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Screening of Chilli Genotypes for Resistance to Fruit Rot caused by *Colletotrichum capsici* at Fruit Bearing and Harvest Stages

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A B S T R A C T

The field and laboratory screening of 31 accessions were carried out against fruit rot of chilli caused by *Colletotrichum capsici* under natural pressure condition. Out of 31 accessions eight were found resistant, remaining twenty three accessions found moderately resistant at 90 days after transplanting. The reaction during harvest stages varied from that of 90 days after harvest which recorded, 2 resistant accessions, eight moderately resistant accessions, twenty moderately susceptible accessions and Byadagi Dabbi as susceptible. During *in vitro* screening18 accessions were found resistant, 8 were moderately resistant, 3 were moderately susceptible and 2 were susceptible to the pathogen during green stage of the fruit. The reaction of chilli fruits during turning red stage recorded, 18 accessions as moderately resistant, 8 as moderately susceptible and one (DCA-298) was susceptible. The reaction varied in red stage of fruit development wherein, 5 accessions were resistant, 18 accessions were moderately resistant, 6 were moderately susceptible and 2 were susceptible to the pathogen. The accessions DCA-67, 69, 189, 302 and 305 were reacted resistant to the *C. capsici* in field and artificial screening. Hence, these accessions having the resistant genes which can be used for resistant breeding programme.

Introduction

Chilli (*Capsicum annuum*) is an important vegetable as well asspice crop belongs to Solanaceae family. The genus *Capsicum* was assumed to have been originated from Mexico, Central America and South America (Perry *et al.*, 2007).Five species of *Capsicum* (*C. annuum*, *C. baccatum*, *C. chinense*, *C. frutescens* and *C. pubescens*) are commonly domesticated and cultivated in different parts of the world. Among these five species, *C. annuum* is the most commonly cultivated worldwide, followed by *C. frutescens* (Bosland, 1994). Chilli is used in all forms starting from fresh green fruits, ripe fruits, dried fruits and powdered form. Fresh green pungent fruits are generally used in salads, stuffing and as a flavoring agent in cooked meals. Indian chilli is considered to be world famous for two important commercial qualities *viz*., color and pungency levels.

Indian chilli is mainly exported to Asian countries like Vietnam, Thailand, Sri Lanka, Bangladesh and U.A.E. In India, Andhra Pradesh, Karnataka, Telangana, Uttar Pradesh, Bihar and Madhya Pradesh are major chilli growing states. In Karnataka, greenchilli is grown over an area of 45,910 ha with the production of 6, 73, 810 MT while dry chilliis grown over 1, 27, 600 ha with the production of 2, 60, 140 MT (Anonymous, 2018). Naturally, the chilli production were affected by both biotic, such as microorganisms (plant pathogenic fungi, bacteria, nematodes, viruses), insect pests (aphids, thrips, mites, midges and fruit borer), weeds and abiotic factors, such as temperature, moisture, light and chemicals. The anthracnose disease caused by *Colletotrichum capsici* is one of the major and devastating diseases of chilli, which causes 10-60 Per cent yield loss apart from reducing quality. This disease was first time reported in India by Sydow during 1913 from Coimbatore (Ridzuan *et al.,* 2018).The present study was carried out to evaluate disease resistance reaction of agronomically superior chilli accessions.

Materials and Methods

Screening of chilli accessions against fruit rot under natural condition

Screening of chilli accessions for resistance against fruit rot was conducted at Horticulture Research and Extension Center, Haveri (Devihosur), during *kharif*2018-19.

The accessions used for the experiment were selected from the germplasm pool of Horticultural Research and Extension Center (HREC), Haveri (Devihosur) which were found superior in yield and other desirable characters. Screening of 31chilli accessions for resistance to fruit rot caused by *C. capsici* was carried out in the field at HREC, Devihosur, both under natural and artificial inoculation of pathogen. Total 31accessions were planted 5m single lines with two replications with a spacing of 60 x 60 cm. Sowing works were carried out during last week of June 2018 and transplanting were carried out during last week of July 2018.In field condition, accessions were screened against *C. capsici* at 90 days after transplanting and during harvest.

In vitro screening of chilli accessions for resistance to fruit rot caused by *Colletotrichum capsici* by challenge inoculation of the pathogen to detached fruits

Spores of *C. capsici* were harvested by adding sterile distilled water to the well sporulated culture plates containing *C. capsici* and diluted the conidial suspension by adding 100 ml of sterile distilled water. The spore load was counted using haemocytometer.

Fruits from each accession at green stage, turning green to red stage and red ripe stage are bought to the laboratory and were surface sterilized with 70 per cent ethanol and washed with sterile distilled water. Three fruits were inoculated with the pathogen inoculum, which was harvested from the *C. capsici* culture plates. The inoculation was done through sterile micro syringe at a concentration of 2.4 x 10^5, one fruit was kept as control, where the sterile distilled water without spore was injected. These fruits were placed in Petri plates containing moist tissue paper to maintain the humidity inside the Petri plates. Observations on disease severity were taken at 1 and 3 days after inoculation. The screening of accessions was done by scoring of fruits using standard scale**.**

Disease intensity was measured by grading the fruits using 0-9 scale given by Mayee and Datar (1986). The scale is as follows.

Grade	Per cent fruit infection	Disease reaction
0	0	Immune
1	1-10	Resistant
3	11-25	Moderately resistant
5	26-50	Moderately susceptible
7	51-75	Susceptible
9	>75	Highly susceptible

The per cent disease index (PDI) was calculated to record the disease intensity, according to the following formula given by Wheeler (1969).

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of all numerical}}{\text{Number of fruits x Maximum observed disease grade}} \times 100$$

Results and Discussion

Screening of chilli accessions against fruit rot under natural condition

The fruits were graded as per scale and percent disease index was recorded at 90 days after transplanting and during harvesting stage. Data are presented in table 1

During 90 DAT, none of the 31accessions showed immune reaction, 8 accessions (DCA 67, 69, 76, 189, 237, 257, 302 and 305) were found resistant and other 23accessions were found moderately resistant to the pathogen. The least PDI was recorded in DCA- 69 (4.45) which was on par with DCA- 305 (5.78) and DCA- 237 (8.89) and highest was noticed in DCA- 145 (24.00) which was on par with DCA- 76 (23.33) and DCA- 176 (20.89).

During harvest, none of the 31accessions was immune against the pathogen. Among 31 accessions, 2 accessions (DCA-69 and 189) was resistant, 8 accessions (DCA- 67, 76, 89, 123, 237, 300, 302 and 305) were categorized under moderately resistant whereas, 20 were moderately susceptible to the pathogen and Byadagi Dabbi categorized under susceptible. The least PDI was recorded in DCA- 69 and DCA-189(10.22) followed by DCA- 302 (12.44) and DCA- 305 (18.22) and highest PDI was recorded in Byadagi Dabbi (39.78) and DCA- 216 (39.78) followed by DCA- 234 (37.11).

In vitro screening of chilli accessions for resistance to fruit rot caused by *Colletotrichum capsici* by challenge inoculation of the pathogen to detached fruits

The observations on disease severity were recorded during 1 and 3 day after inoculation. The results are presented in table 2.

Among 31accessions, 24accessions showed immune without any lesions on the fruits, 7accessions (DCA-76, 107, 145, 222, 234, 240 and 298) developed lesions on the fruits during 1 day after inoculation (DAI) in green stage. But, the lesion diameter and length increased during 3 DAI, the PDI varied from 3.70 to 62.96 (DCA- 145).During 3 days after inoculation at green stage, 18accessions*viz*., DCA-67, 69, 76, 79, 81, 89, 104, 118, 123, 153, 174, 189, 216, 224, 233, 237, 300 and 305 were found resistant, 8 accessions (DCA-98, 154, 176, 222, 240, 257, 295 and Byadagi Dabbi) were moderately resistant, 2accessions (DCA-234 and 302) were moderately susceptible and 3 accessions (DCA-107, 145 and 298) were susceptible (Figure 1).

Among 31accessions, 12accessions reacted as immune and 19accessions developed the lesions after 1 day of inoculation during turning green to red stage. After 3 days of inoculation the PDI varied from 7.41 to 55.56 (DCA- 298). During 3 days after inoculation at turning green to red stage, 4 accessions (DCA-69, 89, 145 and 189) were found resistant, 18 accessions were moderately

resistant, 8 accessions (DCA- 81, 98, 118, 174, 216, 233, 234 and 237) were moderately susceptible and DCA- 298was susceptible to the pathogen.

About 16accessions were reacted as immune to the pathogen and 15accessions developed lesions during red ripe stage. After 3 days of inoculation the PDI was recorded varied from 3.70 (DCA- 69) to 55.56 (DCA- 174). During 3 days after inoculation at red ripe stage, 5 accessions (DCA-67, 69, 89, 189 and 302) were found resistant, 18 were moderately resistant, 6 accessions (DCA-79, 81, 233, 237, 257 and 300) were moderately susceptible and DCA- 174 and Byadagi Dabbi were susceptible to the pathogen (Figure 2).

The reaction of different entries of chilli accessions to *C. capsici* infection at field screening, challenge inoculation and *in vitro* screening are depicted in table 3.

The field screening of 31accessions was carried out under natural pressure, out of which only eight accessions were found resistant and remaining twenty three accessions were found to be moderately resistant at 90 days after transplanting. The reaction during harvest stages varied from that of 90 days after harvest which recorded, 2 accessions as resistant, eight accessions as moderately resistant, twenty accessions were moderately susceptible and ByadagiDabbi as susceptible. Koppad (2014) screened 250 accessions of chilli and found that none of them was immune to *C. capsici* while, 43 accessions were resistant and 110 were moderately resistant for fruit rot under field condition. Similar results were reported by Ruth *et al.*, (2007), Kaur and Singh (2009), Singh and Chowdhury (2011), Varma *et al.*, (2012) and Prasath and Ponnuswami (2008).

Table.1 Screening of chilli accessions under natural field conditions against fruit rot during *kharif*-2018

Sl. No.	Genotypes	90 days after transplanting (PDI)	Max. grade	Reaction	During harvest (PDI)	Max. grade	Reaction
1	DCA 67	10.22 (18.62)	1	R	27.78 (31.79)	3	MR
2	DCA 69	4.45 (12.15)	1	R	10.22 (18.62)	1	R
3	DCA 76	23.33 (28.87)	1	R	23.11 (28.72)	3	MR
4	DCA 79	16.22 (23.73)	3	MR	25.56 (30.35)	5	MS
5	DCA 81	16.00 (23.55)	3	MR	23.78 (29.17)	5	MS
6	DCA 89	12.00 (20.25)	3	MR	22.67 (28.42)	3	MR
7	DCA 98	17.56 (24.75)	3	MR	28.23 (32.08)	5	MS
8	DCA 104	18.67 (25.58)	3	MR	26.67 (31.08)	5	MS
9	DCA 107	18.22 (25.25)	3	MR	32.67 (34.84)	5	MS

10	DCA 118	12.00 (20.25)	3	MR	33.33 (35.25)	5	MS
11	DCA 123	14.22 (22.11)	3	MR	19.34 (26.07)	3	MR
12	DCA 145	24.00 (29.32)	3	MR	30.45 (33.47)	5	MS
13	DCA 153	15.78 (23.38)	3	MR	18.67 (25.58)	5	MS
14	DCA 154	20.45 (26.87)	3	MR	36.00 (36.86)	5	MS
15	DCA 174	19.11 (25.91)	3	MR	31.78 (34.30)	5	MS
16	DCA 176	20.89 (27.17)	3	MR	36.23 (36.99)	5	MS
17	DCA 189	10.45 (18.84)	1	R	10.22 (18.62)	1	R
18	DCA 216	20.00 (26.55)	3	MR	39.78 (39.08)	5	MS
19	DCA 222	17.56 (24.76)	3	MR	31.33 (34.02)	5	MS
20	DCA 224	16.67 (24.07)	3	MR	32.00 (34.43)	5	MS
21	DCA 233	19.33 (26.07)	3	MR	32.23 (34.57)	5	MS
22	DCA 234	18.45 (25.42)	3	MR	37.11 (37.51)	5	MS
23	DCA 237	8.89 (17.32)	1	R	25.12 (30.05)	3	MR
24	DCA 240	12.44 (20.64)	3	MR	35.34 (36.45)	5	MS
25	DCA 257	10.00 (18.42)	1	R	26.89 (31.22)	5	MS
26	DCA 295	20.00 (26.55)	3	MR	25.56 (30.35)	5	MS
27	DCA 298	14.00 (21.96)	3	MR	29.33 (32.78)	5	MS
28	DCA 300	9.56 (17.97)	3	MR	23.34 (28.86)	3	MR
29	DCA 302	10.00 (18.42)	1	R	12.44 (20.64)	3	MR
30	DCA 305	5.78 (13.86)	1	R	18.22 (25.23)	3	MR
31	ByadagiDabbi	15.78 (23.38)	3	MR	59.78 (61.08)	7	S
	SE(m)	0.83			0.69		
	C.D.	2.42			2.00		

Table.2 *In vitro* screening of chilli accessions against *C. capsici* using microinjection method

Sl. No	Genotypes	Green stage			Turning red stage			Red ripe stage		
		1DAI	3DAI	Reaction	1DAI	3DAI	Reaction	1DAI	3DAI	Reaction
1	DCA 67	0.00	3.70	R	3.70	11.11	MR	3.70	7.41	R
2	DCA 69	0.00	7.40	R	0.00	7.41	R	0.00	3.70	R
3	DCA 76	3.70	7.41	R	7.41	25.93	MR	3.70	18.52	MR
4	DCA 79	0.00	3.70	R	0.00	18.52	MR	0.00	40.74	MS
5	DCA 81	0.00	7.41	R	0.00	33.33	MS	3.70	40.74	MS
6	DCA 89	0.00	3.70	R	0.00	7.41	R	0.00	7.41	R
7	DCA 98	0.00	11.11	MR	3.70	33.33	MS	0.00	18.52	MR
8	DCA 104	0.00	7.41	R	0.00	25.93	MR	0.00	25.93	MR
9	DCA 107	7.41	55.56	S	7.41	25.93	MR	3.70	18.52	MR
10	DCA 118	0.00	3.70	R	0.00	33.33	MS	7.41	25.93	MR
11	DCA 123	0.00	7.41	R	3.70	25.93	MR	7.41	25.93	MR
12	DCA 145	11.11	62.96	S	0.00	7.41	R	0.00	25.93	MR
13	DCA 153	0.00	7.41	R	0.00	11.11	MR	0.00	18.52	MR
14	DCA 154	0.00	11.11	MR	3.70	25.93	MR	0.00	11.11	MR
15	DCA 174	0.00	7.41	R	7.41	40.74	MS	7.41	55.56	S
16	DCA 176	0.00	11.11	MR	3.70	18.52	MR	3.70	25.93	MR
17	DCA 189	0.00	3.70	R	3.70	7.41	R	0.00	7.41	R
18	DCA 216	0.00	3.70	R	0.00	33.33	MS	0.00	18.52	MR
19	DCA 222	3.70	11.11	MR	3.70	11.11	MR	0.00	11.11	MR
20	DCA 224	0.00	7.41	R	3.70	11.11	MR	0.00	25.93	MR
21	DCA 233	0.00	7.41	R	7.41	33.33	MS	7.41	33.33	MS
22	DCA 234	7.41	33.33	MS	11.11	33.33	MS	0.00	18.52	MR
23	DCA 237	0.00	3.70	R	3.70	40.74	MS	3.70	33.33	MS
24	DCA 240	3.70	11.11	MR	0.00	25.93	MR	3.70	25.93	MR
25	DCA 257	0.00	18.52	MR	3.70	18.52	MR	0.00	33.33	MS
26	DCA 295	0.00	18.52	MR	11.11	25.93	MR	0.00	25.93	MR
27	DCA 298	11.11	55.56	S	3.70	55.56	S	7.41	11.11	MR
28	DCA 300	0.00	7.41	R	7.41	11.11	MR	0.00	33.33	MS
29	DCA 302	0.00	33.33	MS	0.00	11.11	MR	0.00	7.41	R
30	DCA 305	0.00	7.41	R	0.00	25.93	MR	3.70	11.11	MR
31	ByadagiDabbi	0.00	18.52	MR	11.11	25.93	MR	3.70	55.56	S

Table.3 Reaction of chilli genotypes under natural condition, challenge inoculation and *invitro* fruit inoculation

	Resistant	**Moderately resistant**	**Moderately susceptible**	**Susceptible**	**Highly susceptible**
Screening under natural condition					
90 DAT	DCA-67, 69, 76, 189, 237, 257, 302 and 305	DCA-79, 81, 89, 98, 104, 107, 118, 123, 145, 153, 154, 174, 176, 216, 222, 224, 233, 234, 240, 295, 298, 300 and ByadagiDabbi			
During harvest	DCA-69 and 189	DCA-67, 76, 89, 123, 237, 300, 302 and 305	67, 79, 81, 98, 104, 107, 118, 145, 153, 154, 174, 176, 216, 222, 224, 233, 234, 240, 257, 295 and 298	ByadagiDabbi	
***In vitro* fruit inoculation**					
Green stage	DCA-67, 69, 76, 79, 81, 89, 104, 118, 123, 153, 174, 189, 216, 224, 233, 237, 300 and 305.	DCA-98, 154, 176, 222, 240, 257, 295 and ByadagiDabbi.	DCA-234 and 302	DCA-107, 145 and 298.	
Turning red stage	DCA-69, 89, 145 and 189	DCA-67, 76, 79, 104, 107, 123, 153, 154, 176, 222, 224, 240, 257, 295, 300, 302, 305 and ByadagiDabbi	DCA- 81, 98, 118, 174, 216, 233, 234 and 237.	DCA-298.	
Red ripe stage	DCA-67, 69, 89, 189 and 302	DCA-76, 98, 104, 107, 118, 123, 145, 153, 154, 176, 216, 222, 224, 234, 240, 295, 298 and 305.	DCA-79, 81, 233, 237, 257 and 300.	DCA- 174 and ByadagiDabbi.	

Fig.1 *In vitro* screening of different entries of chilli at green stage

Plate.2 *In vitro* screening of different entries of chilli at red ripe stage

In vitro screening of 31 chilli accessions, 18accessions were found resistant, 8 were moderately resistant, 3 were moderately susceptible and 2 were susceptible to the pathogen during green stage of the fruit. The reaction of chilli fruits during turningred stage recorded, 18accessionsas moderately resistant, 8 as moderately susceptible and one (DCA-298) was susceptible. The reaction varied in red stage of fruit development wherein, 5accessionswere resistant, 18accessions were moderately resistant, 6 were moderately susceptible and2 were susceptible to the pathogen. The pathogen infection was more in case of red stages of the fruit development as compared to mature green stage. Many accessions were found resistant during green stages, but susceptible at red stages of the fruit development. Few accessions were tolerant to the pathogen at red stage but susceptible during green stages. Mesta (1996) found 11 accessions as resistant and 24 as moderately resistant accessions against *Colletotrichum capsici* out of 217 chilli accessions screened under natural and lab condition.

The accessions DCA-67, 69, 189, 302 and 305 were reacted resistant to the *C. capsici* in field and artificial screening. Hence, these accessions having the resistant genes which can be harnessed for resistant breeding programme.

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