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Reaction of chilli (*Capsicum annuum* L.) genotypes and hybrids against *Fusarium* wilt (*Fusarium solani*)

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Abstract

Field experiment was conducted to evaluate chilli (*Capsicum annuum* L.) genotypes and hybrids against *Fusarium solani*. About 56 restorer lines and 38 F_1 hybrids were evaluated for resistance to *Fusarium solani* under laboratory conditions. Among the 56 genotypes, none of them were immune or resistant. However, only one genotype *viz*., P3 was found moderately resistant in both seed inoculation and rapid root dip transplanting techniques. However, out of 38, two hybrids, *viz*., JNA2 × ACB1 × 9608D and Rajaput × P3 showed resistance under sick pot culture condition.

Keywords: *Capsicum annuun, Fusarium solani,* resistant, susceptible

Introduction

Chilli (*Capsicum annuum* L.) is an important tropical and sub tropical condiment and vegetable crop. The crop suffers from many diseases like damping off, anthracnose or fruit rot or die back, wilt, murda complex, leaf spot, powdery mildew and wilt. Wilt disease caused by [*Fusarium solani* (Mart.) Sacc.], is becoming more serious in chilli growing tracts of India (Singh *et al.* 1998) including Karnataka particularly in black cotton soils leading to 25% yield loss (Madhukar & Naik 2004). The incidence of wilt varied from 0-75% in different states of India (Anonymous 2005).

The wilt appears both in seedling and adult stages but highest mortality occurs at flowering and fruiting stages, as a result the whole plant wilts leading to complete loss. Although the disease first appears in patches, it can extend to the entire field if chilli is cultivated repeatedly in the same field.

Host plant resistance has been a choice in all crop improvement programmes and is perhaps the best method available to tackle soil borne diseases especially *Fusarium* wilt which is a typical soil borne disease and can be mitigated appropriately by the use of disease resistant cultivars. Most of the commercial cultivars grown in India are susceptible to wilt including the very popular, Byadagi type of chilli. Further, the use of resistant variety is essential not only in reducing losses due to disease, but also in avoiding fungicidal toxicity which is likely to occur due to application to soil. Hence,

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evaluation of chilli genotypes and hybrids was carried out to identify *Fusarium* wilt disease resistant genotypes/hybrids.

Material and methods

Collection of the Fusarium *culture*

The fungus *Fusarium solani* was collected and sub-cultured on potato dextrose agar (PDA) slants and allowed to grow at 28 ± 1° C for 15 days. Test fungus was multiplied on PDA in petri plates. Conidia and mycelium were harvested after 10 days growth by flooding the petri plates with sterile water and the conidia and mycelium bits were dislodged into water by using camel hair brush. The spore suspension thus obtained was used for experiments. The trial was replicated thrice in all the techniques and 20 seeds in each replication with one control were maintained. To score the incidence of *Fusarium* wilt the scale used by Naik *et al.* (2008) was followed.

Seed inoculation technique

Apparently healthy seeds were collected and surface sterilized with $HgCl_2$ (0.1%). The seeds were dipped in *Fusarium solani* spore suspension (1×10^7 conidia mL^{-1}) for 12 h, thereafter, they were sown in pots containing sterilized soil. The data on wilt incidence was recorded on 15th and 30th days after sowing. About fifty six genotypes were tested using seed inoculation technique. However, genotypes that showed 100% mortality (wilting) were rejected and only 12 genotypes were selected for rapid root dip transplanting technique of screening by harvesting the matured fruits and extracting the seeds from survived plants only.

Rapid root dip transplanting technique

Chilli seedlings were raised in a plastic trays containing sterilized sand in a nylon net house and protected with two insecticidal sprays of malathion (0.1%) and monocrotophos (0.05%) to prevent viral disease (Naik *et al*. 1996). Three weeks old seedlings were removed, roots were thoroughly washed in running tap water and tip of the roots (3 mm) were cut so as to make wounds in the roots. The wounded roots were immersed in spore suspension of *F. solani* and again planted in a plastic pots containing sterilized soil.

Sick pot technique

Chilli seeds were surface sterilized with $HgCl_2$ (0.1%) for one minute and washed thrice in sterile water to remove the traces of $HgCl_2$ and planted in sick pots containing *F. solani*. The sick pots were prepared by using *Fusarium* colonized sorghum grain. In cases where isolates produced typical wilting symptoms, the fungus was successfully re-isolated and Koch's postulates were proved.

Results and discussion

Seed inoculation technique

Among 56 genotypes (Table 1) screened in seed inoculation technique against *F. solani*, none of the genotypes showed immune as well as resistant reactions. However, genotype P3 exhibited moderate resistance and three genotypes *viz*., *Rajput*, JNB1 and LCA 960 showed susceptible reaction. The remaining 52 genotypes exhibited highly susceptible reaction.

Rapid root dip transplanting technique

Among the selected (based on their survival in seed inoculation technique) 12 genotypes screened in rapid root dip transplanting technique, P3 showed moderate resistance. However, other genotypes *viz*., KA2 and *Rajput* were identified as susceptible and PANT-C1, GCV121, H0413, K1-4D, SNK, JNB1, G4, LCA960 and 9608D were highly susceptible to *F. solani* (Table 2). Among the 38 hybrids, 12 hybrids *viz*., JNA2 × JNB1 × K1-4D, JNA2 × JNB1 × KA2, JNA2 × JNB1 × H0413, JNA2 × JNB1 × 9608D, JNA2 × JNB1 × *Rajput*, JNA1 × *Rajput*, JNA1 × P3, JNA2 × ACB1 × H0413, JNA2 × ACB1 × *Rajput*, P3 × K1-4D, P3 × KA2 and SNK × P3 showed moderate resistance. While, 10 hybrids *viz*., JNA2 × JNB1 × P3, JNA1 × KA2, JNA2 × ACB1 × 9608D, JNA2 × ACB1 × P3, JNB1 × K1-4D, JNB1 × KA2, JNB1 × *Rajput*, JNB1 × P3, ACB1 × K1-4D and *Rajput* × P3 showed susceptible reaction and 16 hybrids *viz*., JNA1 × K1-4D, JNA1 × H0413, JNA1 × 9608D, JNA2 × ACB1 × K1-4D, JNA2 × ACB1 × KA2, JNB1 × H0413, JNB1 × 9608D, ACB1 × H0413, ACB1 ×

Table 1. Screening of chilli genotypes for *Fusarium* wilt (*Fusarium solani*) using seed inoculation technique

Sl. No.	Genotypes	Wilt at 15 DAS (%)	Wilt at 30 DAS (%)	Disease reaction
1.	9608D	53.33	56.67	Highly susceptible
2.	K1-4D	40.33	52.67	Highly susceptible
3.	K1-4DS	100.00	100.00	Highly susceptible
4.	KA2	56.67	56.67	Highly susceptible
5.	P3	8.33	21.67	Moderately resistant
6.	BVC37	86.67	100.00	Highly susceptible
7.	ACB1	85.00	100.00	Highly susceptible
8.	*Rajput*	33.33	40.00	Susceptible
9.	GCV121RES	100.00	100.00	Highly susceptible
10.	*B.Dabbi*	86.67	100.00	Highly susceptible
11.	JNB1	38.33	43.33	Susceptible
12.	G4	100.00	100.00	Highly susceptible
13.	*Sankeshwar*	66.67	100.00	Highly susceptible
14.	*Phule Jyoti*	100.00	100.00	Highly susceptible
15.	*Hisar Vijay*	100.00	100.00	Highly susceptible
16.	JM-218	100.00	100.00	Highly susceptible
17.	PANT-C1	46.67	65.00	Highly susceptible
18.	H0413	45.67	51.67	Highly susceptible
19.	K1-4C	100.00	100.00	Highly susceptible
20.	9608-U	30.00	63.33	Highly susceptible
21.	BVC-1	100.00	100.00	Highly susceptible
22.	GUK-1	100.00	100.00	Highly susceptible
23.	GUK-2	100.00	100.00	Highly susceptible
24.	GUK-2-1	100.00	100.00	Highly susceptible
25.	GUK2-1-1	100.00	100.00	Highly susceptible
26.	IC119243	100.00	100.00	Highly susceptible
27.	IC112109	100.00	100.00	Highly susceptible
28.	IC119578	100.00	100.00	Highly susceptible
29.	IC119561	100.00	100.00	Highly susceptible
30.	LCA 235	100.00	100.00	Highly susceptible
31.	LCA 304	100.00	100.00	Highly susceptible
32.	LCA 310	100.00	100.00	Highly susceptible
33.	LCA 310A	100.00	100.00	Highly susceptible
34.	LCA 334	100.00	100.00	Highly susceptible
35.	LCA 960	41.67	50.00	Susceptible
36.	GPC 82	100.00	100.00	Highly susceptible
37.	KDSC-210-10-1	100.00	100.00	Highly susceptible
38.	KDSC-210-10-2	100.00	100.00	Highly susceptible
39.	KDSC-210-10-3	100.00	100.00	Highly susceptible
40.	KDSC-210-10-4	100.00	100.00	Highly susceptible
41.	KDSC-210-10	100.00	100.00	Highly susceptible
42.	KDSC-510-10-1	100.00	100.00	Highly susceptible
43.	KDSC-510-10-2	100.00	100.00	Highly susceptible
44.	KDSC-510-10	100.00	100.00	Highly susceptible
45.	HCS-3	100.00	100.00	Highly susceptible
46.	SUM05-2R	100.00	100.00	Highly susceptible
47.	JM 283	100.00	100.00	Highly susceptible
48.	*P. Jwala*	78.33	81.67	Highly susceptible
49.	HMT-1	100.00	100.00	Highly susceptible
50.	*B.Kaddi*	73.33	80.00	Highly susceptible
51.	*Jayanti*	100.00	100.00	Highly susceptible
52.	GCV 111	100.00	100.00	Highly susceptible
53.	GCV 121	100.00	100.00	Highly susceptible
54.	*Sadabahar*	100.00	100.00	Highly susceptible
55.	AVNPC 131	100.00	100.00	Highly susceptible
56.	X-235	100.00	100.00	Highly susceptible

DAS=Days after sowing

Table 2. Screening of chilli genotypes for *Fusarium* wilt (*Fusarium solani*) using rapid root dip transplanting technique

Sl. No.	Genotypes	Wilt at 15 DAT (%)	Wilt at 30 DAT (%)	Disease reaction
1.	PANTC1	36.67	100.00	Highly susceptible
2.	KA2	40.00	41.33	Susceptible
3.	H0413	66.67	93.33	Highly susceptible
4.	*Rajput*	49.67	49.67	Susceptible
5.	K1-4D	73.33	73.33	Highly susceptible
6.	SNK	83.33	100.00	Highly susceptible
7.	P3	13.33	16.67	Moderately resistant
8.	JNB1	80.00	90.00	Highly susceptible
9.	GCV121	73.33	76.67	Highly susceptible
10.	G4	83.33	100.00	Highly susceptible
11.	LCA960	76.67	86.67	Highly susceptible
12.	9608D	80.00	100.00	Highly susceptible

DAT=Days after transplanting

9608D, ACB1 × *Rajput*, ACB1 × P3, ACB1 × H0413, P3 × *Rajput*, P3 × SNK, K1-4D × P3 and KA2 × P3 were highly susceptible to *F. solani* (Tables 3 & 3a).

Sick pot technique

Among the newly developed 38 hybrids, two hybrids *viz*., JNA2 × ACB1 × 9608D and *Rajput* × P3 showed resistance under sick pot culture technique. However, 10 hybrids *viz*., JNA2 × JNB1 × K1-4D, JNA2 × JNB1 × 9608D, JNA1 × H0413, JNA2 × JNB1 × P3, JNA1 × K1-4D, JNA2 × ACB1 × H0413, JNB1 × H0413, JNB1 × *Rajput*, KA2 × P3 and SNK × P3 showed moderately resistant and JNA2 × JNB1 × KA2, JNA2 × JNB1 × H0413, JNA2 × JNB1 × *Rajput*, JNA2 × JNB1 × P3, JNA1 × K1-4D, JNA1 × KA2, JNA2 × 9608D, JNB1 × KA2, JNB1 × 9608D and ACB1 × K1-4D showed susceptible reaction. However, 10 hybrids *viz*., JNA2 × ACB1 × P3, JNB1 × P3, ACB1 × KA2, ACB1 × H0413, ACB1 × 9608D, ACB1 × *Rajput*, ACB1 × P3, P3 × KA2, P3 × SNK and KA2 × P3 showed highly susceptible reaction (Tables 3 & 3a).

Rapid root dip transplanting encountered higher percentage of mortality obviously due to challenge inoculation. Genotypes commonly cultivated in Northern Karnataka region such as *Byadagi Kaddi*, *Byadagi Dabbi*, *Guntur* and G-4 were susceptible, which is a cause of concern to the farming community. Such wide response of chilli genotypes to *Fusarium* wilt was earlier observed by Ahmed *et al*. (1994), Nayeema *et al*. (1995), Singh *et al*. (1998) and Devika Rani *et al*. (2008).

It could be concluded from the study that higher percentage of mortality was registered in rapid root dip transplanting technique which may be due to challenge inoculation of pathogen. None of the genotypes showed resistance reaction to *F. solani.* However, one genotype namely, P3 was found moderately resistance in both seed inoculation technique and rapid root dip transplanting technique and produced resistant hybrid namely *Rajput* × P3 in sick pot technique. Although the moderately resistant parent P3 was not involved for production of another resistant hybrid JNA2 × ACB1 × 9608D under sick pot technique, it showed resistant reaction due to non allelic gene interaction.

Table 3. Wilt incidence recorded in various chilli genotypes against *Fusarium solani* by rapid root dip transplanting technique and sick pot technique

Sl. No.	Genotypes	Wilt incidence (%)	
		Rapid root dip transplanting technique	Sick pot technique
1.	JNA2 × JNB1 × K1-4D	23.33	25.00
2.	JNA2 × JNB1 × KA2	23.33	35.00
3.	JNA2 × JNB1 × H0413	20.00	65.00
4.	JNA2 × JNB1 × 9608D	20.00	25.00
5.	JNA2 × JNB1 × *Rajput*	16.67	50.00
6.	JNA2 × JNB1 × P3	36.67	40.00
7.	JNA1 × K1-4D	100.00	50.00
8.	JNA1 × KA2	50.00	55.00
9.	JNA1 × H0413	53.33	20.00
10.	JNA1 × 9608D	63.33	40.00
11.	JNA1 × *Rajput*	23.33	20.00
12.	JNA1 × P3	20.00	20.00
13.	JNA2 × ACB1 × K1-4D	56.67	75.00
14.	JNA2 × ACB1 × KA2	100.00	90.00
15.	JNA2 × ACB1 × H0413	23.33	25.00
16.	JNA2 × ACB1 × 9608D	30.00	2.00
17.	JNA2 × ACB1 × *Rajput*	13.33	100.00
18.	JNA2 × ACB1 × P3	36.67	70.00
19.	JNB1 × K1-4D	36.67	100.00
20.	JNB1 × KA2	36.67	30.00
21.	JNB1 × H0413	60.00	20.00
22.	JNB1 × 9608D	53.33	35.00
23.	JNB1 × *Rajput*	33.33	20.00
24.	JNB1 × P3	53.33	70.00
25.	ACB1 × K1-4D	30.00	40.00
26.	ACB1 × KA2	73.33	95.00
27.	ACB1 × H0413	53.33	60.00
28.	ACB1 × 9608D	100.00	55.00
29.	ACB1 × *Rajput*	70.00	75.00
30.	ACB1 × P3	70.00	65.00
31.	P3 × K1-4D	13.33	100.00
32.	P3 × KA2	20.00	70.00
33.	P3 × *Rajput*	100.00	100.00
34.	P3 × SNK	100.00	100.00
35.	K1-4D × P3	63.33	90.00
36.	KA2 × P3	66.67	20.00
37.	*Rajput* × P3	36.67	5.00
38.	SNK × P3	23.33	20.00

Table 3a. Reaction of chilli hybrids against *F. solani* under rapid root dip transplanting technique and pot culture technique (Sorghum giant culture technique)

Infection (%)	Disease reaction	Rapid root dip transplanting technique	Sick pot method
0	Immune	Nil	Nil
1-10	Resistant	Nil	JNA2 × ACB1 × 9608D and *Rajput* × P3
11-25	Moderately resistant	JNA2 × JNB1 × K1-4D, JNA2 × JNB1 × KA2, JNA2 × JNB1 × H0413, JNA2 × JNB1 × 9608D, JNA2 × JNB1 × *Rajput*, JNA1 × *Rajput* JNA1 × P3, JNA2 × ACB1 × H0413, JNA2 × ACB1 × *Rajput*, P3 × K1-4D, P3 × KA2 and SNK × P3	JNA2 × JNB1 × K1-4D, JNA2 × JNB1 × 9608D, JNA1 × H0413, JNA2 × JNB1 × P3, JNA1 × K1-4D, JNA2 × ACB1 × H0413, JNB1 × H0413, JNB1 × *Rajput*, LCA-960 and SNK × P3
26-50	Susceptible	JNA2 × JNB1 × P3, JNA1 × KA2, JNA2 × ACB1 × 9608D, JNA2 × ACB1 × P3, JNB1 × K1-4D, JNB1 × KA2, JNB1 × *Rajput*, JNB1 × P3, ACB1 × K1-4D and *Rajput* × P3	JNA2 × JNB1 × H0413, JNA2 × JNB1 × KA2, JNA2 × JNB1 × P3, JNA2 × JNB1 × *Rajput*, JNA1 × K1-4D, JNA1 × KA2, JNA2 × 9608D, JNB1 × KA2, JNB1 × 9608D, ACB1 × K1-4D
51-100	Highly susceptible	JNA1 × K1-4D, JNA1 × H0413, JNA1 × 9608D, JNA2 × ACB1 × K1-4D, JNA2 × ACB1 × KA2, JNB1 × H0413, JNB1 × 9608D, ACB1 × H0413, ACB1 × 9608D, ACB1 × *Rajput*, ACB1 × P3, ACB1 × H0413, P3 × *Rajput*, P3 × SNK, K1-4D × P3 and KA2 × P3	JNA2 × ACB1 × P3, JNA2 × ACB1 × P3, JNB1 × P3, ACB1 × KA2, ACB1 × H0413, ACB1 × 9608D, ACB1 × *Rajput*, ACB1 × P3, P3 × KA2, P3 × SNK and KA2 × P3

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