderately resistant
NCP F2-5 (6)	31.58	7	Susceptible
NCP F2-5 (7)	40.91	7	Susceptible
NCP F2-5 (8)	47.06	7	Susceptible
NCP F2-5 (9)	42.86	7	Susceptible
NCP F2-5 (10)	14.29	3	Moderately resistant
NCP F2-5 (11)	33.33	7	Susceptible
NCP F2-5 (12)	26.32	5	Moderately susceptible
NCP F2-5 (13)	24.00	5	Moderately susceptible

NCP F2-5 (14)	46.67	7	Susceptible
NCP F2-5 (15)	8.57	1	Resistant
NCP F2-5 (16)	50.00	7	Susceptible
NCP F2-5 (17)	23.33	5	Moderately susceptible
NCP F2-5 (18)	31.71	7	Susceptible
NCP F2-5 (19)	26.09	5	Moderately susceptible
NCP F2-5 (20)	36.36	7	Susceptible
NCP F2-5 (21)	11.54	3	Moderately resistant
NCP F2-5 (22)	47.06	7	Susceptible
NCP F2-5 (23)	35.71	7	Susceptible
NCP F2-5 (24)	15.38	3	Moderately resistant
NCP F2-5 (25)	16.13	3	Moderately resistant
NCP F2-5 (26)	10.34	1	Resistant
NCP F2-5 (27)	46.15	7	Susceptible
NCP F2-5 (28)	43.75	7	Susceptible
NCP F2-5 (29)	20.00	3	Moderately resistant
NCP F2-5 (30)	21.74	5	Moderately susceptible
NCP F2-5 (31)	52.63	9	Highly susceptible
NCP F2-5 (32)	43.75	7	Susceptible
NCP F2-5 (33)	30.77	5	Moderately susceptible
NCP F2-5 (34)	36.36	7	Susceptible
NCP F2-5 (35)	22.73	5	Moderately susceptible
NCP F2-5 (36)	26.92	5	Moderately susceptible
NCP F2-5 (37)	13.79	3	Moderately resistant
NCP F2-6 (1)	8.33	1	Resistant
NCP F2-6 (2)	18.75	3	Moderately resistant
NCP F2-6 (3)	13.33	3	Moderately resistant
NCP F2-6 (4)	28.57	5	Moderately susceptible
NCP F2-6 (5)	11.54	3	Moderately resistant
NCP F2-6 (6)	22.73	5	Moderately susceptible
NCP F2-6 (7)	14.29	3	Moderately resistant
NCP F2-6 (8)	9.68	1	Resistant
NCP F2-6 (9)	8.33	1	Resistant
NCP F2-6 (10)	31.58	7	Susceptible
JG 62	100.00	9	Highly Susceptible
WR 315	5.35	1	Resistant

Table.2 Categorization of chickpea breeding lines screened against *Fusarium oxysporum* f.sp. *ciceris* at wilt sick plot based on their disease reaction

Sl. no.	Disease reaction	No. of entries	Entries name
1	Resistant	34	NCP F_2-1 (1), NCP F_2-1(2), NCP F_2-1(5), NCP F_2-1 (6) NCP F_2-1 (7), NCP F_2-1 (9), NCP F_2-1 (10), NCP F_2-1(11). NCP F_2 -2(2), NCP F_2 -2(3), NCP F_2 -2(4), NCP F_2 -(5), NCP F_2 -2(6), NCP F_2 -2(8), NCP F_2 -2(9), NCP F_2 -(10), NCP F_2 -2(11), NCP F_2 -2(12), NCP F_2 -2(13), NCP F_2 -2(14), NCP F_2 -2(15), NCP F_2 -2(16), NCP F_2 -2(17), NCP F_2 -2(21). NCP F_2-3 (10) NCP F_2-4 (7), NCP F_2-4 (27), NCP F_2-4 (34) NCP F_2- 5(1), NCP F_2- 5(15), NCP F_2- 5(26) NCP F_2- 6 (1), NCP F_2- 6 (8), NCP F_2- 6 (9)
2	Moderately resistant	34	NCP F_2 - 1 (4),NCP F_2 - 1 (5),NCP F_2 - 1 (8),NCP F_2 - 1 (12), NCP F_2 - 1 (13),NCP F_2 - 1 (14) NCP F_2 - 2 (1),NCP F_2 - 2 (7),NCP F_2 - 2 (18),NCP F_2 - 2 (19),NCP F_2 - 2 (20),NCP F_2 - 2 (22) NCP F_2-3 (2),NCP F_2-3 (3),NCP F_2-3 (5),NCP F_2-3 (7),NCP F_2-3 (8),NCP F_2-3 (9) NCP F_2-4(5), NCP F_2-4(21), NCP F_2-4(22), NCP F_2-4(31), NCP F_2-4(35) NCP F_2- 5(5), NCP F_2- 5(10), NCP F_2- 5(21), NCP F_2- 5(24), NCP F_2- 5(25), NCP F_2- 5(29),NCP F_2- 5(37) NCP F_2-6(2), NCP F_2-6(3), NCP F_2-6(5), NCP F_2-6(7),
3	Moderately susceptible	26	NCP F_2- 1(15), NCP F_2-3(1), NCP F_2-3(4), NCP F_2-4(1), NCP F_2-4(3), NCP F_2-4(6),NCP F_2-4(8),NCP F_2-4(9),NCP F_2-4(12),NC F_2-4(14),NCP F_2-4(20),NCP F_2-4(23),NCP F_2-4(26),NCP F_2-4(28),NCP F_2-4(30) NCP F_2-5(4), NCP F_2-5(12), NCP F_2-5(13), NCP F_2-5(17), NCP F_2-5(19), NCP F_2-5(30), NCP F_2-5(33), NCP F_2-5(35), NCP F_2-5(36) NCP F_2-6(4), NCP F_2-6(6),
4	Susceptible	29	NCP F_2- 3(6), NCP F_2-4(2), NCP F_2-4(4), NCP F_2-4(11), NCP F_2-4(13), NCP F_2-4(16), NCP F_2-4(17), NCP F_2-4(18), NCP F_2-4(25), NCP F_2-4(32), NCP F_2-4(33), NCP F_2-5(2), NCP F_2-5(3), NCP F_2-5(6), NCP F_2-5(7) ,NCP F_2-5(8), NCP F_2-5(9), NCP F_2-5(11), NCP F_2-5(14), NCP F_2-5(16), NCP F_2-5(18), NCP F_2-5(20), NCP F_2-5(22), NCP F_2-5(23),NCP F_2-5(27),NCP F_2-5(28),NCP F_2-5(32),NCP F_2-5(34) NCP F_2-6(10)
5	Highly Susceptible	6	NCP F_2-4(10), NCP F_2-4(15), NCP F_2-4(19), NCP F_2-4(24), NCP F_2-4(29), NCP F_2-5(31)

Table.3 The level of resistance and/or susceptibility for each line was determined by using 1-9 rating scale (Anonymous, 2014)

Scale	PDI (%)	Disease reaction
1	1-10%	Resistant
3	11-20%	Moderately resistant
5	21-30%	Moderately susceptible
7	31-50%	Susceptible
9	51-100%	Highly susceptible

These results are inconformity with the investigations of several researchers Thaware D.S. *et al.,* (2018)**,** Kumar *et al., (*2012), Korde, (2011), Mandhare *et al.,* (2011), Ahmed (2010) and Patil (2010) have screened number of chickpea genotypes and identified promising cultivars against the wilt.

Among the 34 resistant lines few lines are highly resistant those are NCP F_2-1(1), NCP F_2-1(7), NCP F_2-2 (6), NCP F_2-2(11), NCP F_2-2(12), NCP F_2-2(14), NCP F_2-3(10), NCP F_2- 4(34) with 0.00 PDI followed by NCP F_2- 2(3) with 2.94 and NCP F_2-2(9) with 3.23.

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