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In vivo Evaluation of Coriander Germplasm against *Fusarium* Root Rot in Augmented Design

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ABSTRACT
Coriander (Coriandrum sativum L.) is a spice herb widely used as an important ingredient in many parts of the world. Among the major diseases which reduce the productivity and yield of coriander is Fusarium root rot which causes a major damage to this crop. One hundred and twenty germplasm accessions were grown in an augmented block design during the Rabi season of 2016-17 to screen and evaluate the Fusarium root rot disease resistance. Three standard varieties viz.,Sudha, Sadhana and APHU Dhania-1 were used as checks in the experiment. Among the germplasm accessions evaluatedin the Fusarium root rot sick plot, lowest per cent of disease incidence was recorded in LCC-22 (2.73%), LCC-7 (4.90%), LCC-8 (5.32%), LCC-32 (10.20%) and LCC-71 (16.04%)at 20-60 days after sowing and haveshown resistant response to Fusariumroot rot. Moderate resistant response was elicited by accessions viz.,LCC-242 (49.64%), LCC-176 (48.53%), LCC-174 (47.37%), LCC-152(45.48%), LCC-120 (35.15%) and LCC-35 (24.71%). Accessions LCC-291 (73.74%), LCC-151 (73.09%), LCC-239 (50.60%) were recorded as susceptible germplasm. Highly susceptible responsewith high per cent of disease incidencewas observed with accessions viz.,LCC-73 and LCC-175 (100%); LCC-262 (99.58%), LCC-302 (99.56%). The checks used in the present study viz., Sudha (39.56%) and Sadhana (43.06%) showed moderate resistant response, whereas, APHU Dhania-1 (80.80%) was observed as a highly susceptible check to Fusarium root rot disease.
Key words: *Fusarium solani, Root rot, Coriander, Augmented Design*

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INTRODUCTION

Either a leaf or seed spice using as a flavouring ingredient in many recipes throughout the world is Cilantro or Chinese parsley or Coriander. Traditionally coriander is an important ingredient due to its immense flavour which is widely used across the world in varied dishes. In India, it is occupying one of the major cultivated leaf and seed spices and occupying an area of 552.7 thousand hectares with a productivity of 0.8 metric tonnes per hectare as per the estimates of 2014-15 [17]. Coriander crop isknown to affectwith various biotic agents present in the soil and air which are considered responsible for causing diseases like stem gall, wilt, root rot and powdery mildew [1, 10, 14, 13, 6]. Amid the incitants, *Fusarium* species, which is present in the soilis causing root rot and wilt. The yield loss by destroying the crop is estimated to approximately 10 per cent [14]. Root rot is another emerging problem inciting by *Fusarium solani* in the Rayalaseemaregion of Andhra Pradesh. Plant will die within a short span of time after severe infection. Information on response of germplasm against this disease was seldom reported. Different methods have been executed by many investigators to manage this problem [11, 12, 14, 7, 8, 9]. In contempt of these taken measures they are not achieving the target. Keeping this constraint in view the following investigation has been carried out with the available coriander germplasm as one of the alternative to combat this issue.

MATERIAL AND METHODS

Preparation of Sick Plot

After the successful isolation and pathogenicity test, a 6.0 mm mycelial disc from the pure culture of *Fusarium solani* was inoculated aseptically and then multiplied at 27±1°C for a fortnight period in Sand-Sorghum Medium (SSM) with an adjusted inoculum density of 10^6 conidia/ml by haemocytometer. Repeated shaking was carried out the inoculation flasks to obtain uniform mycelial growth of the pathogen on SSM. The fully grown culture medium was then inoculated to the sick soil twenty days before seed sowing in a quantity of 75g/plot.

Field Evaluation

An experimental field trial was evaluated to undergo the response of all the available coriander germplasm accessions collected from different Horticultural Research Stations (HRS) located at Lam and Mahanandi as well as from the College of Horticulture, Anantharajupeta in Andhra Pradeshusing Sudha, Sadhana and APHU Dhania-1as standard cultivars and check varieties as well. Investigation was carried out during *Rabi*, 2016 at the Horticultural Farm, Department of Plant Pathology, College of Horticulture, Dr. YSR Horticultural University, Anantharajupeta with one hundred and twenty germplasm accessions of coriander.All the germplasm accessions were dibbled with aspacing of 30 cm x 10 cm in lines of the plot.

Disease Assessment Method

Root rot symptoms were observed on the root system of the plantfrom 20 days after sowing (DAS) and the incidence of root rot disease was recorded upto 100 DAS. Observation on root rotting was recorded at every 10 days interval and the per cent of disease incidence was assessed based on percent incidenceand categorized into 5 groups as explained by *Sallam et al*.[15] as presented in Table-1. Severity of disease progress was summarized using AUDPC values [2] obtained from treatments in the screening procedure. AUDPC was calculated by trapezoidal integration in accordance with 10 days interval disease severity data over the season.

$$AUDPC = \sum_{i=1}^{n-1} \frac{y_i + y_{i+1}}{2} \times \left(t_{i+1} - t_i\right)$$

Statistical Design

The experiment layout was drawn and laid out as per the procedure explained by Federer [5] in an augmented randomized block design with six blocks in which twenty germplasm accessions have been sown randomly along with three check cultivars in the sick plot.

RESULTS AND DISCUSSION

The investigation results of initial and final plant populations (Data not shown), per cent of disease incidence and AUDPC values along with resistance reaction towards the respective screened germplasm accessions were listed in Table-2.

Initial population stand recorded 120 germplasm accessions ranged from 1 to 26 after 20 DAS. Of all the germplasm accessions evaluated,significantly highest initial plants stand was recorded in accession LCC-31 (26) followed by LCC-17, LCC-80 (25),whereas significantly lowest number of germplasm population was observed in LCC-268 (1). Final population stand of germplasm accessions ranged from 0 to 21 after 110 DAS. Of all the germplasm accessions evaluated, significantly highest number of plant stand was observed in accession LCC-82, LCC-71 (21) which wasat par with germplasm accession LCC-37, LCC-38 (20) followed by germplasm accessions LCC-137, LCC-31 (19) stood next highest to them. No seed was found germinated in 14 germplasm accessions (LCC-73, LCC-175, LCC-190, LCC-191, LCC-220, LCC-226, LCC-230, LCC-237, LCC-257, LCC-262, LCC-268, LCC-285, LCC-302 and LCC-305) and single seedling was observed in 12 germplasm accessions (LCC-95, LCC-144, LCC-161, LCC-182, LCC-193, LCC-205, LCC-208, LCC-210, LCC-245, LCC-263, LCC-290 and LCC-292).Disease symptoms started from 20 DAS and continued up to 60 DAS. Disease incidence was medium to high in checks*viz.,*Sudha (39.56%), Sadhana (43.06%) and APHU Dhania-1 (80.80%) respectively. Response of germplasm accessions screened against root rot disease was grouped and accessions were categorized in Table-3.

Table-1:Grouping of coriander genotypes in response to disease reaction.

S.No	Percent Disease (%)	Infection Type	Reaction Type*
1	0	No Infection	Highly Resistant
2	1-25%	Slight infection	Resistant
3	26-50%	Moderate infection	Moderately Resistant
4	51 - 75%	Severe infection	Susceptible
5	76 -100%	Very severe infection	Highly Susceptible

Table 2: Screening of coriander germplasm against *Fusarium* root rot disease

S. No	Germplasm Number	AUDPC value	Disease Incidence (%)	Resistance Type*
1	LCC-1	242.09	19.47	R
2	LCC-4	312.02	27.08	MR
3	LCC-6	159.16	13.31	R
4	LCC-7	47.26	4.70	R
5	LCC-8	54.12	5.32	R
6	LCC-10	521.67	51.61	S
7	LCC-12	126.37	8.93	R
8	LCC-22	40.91	2.73	R
9	LCC-23	367.66	25.10	MR
10	LCC-26	430.08	30.09	MR
11	LCC-30	99.05	9.72	R
12	LCC-31	419.67	28.30	MR
13	LCC-32	153.06	10.20	R
14	LCC-35	315.70	24.71	MR
15	LCC-37	170.52	15	R
16	LCC-38	127.52	15.96	R
17	LCC-41	164.07	14.10	R
18	LCC-45	256.39	22.01	R
19	LCC-48	226.38	15.69	R
20	LCC-50	262.40	19.65	R
21	LCC-55	128.77	10.57	R
22	LCC-56	366.24	30.30	MR
23	LCC-68	323.68	22.47	R
24	LCC-69	180.44	14.95	R
25	LCC-70	184.49	15.45	R

S. No	Germplasm Number	AUDPC value	Disease Incidence (%)	Resistance Type*
26	LCC-71	216.01	16.04	R
27	LCC-72	50.00	5.59	R
28	LCC-73	2817.96	100	HS
29	LCC-74	270.77	26.15	MR
30	LCC-76	327.21	25.95	MR
31	LCC-78	151.65	14.48	R
32	LCC-79	1028.11	70.91	S
33	LCC-80	557.90	46.08	MR
34	LCC-81	95.82	8.97	R
35	LCC-82	161.96	14.29	R
36	LCC-86	165.77	14.29	R
37	LCC-88	298.56	22.58	R
38	LCC-89	1195.83	78.61	HS
39	LCC-92	84.20	6.71	R
40	LCC-95	1213.70	81.63	HS
41	LCC-97	693.11	45.21	MR
42	LCC-99	372.70	27.06	MR
43	LCC-100	302.71	20.95	R
44	LCC-107	526.25	40.82	MR
45	LCC-109	409.63	28.75	MR
46	LCC-120	439.23	35.15	MR
47	LCC-133	343.77	23.75	R
48	LCC-135	103.10	7.30	R
49	LCC-136	91.48	8.90	R
50	LCC-137	222.55	21.38	R

S. No	Germplasm Number	AUDPC value	Disease Incidence (%)	Resistance Type*
51	LCC-139	187.01	16.67	R
52	LCC-140	248.25	21.50	R
53	LCC-141	792.57	57.14	S
54	LCC-142	873.15	55.00	S
55	LCC-144	1590.98	90.91	HS
56	LCC-145	639.65	46.81	MR
57	LCC-148	644.45	47.49	MR
58	LCC-149	460.19	35.61	MR
59	LCC-151	1264.86	73.09	S
60	LCC-152	553.33	45.48	MR
61	LCC-154	414.10	36.84	MR
62	LCC-159	395.39	32.85	MR
63	LCC-161	1267.68	84.29	HS
64	LCC-162	95.92	8.04	R
65	LCC-163	269.27	20.59	R
66	LCC-166	482.28	37.50	MR
67	LCC-171	248.45	23.45	R
68	LCC-172	372.78	31.37	MR
69	LCC-174	626.07	47.37	MR
70	LCC-175	2544.27	100.00	HS
71	LCC-176	596.57	48.53	MR
72	LCC-178	903.02	67.67	S
73	LCC-182	1901.81	97.30	HS
74	LCC-185	836.08	56.74	S
75	LCC-186	994.81	70.89	S

S. No	Germplasm Number	AUDPC value	Disease Incidence (%)	Resistance Type*
76	LCC-188	877.55	56.75	S
77	LCC-189	1260.34	82.91	HS
78	LCC-190	1669.30	91.57	HS
79	LCC-191	2175.77	96.21	HS
80	LCC-193	1989.52	93.18	HS
81	LCC-195	708.22	53.85	S
82	LCC-198	865.66	55.32	S
83	LCC-199	930.02	65.49	S
84	LCC-200	555.40	37.24	MR
85	LCC-204	911.79	59.43	S
86	LCC-205	2009.14	97.21	HS
87	LCC-206	1447.17	85.80	HS
88	LCC-208	2048.51	97.24	HS
89	LCC-210	1540.02	90.67	HS
90	LCC-212	1523.25	85.83	HS
91	LCC-217	998.12	70.24	S
92	LCC-219	1576.61	89.19	HS
93	LCC-220	2026.04	98.40	HS
94	LCC-221	1403.13	80.47	HS
95	LCC-223	1956.24	91.83	HS
96	LCC-226	2111.87	98.19	HS
97	LCC-230	2102.55	98.13	HS
98	LCC-237	2248.61	98.91	HS
99	LCC-238	1804.22	91.70	HS
100	LCC-239	654.58	50.60	S

S. No	Germplasm Number	AUDPC value	Disease Incidence (%)	Resistance Type*
101	LCC-241	1005.72	64.10	S
102	LCC-242	577.91	49.64	MR
103	LCC-245	2102.24	95.58	HS
104	LCC-252	1516.46	85.23	HS
105	LCC-257	1828.01	90.48	HS
106	LCC-258	248.64	23.53	R
107	LCC-259	667.23	58.18	S
108	LCC-261	1266.41	77.42	HS
109	LCC-262	2520.91	99.58	HS
110	LCC-263	2046.82	96.96	HS
111	LCC-265	898.98	60.47	S
112	LCC-266	1326.23	81.19	HS
113	LCC-268	1402.60	90.91	HS
114	LCC-285	1846.74	95.77	HS
115	LCC-290	1973.81	95.36	HS
116	LCC-291	1117.09	73.74	S
117	LCC-292	2073.16	95.03	HS
118	LCC-298	1845.78	93.39	HS
119	LCC-302	3019.17	99.56	HS
120	LCC-305	2612.42	98.12	HS
121	APHU-1	1305.36	80.80	HS
122	SUDHA	564.42	39.56	MR
123	SADHANA	598.51	43.06	MR
	Mean		**51.26**	-
	C.V. %		**62.79**	-

*Resistant type- HR- Highly Resistant (0%) R-Resistant (1 - 25%) MR- Moderately Resistant (26 - 50%) S-Susceptible (51 - 75%) HS-Highly Susceptible (76 -100%) I.P-Initial Population F.P- Final Population

Table 3: Grouping of coriander germplasm on *Fusarium* root rot incidence for resistance reaction

Highly Susceptible	Susceptible	Moderately Resistant	Resistant
LCC-73, LCC-89, LCC-95, LCC-144, LCC-161, LCC-175, LCC-182, LCC-189, LCC-190, LCC-191, LCC-193, LCC-205, LCC-206, LCC-208, LCC-210, LCC-212, LCC-219, LCC-220, LCC-221, LCC-223, LCC-226, LCC-230, LCC-237, LCC-238, LCC-245, LCC-252, LCC-257, LCC-261, LCC-262, LCC-263, LCC-266, LCC-268, LCC-285, LCC-290, LCC-292, LCC-298, LCC-302, LCC-305	LCC-10, LCC-79, LCC-141, LCC-142, LCC-151, LCC-178, LCC-185, LCC-186, LCC-188, LCC-195, LCC-198, LCC-199, LCC-204, LCC-217, LCC-239, LCC-241, LCC-259, LCC-265, LCC-291	LCC-4, LCC-23, LCC-26, LCC-31, LCC-35, LCC-56, LCC-74, LCC-76, LCC-80, LCC-97, LCC-99, LCC-107, LCC-109, LCC-120, LCC-145, LCC-148, LCC-149, LCC-152, LCC-154, LCC-159, LCC-166, LCC-172, LCC-174, LCC-176, LCC-200, LCC-242	LCC-1, LCC-6, LCC-7, LCC-8, LCC-12, LCC-22, LCC-30, LCC-32, LCC-37, LCC-38, LCC-41, LCC-45, LCC-48, LCC-50, LCC-55, LCC-68, LCC-69, LCC-70, LCC-71, LCC-72, LCC-78, LCC-81, LCC-82, LCC-86, LCC-88, LCC92, LCC-100, LCC-133, LCC-135, LCC-136, LCC-137, LCC-139, LCC-140, LCC-162, LCC-163, LCC-171, LCC-258

Per cent of disease incidence and AUDPC values were found ranged in between 2.72 to 100 and 37.47 to 3019.17 respectively. Highest per cent of disease incidence was noticed with germplasm accessions *viz.,* LCC-73 and LCC-175 (100%) with their corresponding AUDPC values of 2818, 2544.30 followed by LCC-262 (99.58%) corresponding with AUDPC value (2520.90) which was at par with germplasm

accession LCC-302 (99.56%) and AUDPC (3019.2). Germplasm accessions LCC-291 (73.74%) and LCC-151 (73.09%) were found next to highest per cent of disease incidence with an AUDPC values of 1117.1, 1264.90 respectively which are followed by LCC-239 (50.60%) and LCC-10 (51.61%) with an AUDPC values of 654.58 and 521.67. Accessions LCC-242 (49.64%) with an AUDPC value of 577.91 recorded moderately resistant reaction followed by LCC-176 (48.53%) with AUDPC value of 596.57, whereas, LCC-74 (26.15%) which has recorded significantly lowest per cent of disease incidence with an AUDPC value of 270.77 was found at par with germplasm accession LCC-35 (24.71%) with AUDPC value of 315.70. The germplasm accession LCC-76 has recorded with 25.95 per cent of disease incidence and AUDPC value of 327.21, which showed a significantdeviation in the per cent of disease incidence with germplasm accession LCC-22 (2.73%) found best and recorded lowest per cent of disease incidence with AUDPC value of 40.91 and was categorized as resistant germplasm accession for root rot disease in coriander.Similar kind of observation was reported earlier Fatima *et al*. [4] while working on lentil germplasm lines against *Fusarium*wilt. Of all the germplasm lines evaluated, sixteen lines were found highly susceptible, seven lines were found susceptible, three lines were found moderately resistant and two lines were found resistant. The result obtained in the present investigation was also found in accordance with the earlier findings of Karima and Nadia [9] wherein they found tomato cultivar Ace susceptible and Boromodro and Castle-Rock were found moderately tolerant. Similar kind of strategic results were also reported in pea with one highly resistant variety Jumbo with 6.4 per cent of disease incidence [14].
Genus *Fusarium* is still a serious problem in agriculture which causes a high yield loss [4]. In the present study of coriander germplasm accessions screening for root rot disease, susceptibility of germplasm might be due to favourable climatic conditions prevailing in the field for the growth of pathogen and presence of dormant chlamydospores of *Fusarium*in soil which causes crop sensitivity due to variability, highly virulence nature of the pathogen and also due to colonization of the pathogen on the upper plant tissues, profuse fungal growth in the intercellular spaces of the parenchymatous cells of plant tissue [3]. The resistance nature might be due to their varied growth habit in the natural supportive conditions, resistance genes [3], tolerant to conditions which are favourable to per cent of disease incidence.

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