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SCREENING OF TOMATO GENOTYPES AGAINST EARLY BLIGHT (*ALTERNARIA SOLANI*) UNDER FIELD CONDITION

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ABSTRACT
Early blight (*Alternaria solani)* of the tomato is most destructive disease in tropical and subtropical countries. In natural epidemics of early blight are strongly inûuenced by environmental conditions, even though severe disease appears every year in northern India. If indices were available to evaluate resistance in breeding materials, breeding programs could be more efficient. Leaf blight, stem blight and apical fruit rot are the most damaging symptoms of the disease and can cause complete loss of the crop when severe. Forty four tomato genotypes were used in this study to differentiate between early blight resistant and susceptible genotypes selected to represent a range of reactions when screened under field condition. Evaluation was conducted in replicated trials under field conditions in two Rabi seasons 2010 and 2011 at vegetable research farm of Banaras Hindu University, Varanasi India. Plants were evaluated for disease symptoms, area under the Percent disease Index (PDI) and area under the diseases progress curve. The highest early blight disease incidence was found in PS-1(73.56%), Kashi Amrit (71.12%), Fla-7171(69.69%), H-T-4 (61.26%), DT-10 (53.65%) and the lowest in H-88-74-1(12.04%), EC-520061(12.29%) and EC-521071 (25.00%) Floraded (27.00%) and Swarna Naveen (28.61%). Other fifteen genotypes showed moderately resistant and twenty genotypes showed susceptible but two genotypes were found highly resistant on the basis of early blight disease intensity in 2010 and semilar result also found in 2011.

INTRODUCTION

India is the fourth largest tomato producer in the world after China, USA and Turkey. In terms of area, it occupies second place after potato at the national level .Early blight is the major disease caused by the fungus *Alternaria solani* (Ellis and Martin). The fungus causes disease in tomato, potato and eggplant. It is now found on all continents of the world. It is very destructive in temperate humid climates. Although the disease is called early blight, but it can occur on the plant at all stages of development. Early blight can cause a decrease in fruit quantity and quality. All aboveground parts of the plant can have symptoms of this disease. Leaf spots are circular, up to 1/2" in diameter, and dark to light brown Spots may occur singly or in large numbers on the leaf. The leaf may turn yellow, then brown and fall off. Older leaves are usually affected before the disease works up the plant. This disease, which in severe cases can lead to complete defoliation, is most damaging on tomato (Peralta *et al.*, 2005). The fruit is usually affected at the stem end. One or more firm, depressed rot spots appear on either the green or ripe fruit. Field evaluation has been the most utilized method of screening tomatoes for Early Blight resistance (Barksdale and Stoner, 1977; Gardner, 1984; Nash and Gardner, 1988). The advantages of field screening include the ability to grow large populations, evaluating plants under natural conditions and recording disease progress throughout the entire life cycle of the plant. Field evaluation is usually conducted throughout the plant's growing season, starting with observation of the first disease symptoms, usually 2 to 3 weeks after initial infection and ending with a recording of final percent defoliation at the end of the season. Disease severity is typically expressed as percent defoliation (Horsfall and Barratt, 1945) and the data expressed over time is used to determine the area under the disease progress curve. Area under the disease progress curve (AUDPC) (Shaner and Finney, 1977) was analyzed since it is the most suitable criterion to determine disease progress for polycyclic foliar pathogens where resistance is governed by quantitative trait loci (Jeger and Viljanen-Rollinson, 2001). Furthermore, Christ (1991) demonstrated that AUDPC is the best criterion to compare early blight severity on different cultivars. Although The area under the disease progress curve and final percent defoliation are the most common criteria used for evaluation of early blight resistance, other indices used include percent of disease index (PDI) and cumulative disease index (CDI) for either stem or foliage infections (Thirthamallappa *et al.*, 2000; Chaerani *et al.*, 2007). In general, however, field evaluation is highly useful as the data can be used to compare across plant genotypes at various time intervals during the season. This kind of information can be particularly useful when breeding early blight resistant tomatoes for targeted environments. The objectives of this study were to find sources of resistance against early blight in cultivated tomato lines.

MATERIALS AND METHODS

A study was conducted to screen forty four tomato genotypes against natural infection of early blight of tomato caused by *Alternaria solani* at vegetable research farm of Banaras Hindu University, Varanasi India during two *Rabi* seasons 2010 and 2011. During the crop season of both years accounted for the occurrence of early blight epidemics naturally, so inoculation

of the spores was not necessary. Disease appeared late in the season during both years, but spread quickly and uniformly. Twenty plants were selected for each treatment and disease severity was assessed in three stage of development at fifteen days interval by using 0-5 scale (Mayee and Datar, 1986) and described as 0 = less than one per cent leaf area infected, 1 = 5-11 per cent leaf area infected, 2 = 6-20 per cent leaf area infected, 3 = 21-40 per cent leaf area infected, 4 = 41-70 per cent leaf area infected and 5 = more than 71 per cent leaf area infected. Percent disease index (PDI) was calculated by using the formula given by Wheeler (1969).

$$\text{Percent disease Index} = \frac{\text{Sum of individual ratings}}{\text{No. of plants examined x disease scale}} \times 100$$

Disease reaction based on PDI was recorded according to the scale of Peteira *et al*., 2002. The area under the disease progress curve (AUDPC) value was calculated according to the formula used by Shaner and Finney (1977) was calculated as follows

$$\sum_{i=1}^{n-1}\left[\left(\frac{X_i + 1 + X_i}{2}\right) x (t_i + 1 - t_i)\right]$$

Where X_i is the disease index expressed as a proportion at the ith observation; t_i is the time (days after planting) at the *i*th observations; and *n* is the total number of observations.

Disease reaction classes for early blight infection based on percent disease severity in tomato are as follows:

Disease reaction	PDI range
Highly resistant	0-12.5
Resistant	12.6–25.0
Moderately resistant	25.1–37.5
Susceptible	37.6–50.0
Highly susceptible	50.1 and above

RESULTS AND DISCUSSION

Field survey conducted in the vegetable research farm of Banaras Hindu University, Varanasi during Rabi 2010-11. In 2010 there were significant differences in genotypes was found on the basis of area under disease progress curve (AUDPC). Mean AUDPC for genotypes ranged from 467.65 to 2221.55(Table 1.). Similar differences in genotypes were also found in 2011 and mean AUDPC for genotypes ranged from 436.92 to 2004.52 (Table 2.). In 2010, maximum disease severity was observed in the variety PS-1 (73.56%), Kashi Amrit (71.12%), Fla-7171(69.69%), H-T-4 (61.26%), DT-10(53.65%) and minimum in H-88-74-1 (12.04%), EC-520061(12.29%) and EC-521071 (25.00%) Floraded (27.00%) and Swarna Naveen (28.61%), (Table 1). While in 2011 maximum disease severity was observed in PS-1(70.56%), Kashi Amrit (70.44%), Fla-7171 (67.34%), H-T-4 (59.23%), DT-10 (54.45%) and minimum in H-88-74-1(12.25%), EC-520061 (12.35%), EC-521071 (25.01%) Floraded (28.337%) and Swarna Naveen (28.77%) (Table 2). Data from both years showed (Table 1, 2)

Table 1: Percent disease incidence and AUDPC of early blight in the tomato under field conditions in 2010

S. No.	Name of Germplasm	% Disease incidence (2010) PDI mean 60 days after transplanting	PDI mean 75 days after transplanting	PDI mean 90 days after transplanting	AUDPC	Score90 days after transplanting	Host reaction
1	Pusa Sadabahar	23.25	31.55	42.93	1291.70	4	S
2	EC-520061	10.04	13.00	12. 29	473.35	1	HR
3	Kashi Amrit	42.98	50.18	71.11	2141.92	5	HS
4	Floraded	12.97	20.14	27.00	804.47	3	MR
5	Kashi Sharad	22.53	27.37	34.00	1089.57	3	MR
6	DT-2	23.54	28.38	37.64	1258.05	3	S
7	Pant T-3	28.29	35.62	40.00	1346.52	3	S
8	H-24	13.09	36.00	41.76	1264.70	4	S
9	CO-3	13.49	29.33	29.90	989.75	3	MR
10	Punjab Upma	21.75	33.33	36.08	1204.32	3	MR
11	H-86	12.71	32.66	41.33	1205.37	4	S
12	N D T-3	28.03	38.75	47.67	1506.70	4	S
13	Selection-18	21.85	32.66	37.65	1209.72	3	S
14	VR-20	19.81	29.16	45.65	1270.82	4	S
15	H-T-4	27.00	42.67	61.25	1761.45	4	HS
16	Azad T-5	14.02	30.66	40.68	1175.35	3	S
17	Sworn Lalima	22.44	32.33	46.99	1358.20	4	S
18	TLC-1	23.64	30.66	36.66	1187.32	3	MR
19	Fla-7171	43.98	56.42	69.69	2221.55	4	HS
20	NDTVR-60	13.49	26.33	30.88	959.47	3	MR
21	DT-10	14.40	32.00	53.65	1392.85	4	HS
22	Selection-7	18.37	33.33	35.45	1169.62	3	MR
23	Flawery	23.43	32.20	47.23	1367.27	4	S
24	Feb-4	20.73	35.00	41.58	1304.25	3	S
25	BT-120	14.33	26.00	32.91	991.25	3	MR
26	NF-315	23.36	36.00	42.54	1353.40	4	S
27	Suncherry	13.49	25.25	30.35	935.30	3	MR
28	Swarna Naveen	13.13	21.08	28.61	843.90	3	MR
29	Kajela	21.25	29.34	42.88	1242.75	4	S
30	PS-1	33.60	43.03	73.56	2001.02	5	HS
31	Angur Lata	21.01	27.71	40.74	1184.47	3	S

Table 1: Contt.

32	Columbia	13.75	27.46	42.97	1159.62	4	S
33	Cholnak-K	16.56	23.51	33.10	973.45	3	MR
34	Grant	18.09	25.27	37.95	1069.15	3	S
35	P.M S-1	12.62	22.52	37.66	992.97	3	S
36	T.Local	14.66	22.38	33.99	955.60	3	MR
37	Superbug	17.18	22.63	47.01	1173.55	4	S
38	Shalimar-2	23.45	28.07	45.59	1280.92	4	S
39	EC-521071	17.21	23.16	25.00	803.025	2	R
40	EC-521086	12.43	19.92	29.07	828.175	3	MR
41	EC-521069	13.78	26.90	29.34	947.025	3	MR
42	EC531803	13.57	26.99	30.33	961.77	3	MR
43	ACE	16.71	27.63	37.72	1105.77	3	S
44	H-88-74-1	9.313	10.48	12.04	467.65	1	HR
	C.D.	1.973	1.86	3.32			

Table 2: Percent disease incidence and AUDPC of early blight in the tomato under field conditions in 2011

S. No.	Name of Germplasm	% Disease incidence (2011) PDI mean 60 days after transplanting	PDI mean 75 days after transplanting	PDI mean 90 days after transplanting	AUDPC	Score 90 days after transplanting	Host reaction
1	Pusa Sadabahar	22.54	29.58	41.07	1228.90	4	S
2	EC-520061	10.33	13.48	12.35	436.92	1	HR
3	Kashi Amrit	37.55	43.92	70.44	2004.52	5	HS
4	Floraded	12.23	21.13	28.33	833.80	3	MR
5	Kashi Sharad	18.39	26.19	35.71	1066.60	3	MR
6	DT-2	21.83	28.37	37.91	1113.07	3	S
7	Pant T-3	25.63	30.85	38.50	1232.65	3	S
8	H-24	15.38	26.18	38.00	1078.10	3	S
9	CO-3	11.74	21.08	30.80	866.37	3	MR
10	Punjab Upma	18.25	26.17	35.40	1060.47	3	MR
11	H-86	12.43	20.90	42.25	1040.55	4	S
12	N D T-3	28.48	35.31	45.84	1430.90	4	S
13	Selection-18	17.38	22.76	38.51	1049.55	3	S
14	VR-20	21.67	26.26	43.02	1201.85	4	S
15	H-T-4	30.56	38.35	59.23	1692.97	4	HS
16	Azad T-5	16.31	26.31	38.31	1031.75	3	S
17	Sworn Lalima	18.58	27.60	43.98	1213.10	4	S
18	TLC-1	16.73	25.50	34.14	1020.17	3	MR
19	Fla-7171	47.24	49.60	67.34	2108.45	4	HS
20	NDTVR-60	12.76	22.88	30.74	900.05	3	MR
21	DT-10	14.51	20.22	54.45	1229.02	4	HS
22	Selection-7	19.70	25.55	35.43	1062.55	3	MR
23	Flawery	24.83	35.45	49.60	1477.12	4	S
24	Feb-4	18.54	26.67	37.63	1067.65	3	S
25	BT-120	14.72	21.68	33.52	938.60	3	MR
26	NF-315	22.34	30.67	38.52	1205.57	3	S
27	Suncherry	15.26	26.50	34.37	1027.57	3	MR
28	Swarna Naveen	11.65	20.36	28.77	815.45	3	MR
29	Kajela	17.30	24.41	40.65	1105.82	4	S
30	PS-1	31.95	36.21	70.56	1841.30	5	HS
31	Angur Lata	20.57	26.72	39.33	1100.25	4	S
32	Columbia	16.00	27.59	41.67	1158.92	4	S
33	Cholnak-K	17.51	27.03	32.80	1029.00	3	MR
34	Grant	22.10	35.77	42.45	1339.22	4	S
35	P.M S-1	12.95	27.92	37.62	1062.35	3	S
36	T.Local	11.70	20.94	33.36	902.37	3	MR
37	Superbug	15.39	27.42	43.99	1186.82	4	S
38	Shalimar-2	23.75	29.35	43.45	1270.17	4	S
39	EC-521071	11.52	20.22	25.01	777.12	2	R
40	EC-521086	16.12	21.05	29.06	872.65	3	MR
41	EC-521069	18.53	26.58	33.02	1033.00	3	MR
42	EC531803	11.87	20.78	35.60	934.80	3	MR
43	ACE	12.02	22.48	39.43	958.95	3	S
44	H-88-74	6.75	11.46	12.25	471.17	1	HR
	C.D.	1.44	1.78	2.65			

that one genotype (EC-521071) was resistant, fifteen genotypes((Floraded, Kashi Sharad, CO-3, Punjab Upma, TLC-1, NDTVR-60, Selection-7, BT-120, Suncherry, Swarna Naveen, Cholnak-K, T. Local, EC-521086, EC-521069 and EC531803) showed moderately resistant and twenty genotypes (Pusa Sadabahar, DT-2, Pant T-3, H-24, H-86, N D T-3, Selection-18, VR-20, Azad T-5, Sworn Lalima, Flawery, Feb-4, NF-315, Kajela, Angur Lata, Columbia, Grant, P.M S-1, Superbug andShalimar-2 showed susceptible and five genotypes (PS-1, Kashi Amrit, Fla-7171, H-T-4 and DT-10) were found highly susceptible and two genotypes H-88-74-1 and EC-520061 was found highly resistant on the basis of early blight disease intensity in both years.

The highly early blight resistance in this population has been supported by our study and agrees with the studies of Singh *et al*. (2011) were also found in genotype (EC-520057, EC-520058, EC-520059, EC-520061, EC-508765, EC-538394, H-88-78-1 and EC-501583) showed highly resistant reaction against the fungus. The survey revealed that, the severity and incidence of early blight of tomato varied from season to season, most probably due to various factors like temperature, relative humidity, rainfall, sowing dates, diverse cultivars used and even it could also be attributed to existence of pathogenic variability. Such higher incidence of early blight was recorded by Datar and Mayee (1981) with coefficient disease index of 11.66 per cent in Maharashtra. The results are also in conformity with the observations of Kanjilal *et al*. (2000) in West Bengal. Alsafadi *et al*. (2012) was recorded disease level based on a 1-9 scale. Results showed that cultivars Bosfer and Daher aljabal had a high level of resistance to early blight, compared to cultivars Dara, Gerdi, Haragel and Magdal Mawash which were moderately or highly susceptible to the disease. Moreover, cultivars Wardiat, Breh and Baskanta showed moderate resistance to the disease. Lohith *et al*. (2011) were found four genotypes EC 251709, EC 251717, EC 164295 and LE 15 showed highly resistant reaction with PDI ranged from 0-10%; whereas LE 44 was resistant (PDI 10.1-25%); EC 165690, EC 163681, EC 136711, EC 163683, LE 16, LE 35, LE 54, LE 85, LE-172 and LE-189 were moderately resistant (PDI 25.1-40%). Upadhyay *et al*. (2009). were supported by our study and reported for disease severity and host resistance of the plants. 'EC520061' (*S. habrochaites*) showed resistance against infection, 3 genotypes 'NCEBR 4', 'FEB 4' and 'DVRT 2' were moderately susceptible, while other genotypes were found either susceptible or highly susceptible. In 1967, USDA researcher R. E. Webb observed field resistance in tomato breeding lines 67B833 and 68B134. (Barksdale, 1971; Barksdale and Stoner, 1973; USDA, 2007). Barksdale (1969) evaluated several breeding lines and accessions of *S. lycopersicum* and found a resistant accession (PI138630), which was later used for early blight resistant breeding. This led to the development and release of resistant breeding lines 71B2 and (C1943) (Barksdale and Stoner, 1977). C1943 was used as a source of early blight resistance in developing breeding lines NC63EB, NC870, NCEBR-2, NCEBR-3 and NCEBR-4 (Gardner, 1988) Subsequently, 71B2 was also used as a source of resistance in developing tomato breeding lines NCEBR-5 and NCEBR-6 (Gardner, 2000). Only a few other studies have found any useful source of early blight resistance within the cultivated species of tomato. Poysa and Tu (1996) identified 11 moderately resistant *S. lycopersicum* accessions, but it is not known whether any of them was used for early blight resistance breeding. A greater number of early blight resistant accessions have been identified in *S. habrochaites* than in any other tomato species. Another highly resistant *S. habrochaites* accession (PI126445) was identified by Alexander and Hoover (1955), which was subsequently utilized in many tomato genetics and breeding programs.

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