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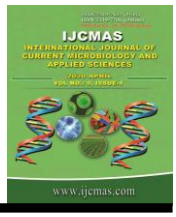

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Evaluation of Tomato Germplasm against Early Blight under Epiphytotic Conditions

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A B S T R A C T

Tomato is one of the most extensively cultivated vegetables and is a rich source of nutrients such as vitamins, antioxidants and minerals for a balanced human diet. World over, early blight (EB) caused by *Alternaria solani* Sorauer is limiting tomato production and causes great losses. In total, 350 tomato genotypes from ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi were evaluated for early blight resistance under epiphytotic conditions at ICAR-Indian Institute of Vegetable Research (ICAR-IIVR), Varanasi. Augmented design with five released varieties as checks was the experimental design followed. EC705445 gave highly resistant (HR) reaction with 0.86 percent disease index (PDI). EC0027336, EC0114504 and EC0027932 gave resistance (R) reaction. Another fourteen genotypes gave moderately resistance (MR) reaction. Seven genotypes (EC705445, EC0013112, EC0026104, EC699717, EC695040, EC000586 and EC0111086) that gave either HR or R or MR reaction under field conditions were further screened for the disease reaction under artificial conditions and none of the genotypes shown either HR or R or MR reaction.

Introduction

Tomato (*Solanum lycopersicum* L.; family: Solanaceae) is an important vegetable crop grown for its nutritional, culinary and economic value. Tomatos are considered as protective food as they provide essential components of a balanced healthy diet like vitamins, minerals antioxidants and rank 2nd after potato in terms of production and consumption across the world (Singh *et al.*, 2017). Early blight (EB) of tomato caused by *Alternaria solani* Sorauer, is one of the most important dreadful fungal diseases that results up to 79% yield losses in India (Datar and Mayee, 1981; Mathur and Shekawat 1986).

Though fungus affects foliage (leaf blight), stem (collar rot) and fruit, the leaf blight phase is the most important phase of the disease. Leaf blight/early blight is characterized by dark brown to black leaf spots with concentric rings which may coalesce leading to blighting of leaves and defoliation. On the stem disease leads to development of dark-brown, shrunken concentric rings. On the fruits, symptoms start at the stem end, where the symptoms may be small and sunken or may enlarge to cover most of the fruit (Chaerani and Voorrips, 2007).

Management of the disease has been achieved through sanitation, crop rotation and fungicide application with limited success especially during humid and rainy seasons (Jayaraj and Punja, 2007). Further, use of chemicals/fungicides considerably increases the cost of cultivation and is hazardous to humans and the environment (Nasr, 2018). To avoid losses caused by the disease and use of hazardous chemicals, cultivation of resistant cultivars is the better alternative. However, there is still no tomato variety available with acceptable levels of resistance against early blight. Here comes the importance of genetic resources. Tomato is one such crop that has benefitted greatly from germplasm resources especially from wild species. Tomato lines with different rates of resistance were developed from wild species like *S. habrochaites*, *S. pimpinellifolium*, and *S. peruvianum* with identified early blight resistance. Reported EB resistance followed quantitative inheritance and controlled by the additive or non-additive interaction of multiple genes and their interaction with the environment (Barksdale and Stoner, 1977; Nash and Gardner, 1988; Adhikari *et al.*, 2017). Till date no single qualitative gene for EB resistance has been reported (Adhikari *et al.*, 2017). Further, resistance against collar rot caused by *A. solani* was reported in two tomato wild species LA2325 (*S. neorickii*) and WIR3928 (yellow fruited wild species) (Yerasu *et al.*, 2019). To identify new resistance sources, evaluation and characterization of available plant genetic resources is required.

In this work, 350 tomato germplasm lines received from ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi were evaluated for early blight resistance under field conditions and among the genotypes, seven germplasm lines that had shown highly resistant (EC705445) or moderately resistant (EC0013112, EC0026104, EC699717, EC695040, EC0005863 and EC0111086) reaction were further screened under artificially inoculated conditions at ICAR-Indian Institute of Vegetable Research (ICAR-IIVR), Varanasi.

Materials and Methods

Plant material

All the 350 tomato accessions (Table 1) of the study were received from ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi for seed multiplication in 2015-16. Five released varieties (Kashi Aman, Kashi Vishesh, Kashi Amrit, Kashi Sharad and Kashi Anupam) were used as checks. In artificial screening, genotypes EC705445, EC0013112, EC0026104, EC699717, EC695040, EC0005863, EC0111086 and Kashi Amrit were included (Table 3).

Field screening for resistance to early blight

The field screening experiment was carried out in 2015–2016 at the research farm of ICAR-IIVR, Varanasi, Uttar Pradesh, India (25°10′N latitude and 82°52′E longitude at mean sea level of 128.93 m). Accessions were

grown in the field in augmented randomized complete block design (RCBD). Checks were replicated in each block and treatment ie germplasm accessions were not replicated. 350 accessions were grown in 10 blocks with 35 accessions in each block. The 25-day-old seedlings were transplanted in the main field in October 2015. Plants were transplanted at 60 × 45 cm spacing. No fungicide or insecticide was used during the entire cropping period. Observations of early blight incidence were taken in March 2016. The percent disease index was calculated as given by Pandey *et al.,* (2003).

Screening for resistance to early blight under artificial conditions

Seven tomato genotypes that have shown highly resistant/moderately resistant reaction were taken for artificial screening under screen house conditions. Seeds of the tomato accessions (EC705445, EC0013112, EC0026104, EC699717, EC695040, EC000586, EC0111086 and Kashi Amrit) were sown in sterile potting mixture (soil: sand: well decomposed farmyard manure at 2:1:1).

After 25 days, seedlings were transplanted into 30-cm-diameter pots filled with the potting mix. 45 days after transplanting, the plants were spray-inoculated with virulent *Alternaria solani* isolate UP-7 (Murugan *et al.,* 2016). The experiment was laid out in a completely randomized design (CRD) with three replications. Artificial inoculation and disease scoring were done as per the standard procedure given by Yerasu *et al.,* (2019). On the basis of PDI values, the genotypes were categorized into highly resistant (HR) (0–5%), resistant (R) (5.1–12.0%), moderately resistant (MR) (12.1–25.0%), moderately susceptible (MS) (25.1–50.0%), susceptible (S) (50.1–75.0%), and highly susceptible (HS) (> 75%).

Statistical analysis

Analysis of augmented design for reaction of the tomato genotypes to early blight disease was done using R package version 0.1.2 (Aravind *et al.,* 2020). Analyses of variance (ANOVA) and multiple comparison test based on Tukey's honestly significant difference (HSD) of PDI results from artificial screening were done with the Agricolae package in computing environment R v 30102 (R Core Team 2012).

Results and Discussion

There was a significant variation in the reaction for early blight expressed as adjusted mean of percent disease index (PDI) among the genotypes under field conditions. EC705445 showed highly resistant reaction followed by EC0027336, EC0114504 and EC0027932 resistance reaction. Fourteen genotypes gave moderately resistance reaction (Table 2). All other genotypes gave moderately susceptible to highly susceptible reaction. All the five checks included in the experiment gave highly susceptible reaction to the disease. Evaluation of plant material under natural epiphytotic conditions for disease resistance improves the reliability of the results (Foolad *et al.,* 2000) and it facilitates screening of a large number of genotypes at the same time under natural conditions. In northern part of the India, weather conditions after winter season favors early blight incidence as soil moisture due to westerlies/irrigation and rising temperature creates favorable conditions for early blight incidence in tomato (Yerasu *et al.,* 2019). Although field screening is the most common method of screening, it has its own limitations like difficulty in maintaining treatment uniformity, confounding effects of other foliar diseases etc which may reduce the effectiveness and reliability of field screening (Foolad *et al.,* 2008).

Table.1 List of tomato germplasm evaluated for early blight resistance under field conditions

S.No	Accessions	S.No	Accessions	S.No	Accessions	S.No	Accessions	S.No	Accessions
1	EC715389	36	EC752618	71	EC0004304	106	EC0009018	141	EC0035392
2	EC695437	37	EC699714	72	EC0003104	107	EC0004201	142	EC0036972
3	EC715399	38	EC721958	73	EC0006148	108	EC0006486	143	EC0035391
4	EC715386	39	EC721954	74	EC0006050	109	EC0004553	144	EC0035461
5	EC715384	40	EC759992	75	EC0006504	110	EC0003216	145	EC0035358
6	EC760007	41	EC760004	76	EC0004958	111	EC0002669	146	EC0035386
7	EC753220	42	EC760088	77	EC0004303	112	EC0003208	147	EC0035227
8	EC759279	43	EC721959	78	EC0002645	113	EC0004522	148	EC0035237
9	EC759290	44	EC752616	79	EC0002689	114	EC0002640	149	EC0035360
10	EC759272	45	EC721963	80	EC0003215	115	EC0000490	150	EC0035420
11	EC705446	46	EC752617	81	EC0002694	116	EC0002635	151	EC0096406
12	EC699710	47	EC752612	82	EC759252	117	EC0002598	152	EC0054729
13	EC753230	48	EC760002	83	EC759259	118	EC000360-2	153	EC0052021
14	**EC695040**	49	EC752610	84	EC759264	119	EC0000482	154	EC0050362
15	EC695045	50	EC705444	85	EC759250	120	EC0000491	155	EC0037163
16	EC715385	51	**EC705445**	86	EC759251	121	EC0000493	156	EC0042595
17	**EC699717**	52	EC695044	87	EC759262	122	EC0002644	157	EC0039976
18	EC705442	53	EC705440	88	EC759271	123	EC0006202	158	EC0050360
19	EC700931	54	EC759288	89	EC759283	124	EC0027950	159	EC0050358
20	EC715391	55	EC759273	90	EC759263	125	EC0027911	160	**EC0111086**
21	EC715398	56	EC759285	91	EC759244	126	EC0019720	161	EC0041067
22	EC760009	57	EC759272	92	EC759284	127	EC0027976	162	EC0086501
23	EC760006	58	EC759286	93	EC759255	128	EC0027961	163	EC0114504
24	EC753232	59	EC759280	94	EC759269	129	EC0027960	164	EC0037250
25	EC760012	60	EC 007282	95	EC759268	130	EC0027941	165	EC0037183
26	EC738041	61	EC 016655	96	EC759267	131	EC0031824	166	EC0054644
27	EC753231	62	EC 006596	97	EC759248	132	EC0027251	167	EC0042596
28	EC699716	63	EC 013902	98	EC759247	133	EC27932-P2	168	EC0041278
29	EC753218	64	EC 007210	99	EC759261	134	EC0026105	169	EC 0037267
30	EC738050	65	EC 009148	100	EC759246	135	EC0017980	170	EC 0057440
31	EC721961	66	EC 009149	101	EC759276	136	EC0026104	171	EC 0035232
32	EC699715	67	EC 007875	102	EC 020695	137	EC0027986	172	EC 0035511
33	EC721955	68	EC 007916	103	EC 007317	138	EC0027932	173	EC 0037211
34	EC759998	69	EC 007262	104	EC0052-8	139	EC127171-P13	174	EC 0035527
35	EC759991	70	EC 004708	105	EC 014167	140	EC0003539	175	EC 0035323
176	EC0035376	211	EC129606PP	246	EC0163615	281	EC753219	316	EC699717
177	EC0035338	212	EC0031515	247	EC0023528	282	EC752611	317	EC0086444
178	EC0035374	213	EC0027917	248	EC0009016	283	EC0117399	318	EC0018841
179	EC033276	214	EC0035514	249	EC0037137	284	EC759253	319	EC0103608
180	EC0233986	215	EC0036888	250	EC0035393	285	EC759248	320	EC595042
181	EC035236	216	EC0042555	251	EC0027336	286	EC753223	321	EC0118295
182	EC036304	217	EC0042885	252	EC0033878	287	EC0041028	322	EC0104393
183	EC032375	218	EC0042592	253	EC0027938	288	EC0041067	323	EC0037183
184	EC032019	219	EC0043269	254	EC759277	289	EC0099927	324	EC715396
185	EC032276	220	EC0042295	255	EC758055	290	EC0086501	325	EC721960
186	EC0032265	221	EC0041272	256	EC759278	291	EC0103811	326	EC695040
187	EC0031340	222	EC0048321	257	EC759242	292	EC0114146	327	EC715393
188	EC0029919	223	EC0082404	258	EC759269	293	EC0050347	328	EC715388

189	EC0163912	224	EC0031767	259	EC759251	294	EC0089252	329	EC0927283
190	EC0007939	225	EC0027945	260	EC759247	295	EC038811A	330	EC0116872
191	EC0005863	226	EC0030313	261	EC759260	296	EC0118292	331	EC0015127
192	EC0000276	227	EC0037218	262	EC759266	297	EC0159959	332	EC0035413
193	EC0035273	228	EC0028969	263	EC759243	298	EC0114904	333	EC759263
194	EC0018841	229	EC038811-A	264	EC759275	299	EC0104211	334	EC721963
195	EC0012659	230	EC0032240	265	EC759256	300	EC0113820	335	EC759264
196	EC0016790	231	EC0032373	266	EC759250	301	EC0118282	336	EC002486
197	EC0161652	232	EC0125557	267	EC759245	302	EC0096406	337	EC076733
198	EC0016652	233	EC0145117	268	EC7532217	303	EC0086500	338	EC0114495
199	EC0004267	234	EC0128968	269	EC753229	304	EC0130046	339	EC759996
200	EC0110116	235	EC0128969	270	EC759265	305	EC9919127	340	EC699715
201	EC0054893	236	EC0119200	271	EC759265	306	EC0004267	341	EC752620
202	EC0075020	237	EC0141827	272	EC759257	307	EC0095252	342	EC705443
203	EC0128254	238	EC0027964	273	EC004302	308	EC759264	343	EC695038
204	EC0054722	239	EC0016786	274	EC004300	309	EC0119110	344	EC699713
205	EC0036976	240	EC0122963	275	EC002528	310	EC0108764	345	EC705436
206	EC0130046	241	EC0119128	276	EC035503	311	EC0114137	346	EC721957
207	EC0137324	242	EC0000232	277	EC043276	312	EC0096403	347	EC006594
208	EC0129608	243	EC0001758	278	EC037183	313	EC0103614	348	EC0035413
209	EC0128769	244	EC0013112	279	EC0026104	314	EC127171PI3	349	EC0016655
210	EC0130165	245	EC0002486	280	EC039406	315	EC0115062	350	EC0000368

Note - accessions in bold front were taken for artificial screening

Table.2 Genotypes recorded less PDI (≤25) under field conditions

S.No	Genotype	Adjusted mean of Percent disease index	Disease reaction
1	EC705445	0.86	HR
2	EC0027336	6.24	R
3	EC0114504	9.34	R
4	EC0027932	10.16	R
5	EC0111086	13.67	MR
6	EC0000276	14.16	MR
7	EC0004302	16.24	MR
8	EC0004300	16.24	MR
9	EC0005863	17.01	MR
10	EC0013112	19.01	MR
11	EC0002644	20.16	MR
12	EC0026104	20.16	MR
13	EC695040	21.07	MR
14	EC699717	21.07	MR
15	EC0033878	21.24	MR
16	EC0050360	21.67	MR
17	EC0037183	21.67	MR
18	EC0000232	24.01	MR

HR highly resistant, *R* resistant *MR* moderately resistant

Table.3 Grouping of genotypes (2012–2013) based on Tukey's HSD for early blight resistance reaction of 70-day-old plants under artificial inoculation conditions

S.No	Genotype	Percent disease index	Disease reaction
1	Kashi Amrit	87.5[a]	HS
2	EC0013112	86.67[ab]	HS
3	EC0026104	76.39[abc]	HS
4	EC705445	63.05[abc]	S
5	EC699717	57.71 [abc]	S
6	EC695040	54.44[abc]	S
7	EC0005863	49.57[bc]	MS
8	EC0111086	45.56[c]	MS

Means with different superscript letters are statistically different at $p < 0.05$ based on Tukey's HSD test *HS* highly susceptible, *S* susceptible, *MS* moderately susceptible

Results of field evaluation can be used in identifying susceptible lines. Genotypes that were showing resistant reaction under field conditions further screened under screen house conditions as the environment can be controlled, it provides a conducive, uniform and repeatable results and removes confounding effects of other diseases. During screen house screening, plants were kept under high relative humidity (RH) (90 ± 5%). After 10 days of spray inoculation the plants were scored for early blight disease and the percent disease index was calculated (PDI) following Pandey *et al.,* (2003). None of the tomato genotypes gave highly resistant or resistant or moderately resistant reaction (Table 3). Accession EC699717 included in the artificial screening has *Mi 1.2* gene in it (Yearsu *et al.,* 2019). *Mi 1.2* offers resistance against the three most damaging root knot nematode species *viz.*, *Meloidogyne incognita*, *M. arenaria*, and *M. javanica* (Seah *et al.,* 2004).

In any crop improvemet progrmme Plant Genetic Resources (PGR) forms the basis. Thus PGR management including augmentation, characterization, utilization etc is important. Screening of available Plant Genetic Resources (PGR) under natural epiphytotic conditions is highly required especially for diseases like early blight in tomato, where reliable resistance source for commercial resistance breeding is not at available.

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References

Adhikari, P., Oh, Y. and Panthee, D. 2017. Current status of early blight resistance in tomato: an update International Journal of Molecular Science 18(10): 2019.

Aravind, J., Mukesh Sankar, S., Wankhede, D. P., and Kaur, V. 2020. Augmented RCBD: Analysis of Augmented Randomised Complete Block Designs. R package version 0.1.2, https://aravind-j.github.io/augmentedRCBD/https://cran.r project.org/package=augmented RCBD.

Barksdale, T. H. and Stoner, A. K. 1977. Study of inheritance of tomato early blight resistance.

Plant Disease Reports 61: 63–70.
Chaerani, R. and Voorrips, R. E. 2007. Tomato early blight (*Alternaria solani*): the pathogen, genetics, and breeding for resistance. Journal of General Plant Pathology. 72:335–347
Datar, V. V. and Mayee, C. D. 1981. Assessment of losses in tomato yield due to early blight. Indian Phytopathology. 34:191–195.
Foolad, M. R., Ntahimpera, N., Christ, B. J. and Lin, J. Y. 2000. Comparison of field, green-house, and detached-leaflet evaluations of tomato germ plasm for early blight resistance. Plant Disease. 84:967–972.
Foolad, M. R., Merk, H. L. and Ashrafi, H. 2008. Genetics, genomics and breeding of late blight and early blight resistance in tomato. Critical Reviews in Plant Sciences. 27: 75–107.
Jayaraj, J. and Punja, Z. K. 2007. Combined expression of chitinase and lipid transfer protein genes in transgenic carrot plants enhances resistance to foliar fungal pathogens. Plant Cell Report 26:1539–1546.
Mathur, N. and Shekawat, R. 1986. Chemical control of early blight in kharif sown tomato. Indian Journal of Mycology and Plant Pathology.16:235–240.
Murugan, L., Venkataravanappa, V., Saha, S., Rai, A. B., Tripathi, S., Rai, R. K., Pandey, A. K. and Chowdappa, P. 2016. Morphological, pathogenic and molecular characterizations of Alternaria species causing early blight of tomato in Northern India. Proceedings of National Academy of Sciences India Section B Biological Sciences. 86(2):325–330.
Nash, A. F. and Gardner, R. G. 1988. Heritability of tomato early blight resistance derived from *Lycopersicon hirsutum* PI 126445. Journal of American Society of Horticultural Science. 113: 264–268.
Nasr, E. M. 2018. Identification of *Ulocladium atrum* causing potato leaf blight in Iran. Phytopathologia Mediterranean. 2018b; 57: 112–114.
Pandey, K. K., Pandey, P. K., Kallo, G. and Banarjee, M. K. 2003. Resistance to early blight of tomato with respect to various parameters of disease epidemics. Journal of General Plant Pathology. 69:364–371.
R Core Team (2012) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-proje ct.org/.versi on3.1.2.31-10-2014s
Seah, S., Yaghoobi, J., Rossi, M., Gleason, C. A. and Williamson, V. M. 2004. The nematode-resistance gene, Mi-1, is associated with an inverted chromosomal segment in susceptible compared to resistant tomato. Theory Applied Genetics. 108:1635–1642.
Singh, V. K., Singh, A. K. and Kumar, A. 2017. Disease management of tomato through PGPB: current trends and future perspective. 3 Biotech. 7:255.
Yerasu, S. R., Murugan, L., Halder, H., Prasanna, H. C., Singh, A. and Singh, B. 2019. Screening Tomato Genotypes for Resistance to Early Blight and American Serpentine Leafminer. Horticulture, Environment, and Biotechnology. 60:427-433.
Yerasu, S. R., Sellaperumal, C., Gowda, M. T., Mishara, P., Tiwari, S. K., Devi, C. and Pandey, S. 2019. Characterization of Tomato Germplasm for Root Knot Nematode Resistance with the help of Mi23 Marker. Indian Journal of Nematology 50(2).
Yerasu, S. R., Murugan, L., Prasanna, H. C. and Singh, A. 2019. Screening tomato genotypes for resistance against collar rot disease caused by *Alternaria solani* Sorauer. Vegetable Science. 46 (1&2): 83-87.

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