IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
e ISSN-0976-593X Volume **13** | Issue 1 | January, 2018 | 26-34

DOI: 10.15740/HAS/IJPS/13.1/26-34
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RESEARCH ARTICLE

In vivo screening of turmeric (*Curcuma longa* L.) germplasm of different duration groups against rhizome rot caused by *Pythium* and *Fusarium* spp.

■ **M. Lakshmi Naga Nandini, C.H. Ruth and K. Gopal**

SUMMARY

Field screening studies were conducted over a period of one year *i.e.* 2016-2017 in augmented block design with 120 available germplasm lines of turmeric (*Curcuma longa* L.) at College of Horticulture, Anantharajupeta. These lines were screened against the rhizome rot caused by *Pythium graminicolum* and *Fusarium solani* under natural conditions. The severity of rhizome rot is ranged from 0.00 to 92.86 per cent irrespective cultures screened. Among the germplasm cultures screened, cultures like IC-319341, Tenali Kasturi, VK-23, GS, IC-420606, IC-033007, IC-211641, PTS-8, Vikici, Dhindigam, ACC-48, Sonia, NB-60, Kasturi in short duration group, Prathibha, Thodupuztha, KTS-9, Prasangali, ACC-79 in medium duration group and NH-1, Ranga, Salem, Salem-2, Wagon, PTS-12, CL-8, CL-9, CL-10, CL-3, CL-4 in long duration group were resistant to rhizome rot showed 0.0% diseases incidence. More disease incidence (susceptible reaction) of rhizome rot was observed in long duration group.

Key Words : Germplasm, Rhizome rot, Turmeric, Varieties, Screening, Resistant

How to cite this article : Nandini, M. Lakshmi Naga, Ruth, C.H. and Gopal, K. (2018). *In vivo* screening of turmeric (*Curcuma longa* L.) germplasm of different duration groups against rhizome rot caused by *Pythium* and *Fusarium* spp. *Internat. J. Plant Sci.*, **13** (1): 26-34, **DOI: 10.15740/HAS/IJPS/13.1/26-34**.

Article chronicle : Received : 17.08.2017; **Revised :** 09.11.2017; **Accepted :** 23.11.2017

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Turmeric (*Curcuma longa* L.) is an important spice for many vegetable curries, rice preparation and other dishes. In some parts of India, turmeric root is used to make a tasty vegetable dish. It is a most important spice in Indian recipes. Curcumin, the active ingredient in turmeric and is widely used in medicinal and ayurveda. In India, turmeric crop is cultivated in an area of 194 thousand ha with a production of 971 thousand MT and Andhra Pradesh stands first both in area (67.78 thousand ha) and production (432.20 thousand MT)

contributing to 35 per cent area under turmeric in India (Anonymous, 2013). But it's production is affected by many biotic diseases and abiotic stresses. The most important biotic diseases reported so far on turmeric are, leaf spot caused by *Collectotrichum capsici* [(Sydner) Butl and Bis], leaf blotch caused by *Taphrina maculans* Butler, leaf blight caused by *Alternaria alternate* (Fr.) Keissler, leaf blast caused by *Pyricularia curcumae* (L.), rhizome rot caused by *Pythium* and *Fusarium* spp. (Wheeler, 1969). Nair and Ramakrishnan (1973) reported that, reduction in rhizome weight by 62.7 % and yield losses in the range of 15-60 % under different conditions due to rhizome rot caused by *Pythium graminicolum* and *Fusarium solani* (Joshi and Sharma, 1980). At present the disease was managed by using the fungicides, (Chawda *et al.,* 2012; Koche *et al.,* 2009; Mishra and Pandey, 2015; Velayudhan and Liji, 2003; Pandey *et al.*, 2010 and Rao *et al.,* 2012) which lead to development of resistant strains besides the environmental pollution and also the residue problem on final produce. Hence, field screening trials were conducted to identify the resistant cultures in the available germplasm lines against the rhizome rot disease. Use of resistant varieties is the most economic and easily adoptable method in integrated disease management. Identification of high yielding turmeric accessions which are relatively resistant or tolerant to major diseases is of utmost importance for increasing the production and productivity of turmeric in Andhra Pradesh.

MATERIAL AND METHODS

Field experiments for screening of turmeric germplasm were conducted at College of Horticulture, Anantharajupeta during 2016-17. During the present study 120 turmeric lines collected from HRS (Horticultural Research Stations) at Kovvur, Chintapalli and Anantharajupeta (Table A) were included for screening against the rhizome rot under natural conditions. These lines were sown at first fortnight of June in shallow, red loamy soils for one year. No plant protections measures were taken during the crop growth period. The trial was laid out in augmented block design with 120 lines including 3 susceptible checks namely Duggirala, Mydukur, Tekuripeta. The data thus obtained was subjected to statistical analysis using PAST (Hammer *et al.,* 2001). These highly susceptible check plants were interplanted as "spreader rows" along with rows of the test material to create the natural disease infection. Sown three highly susceptible checks at intervals, after every 10 rows of the test lines, at the same time as the test lines. Uniform sized forty fingers (fingers with 5-6 cm length and weighing about 20-25 g each) were sown in 2x2 m size plots for two varieties at spacing of 30 x15 cm in four rows accommodating 40 rhizomes/plot. Application of 20 tonnes of farm yard manure and inorganic fertilizers like nitrogen, phosphorus and potassium were applied @ 190 kg, 75 kg and 120 kg per hectare in the form of urea, single super phosphate and murate of potash, respectively, as per the recommendations of the Dr. Y.S.R. Horticultural University. Disease incidence was recorded at 120 days after planting on five randomly selected plants for each culture.

Table A : Source of germplasm collections

Sr. No.	Place of collection or name of the HRS	No. of collections
1.	Kovvur, Coastal Andhra Pradeshew	71
2.	Anantharajupeta, Rayalaseema Zone	17
3.	Chintapalli, Coastal Andhra Pradesh	32
	Total	120

Table B : Disease scale used for screening

Scoring scale	Disease reaction	Disease incidence (%)
0	Resistant (R)	0%
1	Tolerant/ Moderately resistant (MR)	1 - 10%
2	Moderately susceptible (MS)	11 - 25%
3	Susceptible (S)	26 - 50%
4	Highly susceptible (HS)	>50%

According to Pratap *et al.* (2013), finally on the basis of per cent disease incidence (PDI) the germplasms were screened and categorically grouped into different types of reactions as described in Table B.

$$\text{\% Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100$$

RESULTS AND DISCUSSION

Field screening studies were conducted over a period of one year for screening the available germplasm cultures against rhizome rot under natural conditions. These cultures were grouped into three categories *i.e.,* short duration (matured before 210 days or 7 months), medium duration (matured between 210 to 240 days or 7-8 months) and long duration (matured after 240 days or above 8 months) based on the time taken from planting to attain maturity period or harvesting time. Out of 120

turmeric lines screened 42 lines were short duration, 30 lines were medium duration and 48 lines were long duration. The germplasm lines like Dindigam, VK-23, Kasturi, IC-211641, Tenali Kasturi, Sonia, GS, IC-420606, IC-319341, IC-033007, Vikici, PTS-8, NB-60, ACC-48, Enna Chanda, IC-212606, IC-394903, IC-330113, IC-332957, IC-211647, Florescent, T. Sundar, IC-211402, IC-521333, CA-1711, ST-34, IC-353560, IC-416941, CAS-15, VK-9, Parbhani, CA-70, Rajendra, SLP-389-1, Kasturi Anidi, IC-181919, GL Puram, IC-211360, IC-212808, Sugandham, Battiguda and Paderu local were found to be short duration types, Pratibha, Thodupuztha, ACC-79, Prasangali, KTS-9, KTS-8, BSR-2, TCP-64, TCP-129, Gorakpur-3617, Rajapuri, NDH-8, CLI-3611, TCP-70, CLI-317, CL-325, Sports, Morthapuzta, Rashmi, Ochira, CLI-335, RH-50, KTS-6, Rajendra Sonia, RH-80, Suranjana, Pedda pasupu, PTS-55, KTS-7 and RH-9/90 were found to be medium in duration, Salem, PTS-12, CL-3, CL-9, Ranga, NH-1, Salem-2, CL-4, CL-8, CL-10, Wagon, Chintapalli Local-2, Imphal local, Vontimitta, Mydukur, Duggirala, Roma, CL-1, CL-7, CL-18, CL-16, CL-14, CL-11, CC-91-01, CL-19, NDS-18, CL-2, CL-6, CL-17, CL-15, PTS-38, BSR-1, CL-12, Cuddapah Local, TC-4, Tekuripeta, NDH-79, Laccadona, Badipaderu, CL-20, CL-5, North-East *C. amada*, Mahanandi Local, Mega Turmeric, *C. amada,* Chintapalli Local-1, Wynad Local and Anantharajupeta Local were fallen in late duration group. These findings are in confirmations with Shanmugasundaram *et al.* (2001) who had recorded considerable variation in the duration of different genotypes of turmeric.

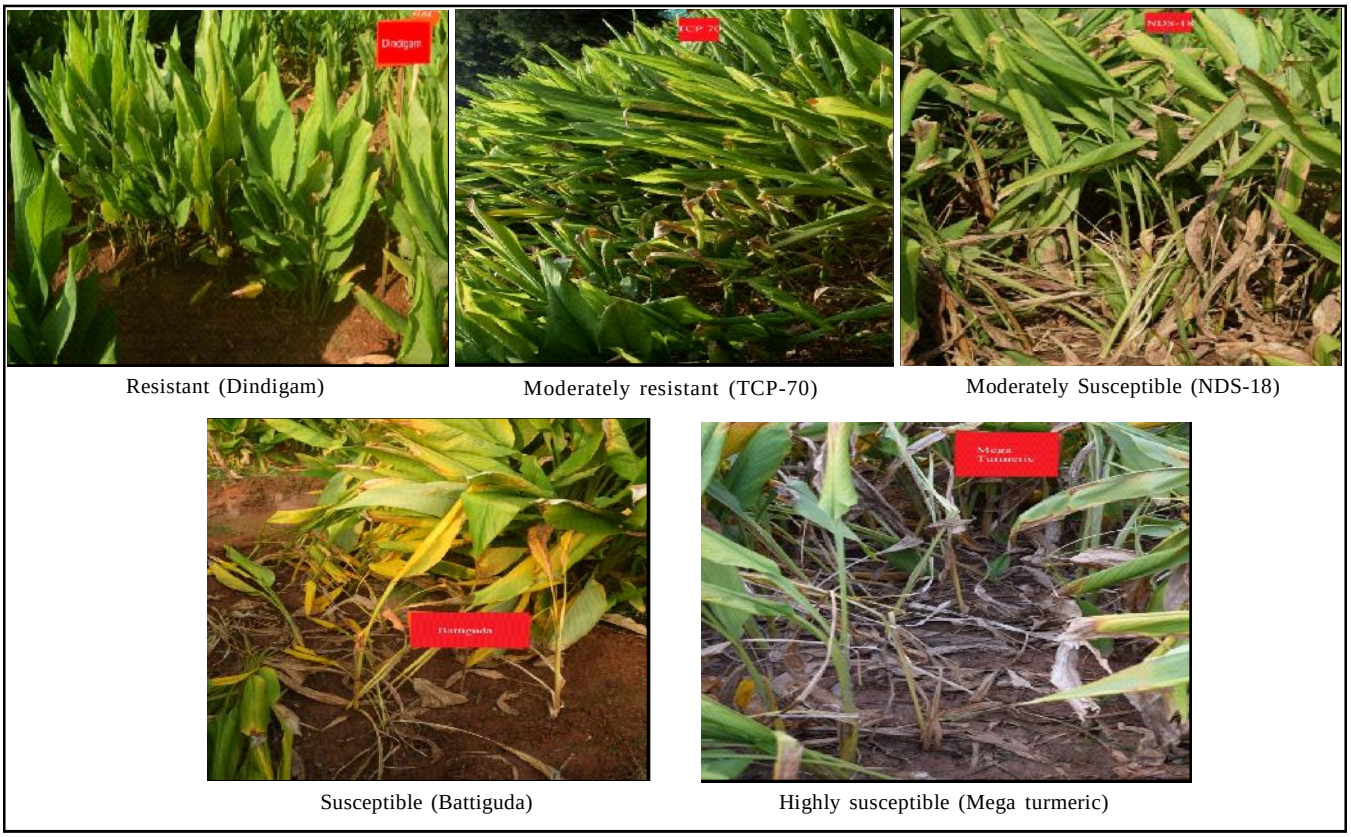
Thirty lines (14 short duration, 5 medium duration, 11 long duration) were found resistant to rhizome rot disease. IC-319341, Tenali Kasturi, VK-23, GS, IC-420606, IC-033007, IC-211641, PTS-8, Vikici, Dhindigam, ACC-48, Sonia, NB-60, Kasturi in short duration group, Prathibha, Thodupuztha, KTS-9, Prasangali, ACC-79 in medium duration group and NH-1, Ranga, Salem, Salem-2, Wagon, PTS-12, CL-8, CL-9, CL-10, CL-3, CL-4 in long duration group were resistant to rhizome rot showed 0.0% disease incidence. It can be seen from the Table 1 and 2, that all the cultures in different duration groups under study are noticed the incidence of rhizome rot disease under natural conditions. The disease incidence of rhizome rot is ranged from 0.00 to 92.86 per cent irrespective cultures and different duration groups under study (Fig. 1).

Long duration varieties:

The results recorded on forty eight long duration turmeric lines revealed that, the incidence of rhizome rot ranged from 0.00 to 92.86 per cent. Eleven out of forty eight (22.91%) cultures were resistant to rhizome rot. Four out of forty eight (8.33%) showed the moderately resistant reaction, seventeen out of forty eight (35.41%) showed the moderately susceptible reaction and eight out of forty eight (16.66%) showed the susceptible reaction and eight out of forty eight (16.66%) showed the highly susceptible reaction to rhizome rot disease. In long duration group germplasm lines like NH-

Table 1 : Screening of turmeric germplasm against the rhizome rot disease under natural field conditions

Scale	Per cent disease incidence	Disease reaction	Germplasm/lines		
			Short duration (200 to 230 days)	Medium duration (230 to 250 days)	Long duration (250 to 270 days)
0	0%	R	Dindigam, VK-23, Kasturi, IC-211641, Tenali Kasturi, Sonia, GS, IC-420606, IC-319341, IC-033007, Vickici, PTS-8, NB-60, ACC-48	Pratibha, Thodupuztha, ACC-79, Prasangali, KTS-9	Salem, PTS-12, CL-3, CL-9, Ranga, NH-1, Salem-2, CL-4, CL-8, CL-10, Wagon
1	1-10%	MR	Enna Chanda, IC-212606, IC-394903, IC-330113, IC-332957, IC-211647, Florescent, T. Sundar, IC-211402, IC-521333, CA-1711	KTS-8, BSR-2, TCP-64, TCP-129, Gorakpur-3617, Rajapuri, NDH-8, CLI-3611, TCP-70	Chintapalli Local-2, Imphal Local, Vontimitta, Mydukur
2	11-25%	MS	ST-34, IC-353560, IC-416941, CAS-15, VK-9, Parbhani, CA-70, Rajendra, SLP-389-1, Kasturi Anidi	CLI-317, CL-325, Sports, Morthapuzta, Rashmi, Ochira, CLI-335	Duggirala, Roma, CL-1, CL-7, CL-18, CL-16, CL-14, CL-11, CC-91-01, CL-19, NDS-18, CL-2, CL-6, CL-17, CL-15, PTS-38, BSR-1
3	26-50%	S	IC-181919, GL Puram, IC-211360, IC-212808, Sugandham, Battiguda	RH-50, KTS-6, Rajendra Sonia, RH-80, Suranjana, Pedda pasupu, PTS-55, KTS-7	CL-12,Cuddapah Local, TC-4, Tekuripeta, NDH-79, Laccadona, Badipaderu, CL-20
4	>50%	HS	Paderu Local	RH-9/90	CL-5, North-East *C. amada*, Mahanandi Local, Mega Turmeric, *C. amada*, Chintapalli Local-1, Wynad Local, Anantharajupeta Local



Resistant (Dindigam) | Moderately resistant (TCP-70) | Moderately Susceptible (NDS-18)

Susceptible (Battiguda) | Highly susceptible (Mega turmeric)

Fig. 1 : Screening of turmeric germplasm for resistance against rhizome rot disease under field condition

1, Ranga, Salem, Salem-2, Wagon, PTS-12, CL-8, CL-9, CL-10, CL-3, CL-4 were resistant to rhizome rot, showed 0.0% disease incidence whereas, Chintapalli local-2, Vontimitta, Mydukur, Imphal local were moderately resistant to rhizome rot disease. The germplasm lines like Tekuripeta, TC-4, NDH-79, CL-12, CL-20, Laccadona, Badipaderu, Cuddapah local were susceptible to rhizome rot whereas, Anantharajupeta local, Wynad local, Mahanandi local, *C. amada*, North-East *C. amada*, Chintapalli local-1, Mega turmeric, CL-5 were highly susceptible to rhizome rot and NDS-18, PTS-38, Duggirala, BSR-1, CL-19, CL-16, CL-6, CC-91-01, Roma, CL-2, CL-1, CL-18, CL-17, CL-15, CL-14, CL-11, CL-7 were moderately susceptible to rhizome rot.

Medium duration varieties:

The results of thirty medium duration lines showed that the rhizome rot disease incidence ranged from 0.00 to 72.72 per cent. Five out of thirty (16.66%) cultures were resistant to rhizome rot. Nine out of thirty (30.00%) showed the moderately resistant reaction, seven out of thirty (23.33%) showed the moderately susceptible reaction and eight out of thirty (26.66%) showed the susceptible reaction and one out of thirty (3.33) showed the highly susceptible reaction to rhizome rot disease. In this group the germplasm lines *viz.*, Prathibha, Thodupuztha, KTS-9, Prasangali, ACC-79 were found resistant to rhizome rot, showed 0.0% disease incidence whereas, Rajapuri, KTS-8, TCP-64, TCP-70, TCP-129, CLI-3611, BSR-2, NDH-8, Gorakpur-3617 were moderately resistant to the rhizome rot disease. The germplasm lines like Pedda pasupu, RH-80, RH-50, Rajendra Sonia, Suranjana, PTS-55, KTS-7, KTS-6 were susceptible to rhizome rot whereas RH-9/90 was highly susceptible and CLI-317, CLI-335, CLI-325, Rashmi, Ochira, Morthapuzta, Sports were moderately susceptible to rhizome rot.

Short duration varieties:

In case of short duration groups, rhizome rot disease incidence ranged from 0.00 to 64.15 per cent. Fourteen out of forty two (33.33%) were resistant to rhizome rot. Eleven out of forty two (26.19%) germplasm showed moderately resistant reaction to rhizome rot. It was found that majority of short duration group were in between

Table 2 : Rhizome rot reaction in natural field conditions of turmeric germplasm in Andhra Pradesh

Sr. No.	Name of the Germplasm	Per cent disease incidence (%)*	Reaction category	Duration
1.	Duggirala	15.38 (23.08)	MS	Long
2.	Cuddapah Local	28.57 (32.30)	S	Long
3.	Pratibha	0.00 (0.00)	R	Medium
4.	Salem	0.00 (0.00)	R	Long
5.	KTS-8	7.14 (15.49)	MR	Medium
6.	BSR-2	8.33 (16.77)	MR	Medium
7.	TCP-64	6.25 (14.47)	MR	Medium
8.	TCP-129	5.00 (12.92)	MR	Medium
9.	PTS-12	0.00 (0.00)	R	Long
10.	Roma	21.42 (27.56)	MS	Long
11.	CL-1	20.00 (26.55)	MS	Long
12.	CL-3	0.00 (0.00)	R	Long
13.	CL-5	66.67 (54.72)	HS	Long
14.	CL-7	11.11 (19.46)	MS	Long
15.	CL-9	0.00 (0.00)	R	Long
16.	IC-181919	28.57 (32.30)	S	Short
17.	Dindigam	0.00 (0.00)	R	Short
18.	VK-23	0.00 (0.00)	R	Short
19.	Gorakpur-3617	9.09 (17.54)	MR	Medium
20.	North-East C.*amada*	66.66 (54.71)	HS	Long
21.	Chintapalli Local-2	8.01 (16.43)	MR	Long
22.	Imphal Local	9.82 (18.26)	MR	Long
23.	Wagon	0.00 (0.00)	R	Long
24.	RH-50	30.77 (33.68)	S	Medium
25.	RH-9/90	72.72 (58.49)	HS	Medium
26.	Enna Chanda	5.50 (13.56)	MR	Short
27.	CL-18	23.08 (28.70)	MS	Long
28.	CL-16	12.5 (20.70)	MS	Long
29.	CL-14	22.22 (28.11)	MS	Long
30.	CL-11	21.42 (27.56)	MS	Long
31.	Kasturi	0.00 (0.00)	R	Short
32.	Ranga	0.00 (0.00)	R	Long
33.	NH-1	0.00 (0.00)	R	Long
34.	ACC-48	0.00 (0.00)	R	Short
35.	CC-91-01	22.22 (28.11)	MS	Long
36.	KTS-6	46.47 (42.96)	S	Medium
37.	CLI-317	14.28 (22.19)	MS	Medium
38.	CL-19	15.38 (23.08)	MS	Long
39.	GL Puram	30.76 (33.67)	S	Short
40.	IC-212606	8.33 (16.77)	MR	Short
41.	IC-211360	57.14 (49.09)	S	Short
42.	Mahanandi Local	92.86 (74.47)	HS	Long
43.	Paderu Local	64.15 (53.20)	HS	Short
44.	ST-34	15.38 (23.08)	MS	Short
45.	IC-353560	11.76 (20.05)	MS	Short
46.	CL-325	12.50 (20.70)	MS	Medium

Contd… Table 2

Table 2 contd…

47.	IC-394903	2.88 (9.77)	MR	Short
48.	NDS-18	11.00 (19.36)	MS	Long
49.	IC-416941	18.18 (25.23)	MS	Short
50.	IC-330113	8.01 (16.43)	MR	Short
51.	IC-332957	9.09 (17.54)	MR	Short
52.	TC-4	33.33 (35.25)	S	Long
53.	IC-211647	9.82 (18.26)	MR	Short
54.	IC-211641	0.00 (0.00)	R	Short
55.	Sports	13.64 (21.67)	MS	Medium
56.	IC-212808	26.08 (30.70)	S	Short
57.	Tekuripeta	28.57 (32.30)	S	Long
58.	Rajendra Sonia	30.77 (33.68)	S	Medium
59.	Morthapuzta	21.42 (27.56)	MS	Medium
60.	Salem-2	0.00 (0.00)	R	Long
61.	Sugandham	42.85 (40.87)	S	Short
62.	CL-2	13.64 (21.67)	MS	Long
63.	CL-4	0.00 (0.00)	R	Long
64.	CL-6	23.08 (28.70)	MS	Long
65.	CL-8	0.00 (0.00)	R	Long
66.	CL-10	0.00 (0.00)	R	Long
67.	NDH-79	28.76 (32.42)	S	Long
68.	Florescent	5.26 (13.75)	MR	Short
69.	Mega Turmeric	64.42 (53.36)	HS	Long
70.	Rajapuri	8.00 (16.42)	MR	Medium
71.	C.*amada*	55.00 (47.85)	HS	Long
72.	Chintapalli Local-1	62.50 (52.22)	HS	Long
73.	RH-80	22.58 (28.36)	S	Medium
74.	Wynad Local	90.00 (71.54)	HS	Long
75.	Laccadona	37.00 (37.45)	S	Long
76.	Suranjana	33.00 (35.05)	S	Medium
77.	Vontimitta	8.12 (16.55)	MR	Long
78.	CL-17	16.66 (24.08)	MS	Long
79.	CL-15	11.42 (19.74)	MS	Long
80.	CL-12	28.76 (32.42)	S	Long
81.	CAS-15	18.75 (25.65)	MS	Short
82.	Rashmi	15.62 (23.27)	MS	Medium
83.	Thodupuzta	0.00 (0.00)	R	Medium
84.	T. Sundar	5.00 (12.92)	MR	Short
85.	PTS-38	40.00 (39.22)	MS	Long
86.	Mydukur	7.22 (15.58)	MR	Long
87.	Tenali Kasturi	0.00 (0.00)	R	Short
88.	VK-9	13.79 (21.79)	MS	Short
89.	ACC-79	0.00 (0.00)	R	Medium
90.	Prasangali	0.00 (0.00)	R	Medium
91.	NDH-8	10.00 (18.43)	MR	Medium
92.	IC-211402	8.12 (16.55)	MR	Short
93.	Anantharaju peta Local	80.00 (63.41)	HS	Long
94.	Sonia	0.00 (0.00)	R	Short

Contd… Table 2

Contd…Table 2

95.	Badipaderu	28.76 (32.42)	S	Long
96.	Parbhani	11.42 (19.74)	MS	Short
97.	GS	0.00 (0.00)	R	Short
98.	KTS-9	0.00 (0.00)	R	Medium
99.	IC-521333	9.40 (17.85)	MR	Short
100.	IC-420606	0.00 (0.00)	R	Short
101.	Pedda pasupu	37.00 (37.45)	S	Medium
102.	BSR-1	15.62 (23.27)	MS	Long
103.	IC-319341	0.00 (0.00)	R	Short
104.	IC-033007	0.00 (0.00)	R	Short
105.	CA-70	30.00 (33.20)	MS	Short
106.	CLI-3611	9.75 (18.19)	MR	Medium
107.	Rajendra	21.11 (27.34)	MS	Short
108.	CA-1711	7.44 (15.82)	MR	Short
109.	Vickici	0.00 (0.00)	R	Short
110.	PTS-8	0.00 (0.00)	R	Short
111.	PTS-55	37.57 (37.79)	S	Medium
112.	Battiguda	60.43 (51.00)	S	Short
113.	Ochira	11.59 (19.90)	MS	Medium
114.	NB-60	0.00 (0.00)	R	Short
115.	KTS-7	60.37 (50.97)	S	Medium
116.	CL-20	22.58 (28.36)	S	Long
117.	TCP-70	6.27 (14.50)	MR	Medium
118.	SLP-389-1	18.79 (25.68)	MS	Short
119.	CLI-335	11.52 (19.83)	MS	Medium
120.	Kasturi Anidi	16.70 (24.11)	MS	Short
	S.E. ±	0.245		
	C.D. (P = 0.05)	0.683		
	CV (%)	1.963		

* Mean of three replications
Figures in parentheses are arc sine transformed values
R - Resistant, MR - Moderately resistant, MS - Moderately susceptible, S-Susceptible, HS - Highly susceptible.

resistant and moderately resistant to rhizome rot. In short duration group, the germplasm lines like IC-319341, Tenali Kasturi, VK-23, GS, IC-420606, IC-033007, IC-211641, PTS-8, Vikici, Dhindigam, ACC-48, Sonia, NB-60, Kasturi were resistant to rhizome rot, showed 0.0% disease incidence. Whereas, Ennachanda, IC-211647, T. Sundar, IC-332957, IC-330113, CA-1711, IC-394903, IC-211402, IC-212606, IC-521333, Florescent were moderately resistant to rhizome rot disease. The germplasm lines like GL- Puram, IC- 211360, IC-181919, IC-212808, Sugandham, Battiguda were susceptible to rhizome rot whereas, Paderu local was highly susceptible and SLP-389-1, Kasturi Anidi, Rajenrda, Parbhani, CA-70, VK-9, IC-416941, CAS-15, IC-353560, ST-34 were moderately susceptible to rhizome rot.

However, this varieties/germplasm will be further tested under controlled conditions by artificial inoculation of the target pathogen for confirmation of resistant reaction. The severity of rhizome rot showed variation among the turmeric germplasm lines/varieties screened. The resistance of the resistant lines and other moderately resistant lines may be attributed to their genetic background with higher metabolic/gene activity unsuitable to the rhizome rot pathogens (Nene and Haware, 1980). The reason for this might be the antifungal compounds such as phenolics produced by resistant lines/germplasm was more potent than other compounds, especially those produced by susceptible lines/germplasm (Iftikhar *et al*., 2005; Jamil *et al*., 1996 and Sahi *et al*., 2000). In addition to environmental conditions, amount of inocula, types of phytoalexins and the genetic structure of a plant also affect the resistance

of plants against the pathogen. The longer incubation period of the resistant and moderately resistant accessions/lines compared to the susceptible ones might be responsible for either delaying the initial infection of the disease or slow down of the rate of wilting (Sahi *et al.*, 2000). These findings are in agreement with Sarma and Krishnamurthi (1962) and Subbarayudu *et al.* (1976). Identification of diverse and stable field source resistance to rhizome rot is imperative and pre-requisite to a resistance breeding programme. The use of resistant variety is beneficial not only in reducing the losses due to diseases but these sources are also useful to minimize the fungicidal toxicity (Granger and Horne, 1924; Parey *et al.*, 2013 and Manu *et al.*, 2014).

Future line of research work:

– Germplasm cultures which showed less disease incidence needs to be studied further under *in vitro* by artificial inoculation for better evaluation and refinement.

– Needs to study the presence of races of the pathogen or resistant genes, as one variety showing the resistant reaction in one year and the same variety showing the susceptible reaction in another year in the same region.

Acknowledgement:

This research work was funded by University Grants Commission, Dr. YSRHU, Venkataramannagudem, Andhra Pradesh, India. I sincerely thank them for their support.

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