



Research Article

STUDIES ON VARIABILITY OF WILT PATHOGEN (*Fusarium oxysporum* f. sp. *cumini*) OF CUMIN (*Cuminum cyminum* L.)

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Abstract- Wilt caused by *Fusarium oxysporum* f. sp. *cumini* is the major disease of cumin. In all, fifteen isolates of *Fusarium oxysporum* f. sp. *cumini* were collected from cumin growing areas of North Gujarat and designated as Foc 1 to Foc 15 found pathogenic on cumin variety GC-2. Studies were made on cultural variations in colony growth, growth pattern colony colour and pigmentation. The colony diam ranged from 57.00 mm (Foc-12) to 88.75 mm (Foc-4). The growth pattern varied as thin flat to slight fluffy growth at middle and submerged at periphery, profuse fluffy growth at middle, moderately fluffy growth at middle and slight fluffy growth at middle and slight thread like spreading at periphery. Mycelium pigmentation among the fifteen isolates varied from white to pinkish white, orange to whitish orange, whereas substrate pigmentation varied from pale white to violet, orange, red. The length of microconidia varied from 7.29 μ m (4.05-13.50 μ m) to 11.47 μ m (6.45-13.50 μ m), while the breadth varied from 2.72 μ m (2.70-3.24 μ m) to 4.75 μ m (3.24-5.40 μ m). The macroconidia were 3 to 6 septate, straight, spindle as well as sickle shaped. The length of macroconidia varied from 18.63 μ m (17.5-20.3 μ m) to 31.48 μ m (24.3-40.3 μ m), while the breadth varied from 3.00 μ m (2.7-4.05 μ m) to 4.75 μ m (2.7-6.75 μ m). Studies on pathogenic variability revealed that the disease intensity on cumin varied from 26.66 to 60.89 percent.

Keywords- Cumin, *Fusarium oxysporum* f.sp. *cumini*, variability

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Introduction

India is the largest producer, consumer and exporter of spices in the world market [19]. Among different spice crops, cumin (*Cuminum cyminum* L.) is an important seed spice crop grown in Gujarat and Rajasthan states. Fungal disease like wilt, blight and powdery mildew are serious problem in cumin crop and cause considerable yield losses in all most cumin growing area of India, however, wilt caused by *Fusarium oxysporum* f.sp. *cumini* [13] is one of the destructive diseases as it causes severe yield losses. [12] recorded approximately 40 % yield losses by the wilt. The disease is soil borne and therefore, it becomes difficult to manage the disease through chemical means. The only practical relation of this problem lies in the breeding of resistant varieties. Variability of wilt pathogen is of great concern in breeding programme for development of high yielding disease resistant variety. It is essential to identify and understand variability in the wilt pathogen to work out strategies for durable and stable resistant cumin varieties. The information on cultural, morphological and pathological variation among different isolates of wilt pathogen is meager. An attempt was made to study variation in cultural, morphological and pathological of isolates collected from north Gujarat region.

Materials and Methods

Collection and Pathogenicity

Cumin (*Cuminum cyminum* L.) plant with typical wilt symptoms were collected from different locations of North Gujarat and Kachchh regions such as Banaskantha, Sabarkantha, Mehsana, Patan and Kachchh districts of Gujarat and designated as Foc1 to Foc15 as mentioned in table-1. The pathogen *Fusarium oxysporum* f.sp. *cumini* was isolated from diseased plant parts and

established on PDA slants. The pathogenicity of the purified fungus of each isolate was tested in pots. The inoculum of different isolates was multiplied separately on sorghum grain medium (the sorghum grains were soaked in 2 percent sucrose solution for overnight and then 100 g sorghum grains kept in 250 ml flasks and autoclaved) by putting aseptically four mycelial discs of 4 mm diameter cut from the periphery of seven days old pure culture of different isolates grown on PDA at $27 \pm 2^\circ\text{C}$ temperature. These inoculated flasks were incubated at $27 \pm 2^\circ\text{C}$ for 20 days. The spore suspension was prepared by transferring the sorghum grains with sporulating fungus into sterile distilled water, stirred well and filtered through sterilized double layer muslin cloth. Inoculum concentration of each isolate was adjusted to 1×10^6 spores/ml with the help of haemocytometer. Twenty days old plants of each variety in each pot were inoculated separately with adjusted spore suspension of 106 spores/ml of each isolate. For inoculation, 50 ml of spore suspension was poured into the soil around each plant to a depth of approximately 1 cm. Healthy seeds of cumin variety GC-2 were sown @10 seeds/pot. Observations on wilting percent were recorded. Reisolation was made from diseased seedlings of each isolate separately and the cultures were compared with original one

Cultural and Morphological variability

Fifteen isolates of *Fusarium oxysporum* f.sp. *cumini* were obtained from the infected plant parts of locally grown cumin cultivars at diverse locations of North Gujarat during 2011-12. The isolates were maintained and multiplied on Potato Dextrose Agar (PDA) medium. To study the morpho-cultural characteristics of *Fusarium oxysporum* f.sp. *cumini*, PDA plates were inoculated with 4 mm dia mycelia disc obtained from the periphery of actively growing fungal colony of 7-d

old cultures of each of 15 isolates and three plates of each isolate were then incubated at $27 \pm 2^\circ\text{C}$ and maintained. The radial growth, pigmentation of mycelium, pigmentation of substrate, length and width of micro and macro conidia and septation of macroconidia were measured. The length and breadth of micro and macro conidia was measured by ocular and stage micrometer.

Pathogenic Variability

The pathogenic variability of fifteen isolates was studied through soil inoculation technique. In this study cumin varieties viz., GC-2, GC-3 and GC-4 were evaluated for wilt reaction against collected isolates. Twenty genetically pure seeds of cumin varieties were sown in per pot. Inoculum of each isolate was multiplied individually on sorghum grain medium (the sorghum grains were soaked in 2 percent sucrose solution for overnight and then 100 g sorghum grains kept in 250 ml conical flasks and autoclaved) for 10 days at $27 \pm 2^\circ\text{C}$. The spore suspension was prepared by transferring the sorghum grains with sporulating fungus into sterile distilled water, stirred well and filtered through sterilized double layer muslin cloth. Inoculum concentration of each isolate was adjusted to 1×10^6 spores/ml with the help of haemocytometer. Twenty days old plants of each variety in each pot were inoculated separately with adjusted spore suspension of 106 spores/ml of each isolate. For inoculation, 50 ml of spore suspension were poured into the soil around each plant to a depth of approximately 1 cm. Three pots as three replications for each variety and isolate were maintained. Parallel three pots of each variety, without inoculation of any isolate were maintained as control. The inoculated plants were inspected daily for the first appearance of wilt symptoms and wilt incidence were recorded at 15th day of inoculation by using the formula given by Champawat and Pathak [1]. On the basis of wilt reaction, cumin varieties were categorized using the following description. HR- Highly resistant (0.0% wilt incidence); R- Resistant (1-20% wilt incidence); MR- Moderately resistant (21-40% wilt incidence); MS- Moderately susceptible (41-60% wilt incidence); S- Susceptible (61-80% wilt incidence); HS- Highly susceptible (81-100% wilt incidence)

Results and Discussion

Pathogenicity

There was a significant difference among fifteen isolates in their ability to induce wilt disease in susceptible variety GC-2 and mean wilt incidence ranged from 35.85 percent (Foc-8) to 53.66 percent (Foc-4). The significant maximum wilt incidence 53.66% was recorded by Foc-4, followed by Foc-1 (50.88%) and Foc-9 (48.30%). The isolate Foc-7 (45.76%), Foc-11 (45.21%), Foc-5 (44.66%), Foc-15 (44.66%) and Foc-3 (44.22%) were statistically at par to each other in producing wilt incidence, while isolate Foc-13 (42.83%), Foc-2 (41.07 %), Foc-10 (39.03%) and Foc-6 (38.55%) were significantly differ to each other in producing wilt incidence. The minimum wilt incidence 35.85% was noted by Foc-8, followed by Foc-14 (36.35%) and Foc-12 (37.50%) were statistically at par to each other in producing wilt incidence. First appearance of disease symptoms ranged from 12 days (Foc-4) to 18 days (Foc-8). The wilt incidence increased positively with increasing incubation period. After 20 days of inoculation 28.93 percent mean wilt incidence was recorded which increased with time and being 55.34 percent after 35 days of inoculation. The isolate Foc-8 produced minimum wilt incidence 49.11% after 35 days of inoculation, while isolates Foc-1, Foc-2, Foc-4, Foc-5, Foc-7, Foc-9, Foc-11, Foc-13 and Foc-15 produced higher wilt incidence 51.12 to 61.53 percent after only 30 days of inoculation except isolates Foc-3, Foc-6 and Foc-12 produced 41.42 to 47.19 percent wilt incidence. The isolates Foc-4, Foc-1 and Foc-9 produced higher wilt incidence after 35 days of inoculation which ranged from 59.30 to 66.67 percent, while rest of the isolates produced wilt incidence with a range of 49.11 to 55.06 percent in susceptible cumin variety GC-2. Isolates within the same species or formae species that are distinctly more virulent than others have been distinguished in *Fusarium*. Champawat and Pathak [1] and Raheja [20] observed considerable difference in virulence of different isolates of *F. oxysporum* f. sp. *cumini*. The present findings are in conformity with the findings of the research workers.

Cultural variability

All the isolates of *F. oxysporum* f.sp. *cumini* showed significant variation in colony growth, growth pattern and colony colour. The colony diameter was ranged from 57.00 mm (Foc-12) to 88.75 mm (Foc-4). The significantly maximum colony diameter was exhibited by Foc-4 (88.75 mm) followed by Foc-13 (85.05 mm) and Foc-14 (82.50 mm). The significantly minimum colony diameter 57.00 mm was noted in the isolate Foc-12, followed by Foc-9 (60.05 mm) and Foc-7 (61.50 mm). Isolates differed in their cultural characteristics on PDA. The isolates Foc-5 and Foc-10 produced thin flat to slight fluffy growth at middle and submerged growth at periphery. The isolates Foc-1, Foc-3, Foc-4, Foc-8 and Foc-13 produced profuse fluffy growth at middle. Isolates Foc-2, Foc-6, Foc-9, Foc-12 and Foc-15 produced slight fluffy growth at middle. While, the isolates Foc-7, Foc-11 and Foc-14 produced moderately fluffy growth at middle. Mycelium and substrate pigmentation varied among different isolates on PDA. The isolate Foc-1, Foc-3, Foc-8, Foc-11 and Foc-15 produced pinkish white mycelium with red substrate pigment. The isolate Foc-7 and Foc-12 produced pinkish white mycelium with violet substrate pigment. The isolates Foc-2, Foc-4, Foc-9, Foc-13 and Foc-14 produced white mycelium but they were differed in substrate pigmentation. The isolates Foc-2 produced violet substrate pigment while, Foc-9, Foc-13 and Foc-14 produced pale white substrate pigment and Foc-4 produced red substrate pigment. The isolate Foc-5, Foc-6 and Foc-10 produced orange white mycelium with orange substrate pigment. Variation in cultural characteristics among the isolates of *fusarium* wilt pathogen have been reported in pignon pea (Eswara Reddy and Basu Chaudhary [5]; Gaur and Sharma [6]; Das and Sengupta [3]; Patel *et al* [14]; Tiwari and Dhar [23] and Kumar and Upadhyay [11], chickpea (Gupta *et al* [7]; Paul *et al* [16]; Paulkar and Raut [18]; Honnareddy and Dubey [9] and Kumar *et al* [10]), Banana (Sanjeevkumar *et al* [21]), castor (Desai *et al* [4]; Chauhan [2]; Santha Lakshmi Prasad *et al* [22]), pea (Gupta *et al* [8]) and cotton (Patil *et al* [15]). Champawat and Pathak [1] and Raheja [20] also observed cultural variability among different isolates of cumin wilt pathogen, *F. oxysporum* f. sp. *cumini*. The present findings agree with earlier research workers.

Morphological Variability

The morphological variability of fifteen isolates of *F. oxysporum* f. sp. *cumini* revealed the variation in size of microconidia and macroconidia among fifteen isolates of cumin wilt pathogen. The microconidia were hyaline, round to oval in shape. The length of microconidia varied from 7.29 μm (4.05-13.50 μm) in isolate Foc-7 to 11.47 μm (6.45-13.50 μm) in isolate Foc-6, while the breadth of microconidia ranged from 2.72 μm (2.70-3.24 μm) in isolate Foc-12 to 4.75 μm (3.24-5.40 μm) in isolate Foc-11. The macroconidia were 3 to 6 septate, straight, spindle as well as sickle shaped. The length of macroconidia varied from 18.63 μm (17.5-20.3 μm) in isolate Foc-14.00 to 31.48 μm (24.3-40.3 μm) in Foc-6, while the breadth of macroconidia varied from 3.00 μm (2.7-4.05 μm) in isolate Foc-13 to 4.75 μm (2.7-6.75 μm) in isolate Foc-4 (Table). The present findings agree with the work done on different formae species of *Fusarium* wilt pathogen by several workers. Champawat and Pathak [1] showed morphological variability among nine isolates of *F. oxysporum* f. sp. *cumini*. Das and Sengupta [3] observed morphological variability among six isolates of *Fusarium udum* Butler, obtained from different parts of India, isolates differently varied in size and septation of conidia. Desai *et al* [4] showed morphological variation among 15 isolates of *F. oxysporum* f. sp. *ricini*. Raheja [20] revealed morphological variation among fourteen isolates of *F. oxysporum* f. sp. *cumini*. Patel *et al* [14] reported morphological variation among twenty one isolates of *Fusarium udum* in the size of microconidia and macroconidia, septation and sporulation. Kumar *et al* [10] observed variation among four isolates of *F. oxysporum* f. sp. *ciceri* in the micro and macro conidia shape and size. Kumar and Upadhyay [11] revealed morphological variation of micro and macro conidia among 15 isolates of *F. udum*.

Pathogenic Variability

Variation in respect of wilt incidence was noticed among different varieties as well as isolates. Among different three varieties, significantly maximum mean wilt incidence 57.31 percent was observed in GC-2.

Table-1 List of isolates of *F. oxysporum* f. sp. cumini obtained from different locations of cumini growing areas

S	Isolates	Locations		
		Village	Taluka	District
1	Foc- 1	Lorvada	Tharad	Banaskantha
2	Foc- 2	KVK Deesa	Deesa	Banaskantha
3	Foc- 3	Siya	Dhanera	Banaskantha
4	Foc- 4	Jagudan	Mehsana	Mehsana
5	Foc- 5	Charol	Kadi	Mehsana
6	Foc- 6	Dethali	Bechraji	Mehsana
7	Foc- 7	Sultanpura	Radhanpur	Patan
8	Foc- 8	Boratwada	Sami	Patan
9	Foc- 9	Vasna	Harij	Patan
10	Foc- 10	Kesharpura	Idar	Sabarkantha
11	Foc- 11	Khambhasan	Modasa	Sabarkantha
12	Foc- 12	Jetpur	Khedbrahma	Sabarkantha
13	Foc- 13	Ratanpura	Bhachau	Kachchh
14	Foc- 14	Pragpara	Rapar	Kachchh
15	Foc-15	Navagam	Anjar	Kachchh

 Table-2 Pathogenic reaction of fifteen isolates of *F. oxysporum* f. sp. cumini on cumini variety GC-2

S	Isolates	Incubation period (days)	Wilt incidence (%)*				Mean
			Days after inoculation				
			20 days	25 days	30 days	35 days	
1	Foc-1	13	35.50(33.72)**	47.19(53.64)	59.30(73.94)	61.53(77.72)	50.88(59.68)
2	Foc-2	14	24.24(16.85)	35.50(33.72)	51.12(60.60)	53.33(64.33)	41.07(43.16)
3	Foc-3	15	31.30(26.99)	43.34(47.10)	47.19(53.64)	55.06(67.19)	44.22(48.19)
4	Foc-4	12	37.50(37.05)	49.11(57.14)	61.53(77.27)	66.67(84.31)	53.66(64.88)
5	Foc-5	14	29.11(23.66)	41.42(43.76)	53.33(64.33)	55.06(67.19)	44.66(49.40)
6	Foc-6	16	24.24(16.85)	35.50(33.72)	41.42(43.76)	53.33(64.33)	38.55(38.83)
7	Foc-7	13	35.50(33.72)	41.42(43.76)	53.33(64.33)	55.06(67.19)	45.76(51.36)
8	Foc-8	18	21.57(13.51)	31.30(26.99)	41.42(43.76)	49.11(57.14)	35.85(34.30)
9	Foc-9	13	35.50(33.72)	43.34(47.10)	55.06(67.19)	59.30(73.93)	48.30(55.74)
10	Foc-10	15	24.24(16.85)	35.50(33.72)	43.34(47.10)	53.33(64.33)	39.03(39.65)
11	Foc-11	13	31.30(26.99)	41.42(43.76)	53.33(64.33)	55.06(67.19)	45.21(50.36)
12	Foc-12	17	24.24(16.85)	31.30(26.99)	41.42(43.76)	53.33(64.33)	37.50(37.05)
13	Foc-13	14	29.11(23.66)	41.42(43.76)	51.12(60.60)	51.12(60.60)	42.83(46.21)
14	Foc-14	16	21.57(13.51)	29.11(23.66)	41.42(43.76)	53.33(64.33)	36.35(35.31)
15	Foc-15	14	29.11(23.66)	41.42(43.76)	53.33(64.33)	55.06(67.19)	44.66(49.40)
			Isolates (Treatments)	Incubation Period	Isolates x Incubation Period		
CD(P<0.05)			1.55	2.99	5.99		

*Average of three replications, **Arc-sin transformed values, Figures in parenthesis are retransformed values.

 Table-3 Cultural characteristics of fifteen isolates of *F. oxysporum* f. sp. cumini on PDA after eight days of incubation at 27 ± 2°C

N	Isolate	Colony Diameter (mm)*	Cultural characteristics		
			Colony character	Pigmentation	
				Mycelium	Substratum
1	Foc-1	75.15	Profuse fluffy growth at middle and moderate fluffy at periphery	Pinkish white	Red
2	Foc-2	79	Slightly fluffy growth at middle and slightly thread like spreading at periphery	White	Violet
3	Foc-3	65.25	Profuse fluffy growth at middle and slightly thread like spreading at periphery	Pinkish white	Red
4	Foc-4	88.75	Profuse fluffy growth at middle and moderate fluffy at periphery	White	Red
5	Foc-5	80.5	Thin flat to slight fluffy growth at middle and submerged growth at periphery	Orange	Orange
6	Foc-6	65	Slight fluffy growth at middle and slight fluffy growth at periphery	Orange	Orange
7	Foc-7	61.5	Moderately fluffy growth at middle and slight fluffy growth at periphery	Pinkish white	Violet
8	Foc-8	70.15	Profuse fluffy growth at middle and moderate fluffy at periphery	Pinkish white	Red
9	Foc-9	60.05	Slight fluffy with visible hairy growth	White	Pale white
10	Foc-10	63.5	Thin flat to slight fluffy growth at middle and submerged growth at periphery	White orange	Orange
11	Foc-11	72.25	Moderately fluffy growth at middle and submerged growth at periphery	Pinkish white	Red
12	Foc-12	57	Slight fluffy growth at middle and submerged growth at periphery	Pinkish white	Violet
13	Foc-13	85.05	Profuse fluffy growth at middle and thread like spreading at periphery	White	Pale white
14	Foc-14	82.5	Moderately fluffy growth at middle and slight thread like spreading at periphery	White	Pale white
15	Foc-15	78.15	Slight fluffy growth at middle and moderately fluffy growth at periphery	Pinkish white	Red
CD(P<0.05)			1.49		

* Average of three replications.

The significantly minimum mean wilt incidence 26.13 percent was recorded in GC-4. The moderate wilt incidence 35.92 percent was observed in GC-3. All the isolates showed moderately resistant reaction against cumini variety GC-4 except isolate Foc-8 which showed resistant reaction. The isolates Foc-2, Foc-6, Foc-8, Foc-10, Foc-12, Foc-13 and Foc-14 showed moderately resistant reaction against cumini variety GC-3 and rest of isolated showed moderately susceptible reaction.

In case of cumini variety GC-2, isolates Foc-2, Foc-6, Foc-8, Foc-10, Foc-11, Foc-12, Foc-13 and Foc-14 showed moderately susceptible reaction and rest of isolated showed susceptible reaction. Among different fifteen isolates, significant maximum mean wilt incidence 51.29 % was noted by Foc-4, followed by Foc-1 (48.34%) and Foc-9 (45.98%). The isolates Foc-7, Foc-11 and Foc-3 exhibited 45.39 %, 44.65 % and 44.41 % were statistically at par in producing wilt incidence.

Table-4 Measurement of microconidia and macroconidia of fifteen isolates of *F. oxysporum* f. sp. cumini in Potato dextrose medium after 15 days of incubation at 27 ± 2 °C

S	Isolates	Micro conidia*				Macro conidia*				Septation
		Length(um)		Breadth(um)		Length(um)		Breadth(um)		
		Range	Average	Range	Average	Range	Average	Range	Average	
1	Foc-1	5.40-13.50	8.91	2.70-4.05	3.13	21.6-36.5	27.94	2.7-4.05	3.11	03-Jun
2	Foc-2	4.35-12.70	7.98	2.70-5.40	3.38	19.4-29.8	24.87	2.7-4.05	3.21	03-May
3	Foc-3	4.05-13.50	7.83	2.70-4.05	3.26	16.2-25.7	21.6	2.7-4.65	3.48	04-Jun
4	Foc-4	5.40-10.80	8.5	2.70-3.24	2.78	16.2-27.0	20.9	2.7-6.75	4.75	03-Jun
5	Foc-5	8.10-13.50	10.6	2.70-4.05	3.04	21.6-27.0	23.89	2.7-5.40	3.62	03-May
6	Foc-6	6.45-13.50	11.47	2.70-4.05	3.21	24.3-40.3	31.48	2.7-4.05	3.47	03-May
7	Foc-7	4.05-13.50	7.29	2.70-3.24	2.81	16.2-27.0	20.12	2.7-5.40	4.08	04-Jun
8	Foc-8	5.40-10.80	8.51	2.70-4.59	3.54	21.6-28.4	24.38	2.7-4.05	3.67	03-May
9	Foc-9	8.10-14.85	10.8	2.70-5.40	3.46	17.6-24.3	20.79	2.7-5.40	3.92	03-May
10	Foc -10	5.40-12.15	10.13	3.24-4.05	3.56	18.9-29.7	25.25	3.2-5.40	3.92	03-May
11	Foc -11	6.50-13.05	9.45	3.24-5.40	4.75	19.9-37.1	29.35	2.7-5.40	4.02	03-Jun
12	Foc-12	6.75-12.15	9.58	2.70-3.24	2.72	18.9-25.7	20.22	3.2-5.40	4.18	03-Jun
13	Foc-13	6.75-12.15	8.91	2.70-4.05	3.19	18.9-25.7	21.44	2.7-4.05	3	03-May
14	Foc-14	5.40-10.80	8.51	2.70-3.24	2.81	17.5-20.3	18.63	2.7-4.05	3.08	04-Jun
15	Foc-15	5.40-16.20	10.97	2.70-4.05	3.24	18.9-24.3	22.14	2.7-4.05	3.16	03-May

*Average of five replications

Table-5 Pathogenic variability among fifteen isolates of *F. oxysporum* f. sp. cumini against three cumin varieties

S	Isolate	Wilt Incidence (%)*			Mean
		GC-2	GC-3	GC-4	
1	Foc-1	66.51(84.11)**	47.19(53.81)	31.30(26.99)	48.34(55.81)
2	Foc-2	55.06(67.19)	37.50(37.05)	21.57(13.51)	38.04(37.97)
3	Foc-3	61.53(77.27)	45.27(50.47)	26.43(19.81)	44.41(48.97)
4	Foc-4	69.26(87.45)	49.11(57.14)	35.50(33.32)	51.29(60.89)
5	Foc-5	59.30(73.93)	41.42(43.76)	24.24(16.85)	41.65(44.16)
6	Foc-6	47.19(53.81)	35.50(33.72)	21.57(13.51)	34.75(32.48)
7	Foc-7	61.53(77.27)	43.34(47.10)	31.30(26.99)	45.39(50.68)
8	Foc-8	45.27(50.47)	29.11(23.66)	18.89(10.48)	31.09(26.66)
9	Foc-9	66.51(84.11)	47.19(53.81)	24.24(16.85)	45.98(50.66)
10	Foc-10	53.05(63.86)	35.50(33.72)	29.11(23.66)	39.22(39.98)
11	Foc-11	59.30(73.93)	43.34(47.10)	31.30(26.99)	44.65(49.38)
12	Foc-12	47.19(53.81)	31.30(26.99)	21.57(13.51)	33.35(30.22)
13	Foc-13	57.29(70.79)	39.42(40.32)	29.11(23.66)	41.94(44.66)
14	Foc-14	49.11(57.14)	33.30(30.14)	26.57(20.00)	34.66(32.34)
15	Foc-15	61.53(77.27)	41.42(43.76)	24.24(16.85)	42.40(45.46)
CD(P<0.05)		7.11	6.86	7.42	
		Isolates	Varieties	Isolates x Varieties	
CD(P<0.05)		1.78	3.98	NS	

* Average of three replications, **Arc-sin transformed values, Figures in parenthesis are retransformed values

Isolates Foc-15 (42.40%), Foc-13 (41.94) and Foc-5 (41.65%) were statistically at par in producing wilt incidence. Isolates Foc-10 (39.22%) and Foc-2 (38.04%) were statistically at par in producing wilt incidence. Isolates Foc-6 (34.75) and Foc-14 (34.66%) were statistically at par in producing wilt incidence. The minimum wilt incidence 31.09 percent was noted by Foc-8, which was at par with Foc-12 (33.35%). Interaction among isolates and varieties showed non significant. Pathogenic variability among different isolates of *Fusarium* wilt pathogen against host genotype has been reported in pigeon pea (Gaur and Sharma [6]; Das and Sengupta [3]; Patel *et al* [14]; Tiwari and Dhar [23] and Kumar and Upadhyay [11]); chick pea (Gupta *et al* [8]; Paul *et al* [16]; Paulkar *et al* [17]; Paulkar and Raut [18]; Kumar *et al* [10]) and castor (Desai *et al* [4]; Chauhan [2]; Santha Lakshmi Prasad *et al* [22]). Champawat and Pathak [1] observed pathogenic variability among nine isolates of *F. oxysporum* f. sp. cumini. Isolate 14 was highly virulent causing 94.28 Percent wilt after 10 days of inoculation and abundant sporulation, while 17 was low virulent causing 56.00 percent wilt after 10 days of inoculation and poor sporulation. Raheja [20] observed that isolate For-5 produced earliest wilt symptoms and highest wilt incidence against all the four cumin varieties i.e. GC-1, GC-2, GC-3 and GC-4 in comparison to other isolates.

Application of research: Isolation of wilt resistance genotypes which will further help in developing wilt resistance or tolerance varieties.

Research Category: Mycology and Plant Pathology

Abbreviations: GC- Gujarat Cumin, PDA-Potato Dextrose Agar

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