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Survey and screening of tomato germplasm against early blight disease caused by *Alteernaria solani*

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Abstract
Early blight disease caused by *Alternaria solani* is the most catastrophic disease causing losses both at pre and post-harvest stages in tomato growing places of India. Roving surveys were conducted during *Kharif* 2017 in tomato growing belt areas of Southern Karnataka covering *viz.*, Kolar, Chikkballapur, Ramanagara and Tumakuru districts to assess disease prevalence. Disease severity (Per cent Disease Index) ranged from 28.75 to 57.50. Maximum mean PDI of the disease was recorded in Kolar (50.43%) followed by Chikkaballapur district (42.75%) and least in Tumkur (31.75%). The highest PDI was recorded in Chowdadenahalli village of Kolar district (57.50) and lowest PDI of 28.75 was recorded in Janapanahalli village of Tumkur district. In an another experiment, field screening of tomato germplasm against early blight disease was taken up during *Kharif* 2017. Among the 50 genotypes screened, ten genotypes *viz.*, COHB-3,12,11,66,52,133,30,27,177 and 186 were resistant whereas thirty genotypes were moderately resistant. Ten genotypes were susceptible and one genotype was highly susceptible.

Keywords: Survey, early blight, *Alternaria solani*, screening

Introduction
Tomato (*Solanum lycopersicum* L.) is believed to be the most preferred and widely cultivated vegetable crop not only in India but all over the world. Due to its popularity the crop enjoys second position after potato in terms of world acreage and first among the processing crops. It is also a protective food because of its special nutritive value and is one of important components of the kitchen diet in the preparation of Indian culinary. The edible fruits can be consumed either fresh or it can be processed to several products like paste, soup, juices, ketchup, whole canned fruits etc. In addition, it has high medicinal value; the pulp and juice is digestible, promoter of gastric secretion and blood purifier apart being rich in vitamin A and C. Tomato contains Lycopene and Beta-carotene pigments (Rais and Sheoran 2015) [19]. Tomatoes are called as "Poor man's orange".

Tomato occupies an area of 4.85 m. ha. in the world with the production of 182.3 m. tones and the productivity of 37.6 t/ha (FAO, 2018) [5]. In India it is gown in an area of 809 thousand hectares with production of 19697 thousand tones and the productivity of 24.4 t/ha. The major tomato growing states in the country are Madhya Pradesh, Odisha, Karnataka, West Bengal, Andhra Pradesh and Maharashtra. In Karnataka, it occupies an area of 6373 hectares with an annual production of 20.31 lakh tones (Anon., 2018) [1].

However, there are several impediments in the cultivation of tomato crop in India that include both biotic and abiotic that are responsible for bringing down the productivity far lower than that of world productivity. Among the biotic ones, the diseases caused by fungi, bacteria, viruses and nematodes are the major constrictions in tomato production. Some of these diseases include: early blight (*Alternaria solani*), late blight *(Phytophthora infestans*), damping off (*Phythium* spp.), bacterial wilt (*Ralstonia solanacearum*), fungal wilt (*Fusarium oxysporum* f. sp. *lycopersici*) tomato leaf curl virus and nematode (*Meloidogyne incognita*). Among the fungal diseases the early blight also known as target spot disease incited by *Alternaria solani* is one of the world's most catastrophic diseases incurring losses both at pre and post-harvest stages in tomato growing tracks of India.

The fungus attacks leaves, stems and fruits. *Alternaria solani* may cause damping-off in the seedbed and a stem canker or collar rot that is destructive to transplants in the field. It has been considered as the most common disease of tomato causing heavy losses in quality of the fruits rendering large quantity of tomato fruits unfit for consumption (Hassan, 1996; Singh *et al*., 1997) [6, 20]. This disease, in severe cases can lead to a complete defoliation of the crop (Peralta *et al*., 2005) [17]. Yield losses up to 79% due to early blight damage were reported in India (Datar and Mayee, 1981) [3]. The disease is prevalent during rainy season and can become severe if the control measures are not implemented at the appropriate time.
Principal methods of controlling early blight are sanitation, cultivation of resistant varieties or hybrids and application of fungicides (Namanda *et al*, 2004; Kirk *et al*, 2005; Kumar and Srivastava, 2013) [14, 11, 12]. Among these, the cultivation of resistant varieties is consistent practice to manage this disease. Though, heritable resistance has been reported (Holley, 1983; Herriot *et al*.; 1986; Christ, 1991) [8, 7, 2], the disease is still by and large managed by foliar fungicides indicating paucity of resistance source of germplasm or varieties of tomato. And also there is no reliable information about the disease prevalence in South Karnataka. Previous reports have given information on the widespread occurrence of the disease. Prasad (2003) [18] conducted a field survey on early blight of tomato in northern districts of Karnataka *viz.* Raichur, Gulbarga and Dharwad during *kharif* 2001 and recorded a per cent disease index of 28.60 to 65.36. Kamble *et al*. (2009) [9] found the early blight disease caused by *Alternaria solani* was major disease of tomato under agro climatic conditions of Konkan region of ranging between 20.78 to 42.30 per cent in Raigad district and 35.12 to 55.75 per cent in Thane district. Pachori and Sharma (2016) [15] conducted field survey during *Kharif* season 2014-15 at Gwalior, Bhind and Morena Districts of Madhya Pradesh and noticed disease incidence was varying between 27.50 and 63.36 per cent. The highest disease (63.36 %) was observed in Gwalior District and least (27.5 %) was observed in Bhind District.
Evaluation of germplasm at field level is a useful technique to compare the various genotypes of their ability to overcome the disease in nature. Thus, this is useful predominantly for breeding programmes to come out with early blight resistant varieties. Keeping in this view, the present study was conducted to undertake the survey to know the status of disease prevalence in South Karnataka and to evaluate the germplasm against early blight disease under field conditions.

Material and Methods

Survey

An intensive roving survey was conducted during *Kharif* 2017 in Kolar, Chikkaballapur, Ramanagara and Tumkurudistricts to know the incidence and severity of early blight disease on tomato. Two talukas in every district and in each taluk two villages were surveyed comprising four fields in each village were assessed for the disease incidence and severity. In each field five plants were selected randomly and disease severity was assessed by using 0-5 scale (Datar and Mayee, 1986) [4] where 0-No symptoms on the leaf; 1- 0-5 per cent leaf area is infected and covered by spot, no spot on petiole and branches; 2-6-20 per cent leaf area is infected and covered by spot, some spots on petiole; 3- 21-40 per cent leaf area is infected and covered by spot, spots also seen on petiole, branches; 4- 41-70 per cent leaf area is infected and covered by spot, spots also seen on petiole, braches, stem and 5- >71 per cent leaf area is infected and covered by spot, spots also seen on petiole, branch, stem and fruits.
Per cent Disease Index (PDI) was calculated using the following formula proposed by Wheeler (1969) [21].

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of the individual disease ratings} \quad X \quad 100}{\text{Number of fruits or leaves observed X Maximum disease grade}}$$

Field screening of tomato germplasm against early blight disease

The tomato germplasm was evaluated for its resistance or susceptibility to the early blight disease caused by *Alternaria solani* in field conditions. The experiment was conducted at College of Horticulture, Bengaluru. The experiment was laid out in Randomized Block Design (RBD) with two replications. The disease severity was recorded at monthly interval beginning from 1 month after transplanting. The disease severity was assessed on five selected plants using the disease score (0-5 scale) and later converting in to Per cent Disease Index (PDI) as mentioned above.

Fruit yield

Crop was harvested at maturity stage and yield of the fruits in each plot was recorded and yield per hectare was computed by using net plot yield data and then converted to tones per hectare and the data were statistically analyzed.

Results

Survey

Data pertaining to survey (Table 1) revealed that, Per cent Disease Index (PDI) ranged from 28.75 to 57.50 per cent. The PDI in Kolar district ranged from 46.75 per cent (Yalavara) to 57.50 per cent (Chowdadenahalli) whereas it ranged from 36.50 per cent (Nandiganhalli) to 50.25 per cent (Bachahalli) in Chikkaballapur district. In Tumkuru district, the PDI ranged from 28.75 per cent (Janapanahalli) to 35.75 per cent (Rayavar) whereas in Ramanagara district, it ranged from 35.75 (Tavarikeri) to 42.50 per cent (Hallimala).
Among the talukas (Table 2), Kolartaluk recorded highest severity (52.12%) followed by Srinivaspura (48.75 %) taluka in Kolar district, Sidlaghatta (45.25 %) taluk of Chikkaballapur district and Ramanagara (40.7 %) of Ramanagara district. Tumkurutaluka of Tumkuru district recorded the least disease severity (30.37 %).
The present findings are in conformity with the work of Prasad (2002) [18], who recorded the PDI of 28.60 to 65.36 in northern districts of Karnataka during 2001. Kamble *et al*. (2009) [9], after conducting the survey in different agro climatic conditions of Konkan region of Maharashtra found the early blight disease caused by *Alternaria solani* was major disease of tomato which ranged between 20.78 to 42.30 per cent in Raigad district and 35.12 to 55.75 per cent in Thane district.

Table 1: Severity of early blight of tomato caused by *Alternaria solani* in major areas of Sothern Karnataka during *Kharif* 2017

Sl. No.	District	Taluk	Village	Age of crop DAS	Area (acre)	Name of cultivar	Percent disease index (PDI)
1	Kolar	Kolar	Yalvara	90	3	Abhinav	46.75
			Chowdadenahalli	85	2.5	Abhinav	57.50
						Mean	**52.12**
		Srinivaspura	Byrepalli	75	4	Prabha	47.75
			Kummankunte	80	2	Prabha	49.75
						Mean	**48.75**
2	Chikkaballapur	Chintamani	Nandhiganahalli	70	2.5	Local	36.50
			Uluvanayakanahalli	65	3	Abhinav	44.00
						Mean	**40.25**
		Sidlaghatta	Bommanhalli	55	2	Local	48.75
			Bachahalli	60	3	Prabha	50.25
						Mean	**45.25**
3	Tumakuru	Gubbi	Jyothinagar	75	1.5	Laxmi	30.50
			Rayavar	60	2	Local	35.75
						Mean	**33.12**
		Tumakuru	Janapanahalli	55	2.5	Prabha	28.75
			Heggere	70	4	Laxmi	32.00
						Mean	**30.37**
4	Ramanagara	Magadi	Tavarikeri	65	1	Prabha	35.75
			Harisandra	70	1.5	Local	38.50
						Mean	**37.12**
		Ramanagara	Hallimala	75	2.5	Laxmi	42.50
			Basavanpura	80	2	Local	38.92
						Mean	**40.71**

Table 2: District wise mean severity of early blight of tomato caused by *Alternariasolani*in major areas of Southern Karnataka during *Kharif* 2017

Sl. No.	District	Taluk	PDI	Mean
1	Kolar	Kolar	52.12	50.43
		Srinivaspura	48.75	
2	Chikkaballapur	Chintamani	40.25	42.75
		Sidlaghatta	45.25	
3	Tumakuru	Gubbi	33.12	31.75
		Tumakuru	30.37	
4	Ramanagara	Magadi	37.12	38.92
		Ramanagara	40.71	

Field screening of tomato germplasm against early blight disease

Planting cultivars that are less susceptible to early blight may reduce the severity of early blight of tomato. It is the cheapest and economical method of controlling disease. It takes the major role in the integrated management of the any disease.

In this context a total of fifty tomato genotypes along with one check (ArkaVikas-a susceptible check) was screened against early blight disease in natural condition during kharif season of 2017 (Table 3 and 4).

From the results it was observed that none of the accessions were either immune or highly resistant to the early blight disease. However, the germplasm accessions COHB-3, 12, 11, 66, 52, 133, 30, 27, 177 and 186 were observed to be resistant whereas the germplasm accessions COHB-32, 43, 65, 68, 69, 1, 5, 175, 182, 187, 189, 2, 162, 47, 53, 49, 176, 131, 65, 142, 29, 184, 171, 153, 31, 60, 88, 132, 137, 139 were moderately resistant. The accessions COHB-46, 48, 163, 70, 156, 149, 140, 181, 185 and ArkaVikas were susceptible while the accession COHB-143 was highly susceptible. Similar results are also reported by Krithika *et al*. (2012) who evaluated one hundred and eighty tomato genotypes against Alternariasolani and reported that IIHR 2101 (Solanumhabrochaires LA-1777) was highly resistant, IIHR-2758 moderately resistant, 78 genotypes showed moderately susceptible reac¬tion, 90 genotypes were susceptible and the remaining genotypes were highly susceptible. Similar results were also reported by Singh *et al*. (2011), Pandey *et al*. (2003) and Kumar *et al*. (2015) [16, 13].

Table 3: Screening of germplasm against early blight disease of tomato caused by *Alternaria solani* under field conditions

		Per cent Disease Index (PDI)					
Sl. No.	**Genotypes**	**30 days after transplanting**	**60 days after transplanting**	**90 days after transplanting**	**Score 90 days after transplanting**	**Host reaction**	**Yield (t/ha)**
1	COHB-43	18 (25.10)*	25.75 (31.50)	44.11 (41.61)	3	MR	26.95
2	COHB-46	20.3 (26.77)	36.75 (38.35)	58.4 (49.84)	4	S	23.04
3	COHB-48	36.35 (37.07)	42.76 (42.30)	66.75 (54.79)	4	S	18.1
4	COHB-32	37.7 (37.87)	43.85 (43.57)	48.75 (44.28)	3	MR	23.3
5	COHB-163	45 (42.12)	55.50 (49.89)	72.6 (58.46)	4	S	17.57
6	COHB-65	26.7 (31.11)	35.46 (38.35)	42.2 (40.50)	3	MR	33.56
7	COHB-68	38.5 (38.35)	43.33 (45.24)	48.1 (43.91)	3	MR	28.1
8	COHB-69	20.9 (27.19)	27.92 (33.37)	33.1 (35.11)	3	MR	33.51
9	COHB-1	22.45 (28.26)	26.9 (32.92)	31.2 (33.93)	3	MR	25.52
10	COHB-3	19 (25.82)	22.83 (30.21)	23.27 (28.82)	2	R	32.15
11	COHB-5	27.85 (31.84)	35.5 (38.35)	40.85 (39.72)	3	MR	21.35
12	COHB-12	16.75 (24.13)	23.13 (30.16)	25.00 (29.12)	2	R	31.89
13	COHB-175	23 (28.63)	24.55 (28.19)	28.4 (32.20)	3	MR	31.25

		Per cent Disease Index (PDI)					
Sl. No.	**Genotypes**	**30 days after transplanting**	**60 days after transplanting**	**90 days after transplanting**	**Score 90 days after transplanting**	**Host reaction**	**Yield (t/ha)**
14	COHB-182	26.05 (30.66)	28.91 (33.52)	32.72 (34.88)	3	MR	30.88
15	COHB-187	28.05 (31.95)	32.8(36.51)	40.35 (39.43)	3	MR	23.04
16	COHB-189	24.8 (29.83)	30.5 (34.76)	32.41 (34.68)	3	MR	28.64
17	COHB-2	29.9 (33.12)	34.65 (37.35)	38.39 (38.28)	3	MR	23.43
18	COHB-162	32.65 (34.82)	46 (44.14)	48.8 (44.31)	3	MR	19.53
19	COHB-166	16.35 (23.80)	22.75 (27.62)	25.00 (32.91)	2	R	30.59
20	COHB-47	22.9 (28.55)	26.55 (29.73)	33.7 (35.47)	3	MR	20.96
21	COHB-53	34.5 (35.93)	37.05 (38.35)	39.85 (39.14)	3	MR	25.67
22	COHB-48	8.2 (16.52)	15.12 (25.29)	18.2 (23.70)	2	R	39.37
23	COHB-49	27.25 (31.43)	36.5 (38.06)	37.48 (37.74)	3	MR	22.13
24	COHB-176	30 (33.20)	33.4 (33.96)	42.70 (40.79)	3	MR	22.8
25	COHB-52	6.15 (14.35)	12.25 (21.13)	19.50 (26.14)	2	R	34.24
26	COHB-131	34.5 (35.95)	37.74 (39.38)	44.50 (41.84)	3	MR	27.99
27	COHB-133	12.8 (20.88)	18.25 (23.77)	20.47 (26.88)	2	R	39.06
28	COHB-30	14.25 (22.13)	20.00 (25.10)	21.95 (27.87)	2	R	36.06
29	COHB-27	18.35 (25.33)	21.95 (27.03)	25.85 (30.54)	2	R	32.16
30	COHB-65	39.35 (38.82)	42.37 (38.94)	49.39 (44.63)	3	MR	21.09
31	COHB-139	38.62 (38.28)	43.6 (39.35)	44.71 (46.65)	3	MR	25.7
32	COHB-142	26.5 (30.96)	30.85 (33.53)	32.75 (34.88)	3	MR	31.64
33	COHB-29	30.34 (33.42)	32 (35.97)	44.65 (41.92)	3	MR	24.34
34	COHB-177	13.55 (21.54)	18.85 (27.42)	24.5 (29.59)	2	R	36.06
35	COHB-184	31.35 (34.02)	40.35 (38.35)	48.93 (44.39)	3	MR	23.56
36	COHB-70	40.35 (39.42)	52.40 (44.77)	73.66 (59.14)	4	S	18.22
37	COHB-171	25.35 (30.21)	34.05 (34.76)	36.5 (37.16)	3	MR	27.86
38	COHB-153	25.6 (30.35)	35.50 (34.67)	46.30 (42.87)	3	MR	23.43
39	COHB-156	40.35 (39.43)	42.70 (39.35)	59.15 (50.28)	4	S	17.58
40	COHB-31	34.8 (36.14)	35.50 (34.76)	40 (39.23)	3	MR	25.62
41	COHB-60	29.5 (32.88)	32.60 (32.71)	37.55 (37.78)	3	MR	30.85
42	COHB-186	18.85 (20.72)	21.85 (30.13)	25.00 (24.58)	2	R	31.5
43	COHB-88	19.6 (26.24)	41.10 (38.17)	48.25 (44.00)	3	MR	23.95
44	COHB-149	35.95 (36.82)	48.85 (42.25)	64.87 (53.68)	4	S	20.18
45	COHB-132	31.35 (33.05)	36.35 (35.79)	42.1 (40.44)	3	MR	22.45
46	COHB-137	25.55 (30.29)	45.25 (40.40)	49.2 (44.54)	3	MR	23.6
47	COHB-140	28 (31.91)	48.90 (42.42)	72.7 (58.33)	4	S	20.18
48	COHB-143	37.5 (37.74)	51.85 (47.98)	75.5 (60.41)	5	HS	16.2
49	COHB-181	38 (38.04)	44.70 (43.97)	63.85 (53.05)	4	S	24.36
50	COHB-185	30.5 (33.51)	42.71 (42.25)	56.20 (48.56)	4	S	28.05
51	ArkaVikas	39.05 (38.65)	43.35 (38.74)	51.25 (45.66)	4	S	35.41
	S.Em±	**1.02**	**1.57**	**1.68**			**0.54**
	CD(P=0.05)	**2.91**	**4.45**	**4.77**			**1.53**
	CV (%)	**4.61**	**6.18**	**5.85**			**7.35**

Table 4: Grouping of tomato genotypes into different categories of resistance against early blight disease under field condition on disease score

Disease score	Description	Host reaction	Number of genotypes	Genotypes
0	No symptoms on the plant	Immune	0	-
1	Up to 10%	Highly Resistant	0	-
2	11-25%	Resistant	10	COHB-3,12,11,66,52,133,30,27,177 and 186
3	26-50%	Moderate resistant	30	COHB-32,43,65,68,69,1,5,175,182,187,189,2, 162, 47,53,49,176,131,65,142,29,184,171,153,31,60,88,132,137,139
4	51-75%	Susceptible	9	COHB-46,48,163,70,156,149,140,181,185 and ArkaVikas
5	>75%	Highly susceptible	1	COHB-143

Yield

Significant difference in yield was observed among several tomato genotypes. The yield ranged from 39.37 to 16.2 t/ha. The genotype COHB-48 that had higher degree of resistance registered highest yield i.e., 39.37 t/ha (18.2 PDI) whereas, minimum yield was noticed in COHB-143 i.e., 16.2t/ha which was highly susceptible with PDI of 75.5 compared to check Arka Vikas which gave yield about 30.21 t/ha with PDI of 51.25. The results are in conformity with the observations of Kanjilal *et al.* (2000) [10] in West Bengal.

From the present study it can be established that in Kolar district, South Karnataka, which is of course a major tomato growing area in Karnataka, the early blight disease is very severe based on our survey and with respect to the germplasm

that was screened against the early blight disease under field conditions, ten genotypes were found to be resistant to the disease which can be further exploited for breeding purpose.

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