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Evaluation of different germplasms/genotypes/lines/cultivars of tomato against early blight (*Alternaria solani*) in field conditions

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Abstract

Early blight of tomato, caused by *Alternaria solani* (Ellis and Martin) Sorauer, is a serious disease in warm and humid regions and in semiarid areas where frequent and prolonged night dew occurs. In this study, 129 tomato genotypes under field conditions were screened at Research Farm Plant Pathology, in the Division of Plant Pathology, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu, Chatha during the year 2017-18 and 2018-2019 against early blight. Eleven genotypes (Money Maker, EC-170047, EC -320574-1, EC-617047, EC -310301, EC -310303, EC -520078, EC -521067-B, EC -523351, EC -620406, EC -645179-D) were found highly resistant while twenty genotypes were found resistant (Punjab Chhuhara, Flora Dade, EC -501574, EC -317641, EC -3176-1, EC -109746, EC -163611, EC -164838, EC -620515, EC -515014, EC -169966, EC -320518, EC -620510, EC -538156, EC -620361, EC -620376, EC -320387, EC -620395, EC -163605, EC -251750.) and three genotypes (Pusa Ruby, C-26-1, EC -170089) were found highly susceptible.

Keywords: Early blight, *Alternaria solani*, screening, genotypes, resistant and susceptible

Introduction

Early blight is the major disease of tomato [*Solanum lycopersicum* L. (Peralta *et al.*, 2005) ^[9] syn. *Lycopersicon esculentum* Mill.)] Caused by the fungus *Alternaria solani* (Ellis and Martin) Sorauer. The disease in severe cases can lead to complete defoliation and is most damaging on tomato in regions with heavy dew, rainfall, high humidity, and fairly high temperatures (24-29 °C) ^[2]. All above ground parts of the plant can have symptoms of this disease. Leaf spots are circular, upto 1/2 in diameter, and dark to light brown spots may occur singly or in large numbers on the leaf. Leaf blight is the most important phase of the disease (3). The lesions are surrounded by yellow rings (4). The disease first appears on lower older leaves and moves upwards as the plant becomes mature (5). Older leaves are more susceptible than younger leaves. Tomato crop is damaged due to severe infection of *Alternaria solani* every year globally. Yield losses upto 79% due to early blight were reported from Canada, India, USA and Nigeria (6-10). Application of several fungicides (systemic and contact) has been recommended to control the disease, however non-judicial use of the fungicides leads to human and environmental hazards. Thus the access to resistant to moderately resistant genotypes may reduce the dependency on fungicides and can also be an important component of effective integrated disease management programme. Among the various recognised methods of plant disease control, the use of resistant varieties is considered to be cost effective and the best way. Therefore, screening of available lines and genotypes of tomato was carried out to find the source of resistance against early blight disease caused by the fungus, *Alternaria solani*.

Material and Methods

The present study was conducted in Research field of Plant Pathology, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu, Chatha during the year 2017-18 and 2018-19. The details of materials used and the methodology adopted in the present investigation are briefly described below

Screening of tomato germplasm against *Alternaria solani*

One hundred twenty ninetomato genotypes were screened against natural infection of early blight disease during cropping season 2018 and 2019.

Five plants selected randomly in each genotype by observing 15 leaves from lower, middle and upper portion of plants was recorded for disease severity using 0-5 scale (Pandey *et al*, 2003) ^[9] and per cent disease Intensity (PDI) was worked out using formula of Wheeler(1969) ^[18]. Per cent Disease Index (PDI) was worked out by using formula given by Wheeler (1969) ^[18].

Per cent disease index PDI = sum of individual disease

$$\frac{\text{Sum of individual disease ratings}}{\text{Total No. of plant examined X Maximum No. of disease rating}} \times 100$$

Intensity of the early blight was determined by using 0-5 scale (Pandey *et al*, 2003) ^[9].

Table 1: Disease rating Scale used (Pandey *et al.*, 2003) ^[9].

Grade	Symptoms
0	Free from infection
1	< 10% surface area covering leaf, stem and fruit infected by early blight
2	11-25% foliage of plant covered with a few isolated spot
3	Many spot coalesced on the leaves, covering 26-50% surface area of plant
4	51-75% area of plants infected, fruits and also infected at peduncle and defoliation and blighting started. Sunken lesions with prominent concentric ring on stem, petioles and fruits
5	> 75% area of plant part blighted, severe lesion on stem and fruit rotting on peduncle end

Table 2: Varietal reaction was categorized as per scale used by Pandey *et al*, 2003 ^[9].

Disease Intensity (%)	Reaction Notation
0-5	Highly Resistant HR
5.1-12	Moderately resistant R
12.1-25	Moderately resistant MR
25.1-50	Moderately susceptible MS
50.1-75	Susceptible S
> 75	Highly susceptible HS

Result and Discussion

To find the suitable source of resistance against early blight pathogen (*A. solani*) 129 genotypes were screened under natural epiphytotic conditions. The progress of disease was recorded at 10 day intervals in all the selected genotypes from

20th March to 20th May during the year 2017-18 and 2018-19. Data presented in the table 3 and 4 revealed that Many maker, EC-170047, EC -320574-1, EC-617047, EC -310301, EC -310303, EC -520078, EC -521067-B, EC -523351, EC -620406, EC -645179-D were found highly resistant genotypes with minimum per cent disease index (0-5%) over susceptible check (Pusa ruby) having per cent disease index of > 75%. During periods of high humidity and high temperature from 70-80 per cent relative humidity and when temperature was in between 25 °C to 30 °C, maximum per cent disease index (>75 per cent) was recorded in genotypes Pusa ruby, C-26-1, EC -170089 and minimum per cent disease index (0-5 per cent) was recorded in Many maker, EC-170047, EC -320574-1, EC-617047, EC -310301, EC -310303, EC -520078, EC -521067-B, EC -523351, EC -620406, EC -645179-D.

Table 3: Screening of tomato germplasm against *Alternaria solani* causing early blight of tomato

S. No	Germplasm	PDI (%)		Pooled mean
		2018	2019	
1.	Hisar Arun	10.50	8.500	09.50
2.	Flora Dade	19.20	17.21	18.20
3.	Kashi Anupama	15.70	14.00	14.85
4.	C-26-1	78.57	72.00	75.28
5.	Kashi Hemant	54.50	51.00	52.75
6.	Arka Alok	17.10	15.10	16.10
7.	Kashi Sharad	30.28	27.00	28.64
8.	WIR-4360	51.00	48.00	49.50
9.	Money Maker	04.20	03.00	03.60
10.	Roma	62.20	56.00	59.10
11.	WIR-13706	24.00	21.00	22.50
12.	Aarksh Vikas	28.20	25.00	26.60
13.	Kashi Vishesh	54.00	51.66	52.83
14.	bc-529083	31.00	27.44	29.22
15.	Swarn Lalina	30.00	26.73	28.36
16.	VRT-2	28.20	25.00	26.60
17.	H-86	28.00	25.00	26.50
18.	EC501574	06.28	04.00	05.14
19.	Azad-T5	72.20	67.20	69.70
20.	Azad-T2	63.14	60.13	61.63
21.	EC-317641	12.70	10.00	11.35
22.	EC-3176-1	16.10	14.12	15.11
23.	Pusa Ruby	87.00	83.00	78.00
24.	Kajal	26.20	24.14	25.17
25.	F-7026	15.20	13.00	14.10
26.	WIR-2924	26.85	24.23	25.54
27.	S. Vaibhav	19.20	17.00	18.10
28.	Punjab Chhuhara	10.70	08.22	09.46
29.	Kashi Aman	26.85	25.00	25.92

30.	BL-1200	25.00	23.00	24.00
31.	WIR-2924	26.85	25.85	26.35
32.	NF-375B-8	18.50	17.50	18.00
33.	EC-3176	16.10	15.00	15.55
34.	EC-109746	07.70	06.00	06.00
35.	EC-109751	52.10	49.32	50.71
36.	EC-151568	13.57	12.00	12.78
37.	EC-168282	19.57	18.00	18.78
38.	EC-160885	20.50	18.43	19.46
39.	EC-164334	55.10	53.55	54.32
40.	EC-163611	06.57	05.23	05.90
41.	EC-164838	06.00	05.13	05.56
42.	EC-164760	18.00	16.43	17.21
43.	EC-249508	29.20	27.50	28.35
44.	EC-249514	26.28	26.00	26.14
45.	EC-631380	22.20	20.31	21.25
46.	EC-617048	13.10	11.11	12.10
47.	EC-614998	13.20	12.00	12.60
48.	EC-173854	26.28	25.00	25.64
49.	EC-177329	33.14	30.00	31.57
50.	EC-170089	81.40	79.00	76.25
51.	EC-645165	63.14	60.21	61.67
52.	EC-163605	21.70	19.70	20.70
53.	EC-168283	18.50	17.00	17.75
54.	EC-170047	01.14	01.00	01.07
55.	EC-251709	27.85	25.50	26.67
56.	EC-320574-1	05.42	04.10	04.76
57.	EC-617053	52.00	50.00	51.00
58.	EC-615018	36.14	35.00	35.57
59.	EC-620515	08.50	08.00	08.25
60.	EC-515014	11.40	10.40	10.90
61.	EC-631421	14.70	12.50	13.60
62.	EC-169966	11.00	09.00	10.00
63.	EC-251750	13.85	12.00	12.92
64.	EC-367930	29.57	28.00	28.78
65.	EC-320575	31.40	30.00	30.70
66.	EC-320518	06.28	05.50	05.89
67.	EC-620510	09.40	08.23	08.81
68.	EC-368832	52.00	50.00	51.00
69.	EC-338723	53.71	51.00	52.35
70.	EC-370867	13.00	12.00	12.50
71.	EC-362940	16.85	15.50	16.17
72.	EC-176933	16.50	15.00	15.75
73.	EC-338725	60.14	58.00	59.07
74.	EC-251729	16.10	15.00	15.55
75.	EC-251672	75.71	73.21	74.46
76.	EC-320561	17.20	16.00	16.60
77.	EC-168290	60.00	58.50	59.25
78.	EC-617047	03.71	02.50	03.10
79.	EC-676042	21.50	19.00	20.25
80.	EC-620417	52.00	50.00	51.00
81.	EC-368199	35.14	34.00	35.14
82.	EC-338735	42.28	40.00	41.14
83.	EC-249574	20.10	18.00	19.05
84.	EC-251672	70.41	54.00	62.20
85.	Kashi Hemant	56.00	56.00	56.00
86.	EC-310301	03.28	03.00	03.14
87.	EC-310303	04.85	03.00	03.92
88.	EC-313478	40.71	38.00	39.35
89.	EC-315457	16.20	15.50	15.85
90.	EC-315460	17.85	15.50	16.67
91.	EC-315464	55.00	50.00	52.50
92.	EC-313466	52.00	50.00	51.00
93.	EC-315476	2.710	05.00	03.85
94.	EC-315477	07.57	01.50	04.53
95.	EC-315478	18.50	17.00	17.75
96.	EC-315489	52.00	50.00	51.00
97.	EC-315480	11.20	12.50	11.85

98.	EC-315481	12.57	12.50	12.53
99.	EC-315485	30.80	28.00	29.40
100.	EC-165395	56.00	54.32	55.16
101.	EC-520078	03.10	02.00	02.55
102.	EC-620394	19.60	18.00	18.80
103.	EC-521067-B	2.800	02.50	02.65
104.	EC-523351	01.28	01.00	01.14
105.	EC-528368	12.70	08.00	10.35
106.	EC-538156	09.10	08.00	08.55
107.	EC-620361	09.00	08.00	08.50
108.	EC-620370	15.40	14.00	14.70
109.	EC-620372	18.00	14.00	16.00
110.	EC-620376	05.70	05.00	05.35
111.	EC-620382	54.42	51.00	52.71
112.	EC-620387	10.40	08.82	09.61
113.	EC-620392	60.00	61.00	60.50
114.	EC-620394	19.60	18.00	18.80
115.	EC-620395	06.00	05.00	05.50
116.	EC-620406	02.80	01.50	02.15
117.	EC-620410	21.00	20.00	20.50
118.	EC-620427	24.20	23.00	23.60
119.	EC-620429	19.20	18.00	18.60
120.	EC-631359	11.20	10.00	10.60
121.	EC-631379	14.70	13.00	13.85
122.	EC-645165	63.14	61.14	62.14
123.	EC-631369	34.71	32.50	33.60
124.	EC-251709	27.85	26.00	26.92
125.	EC-167860	13.80	12.50	13.15
126.	EC-626519	13.10	12.00	12.55
127.	EC-645179-D	02.00	01.00	01.50
128.	EC-620529	11.28	10.00	10.64
129.	EC-631368	30.00	28.00	29.00
130.	EC-676742	21.50	19.23	20.36

Table 4: Reaction of tomato genotypes against *Alternaria solani* under artificial inoculation conditions

Reaction	PDI (%)	Genotypes
Highly resistant (HR)	0-5	Money Maker, EC-170047, EC -320574-1, EC-617047, EC -310301, EC -310303, EC -520078, EC -521067-B, EC -523351, EC -620406, EC -645179-D
Resistant (R)	5.1-12	Punjab Chuhara, Flora Dade, EC -501574, EC -317641, EC -3176-1, EC -109746, EC -163611, EC -164838, EC -620515, EC -515014, EC -169966, EC -320518, EC -620510, EC -538156, EC -620361, EC -620376, EC -320387, EC -620395, EC -163605, EC -251750,
Moderately resistant (MR)	12.1-25	Hisar Arun, Kashi Anupama, Arka Alok WIR 13706, F-7026, WIR 2924, NF-375B-8, S. Vaibhav, BL-1200, EC -3176, EC -151568, EC -168282, EC -106885, EC -164760, EC -631380, EC -617048, EC -614998, EC -168283, EC -631421, mEC -370867, EC -362940, EC -176933, EC -251729, EC -320561, EC -676042, EC -249574, EC -315457, EC -315460, EC -315478, EC315481, EC -620394, EC -620370, EC -620372, EC -620410, EC -620427, EC -620429, EC -631379, EC -167860, EC -626519, EC -676742
Moderately susceptible (MS)	25.1-50	Kashi Aman, Kajal, Swarn Lalina, Aarksh Vishesh, Kashi Sharad, VRT-2, H-86, EC -251709, EC -631369, EC -313478, EC -338735, EC -315485, EC -368199, EC -320575, EC -367930, EC -615018, EC -177329, EC -173854, EC -249508, EC -249514
Susceptible (S)	50.1-75	Roma, Kashi Hemant, Azad-T2, Azad-T5, EC -109751, EC -164334, EC -645165, EC -368832, EC -338725, EC -251672, EC -168290, EC -620417, EC -251672, EC -315464, EC -313466, EC -315489, EC -165395, EC -620382, EC -620392, EC -645165
Highly susceptible (HS)	> 75	Pusa Ruby, C-26-1, EC -170089

The present findings emphasized the evaluation of lines against early blight to find the resistance sample which can be used as a donor source for breeding of disease resistance programmes. Moreover, high humidity and high temperature parameters should be considered before the crop is planted as these factors found most congenial for spreading of the disease.

The above results are in conformity with the findings of Vijaya Mahanttesha *et al.*, (2012) who tested twenty one genotypes against early blight of tomato under field condition. None of the genotypes exhibited immune or resistant reaction; however US 654 exhibited moderately resistant reaction.

Among the remaining genotypes, four genotypes were moderately susceptible and only one was highly susceptible. Similar results were recorded by Sunil Kumar (2013) ^[5] who *evaluated* forty four tomato genotypes against early blight of tomato under field condition. The maximum early blight disease incidence disease was found in PS-1 (73.56 per cent), Kashi Amrit (71.12 per cent), Fla-7171 (69.69 per cent), H-T-4 (61.26 per cent), DT-10 (53.65 per cent) and the lowest in H-88-74-1(12.04 per cent), EC520061(12.29 per cent) and EC-521071 (25.00 per cent) Floraded (27.00 per cent) and Swarna Naveen (28.61 per cent). Meitei *et al.*, (2014) ^[8] also reported that Sel-35 (TLBRH-6 X Konbilahi) and Sel-19

(TLBRH-6 X Konbilahi) were highly resistant against early blight of tomato. Yadav *et al.*, (2015) ^[19] also screened various genotypes against early blight of tomato caused by *A. solani*. Nine genotypes were screened under natural epiphytic condition. Nineteen advanced line were found resistant against *A. solani*, three were found moderately resistant, fifteen advanced lines and genotypes were found moderately susceptible and one was found susceptible. Five genotypes were found highly susceptible. Chohan *et al.* (2015) ^[2] reported similar results and assessed six tomato varieties against early blight disease and found that no variety was found resistant. Roma exhibited maximum susceptibility (70.50 per cent) while Nagina showed minimum susceptibility of 29.38 per cent.

Kumar (2015) ^[6] *et al.*, also screened 141 tomato germplasm/cultivars including wild accessions, advanced lines and indigenous cultivars under field conditions among the 141 germplasm, 5 wild accessions *viz.* EC-520057, EC-520058, EC-520059, EC-52061 and EC-501583 exhibited complete resistant against early blight and 10 lines *viz.* RCMT-1, LA-40-40-1, KS-118, H-88-78-3, IIVR-18, Sel-2, H-88-78-1, EC-538394, EC-538404, NCEBR-4 and EC-508765 were found moderately resistant. The results indicated that the lines/genotypes which were highly resistant may be utilized as sources for development of pre-bred lines or recombinant inbred lines or in other molecular works for the improvement of tomato crop against early blight disease and may also be promoted for growing in disease prone areas besides using them in development of resistant varieties.

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