Indian J. Pl. Genet. Resources 10(2): 197-204, 1997

RESISTANCE OF *LYCOPERSICON* GERMPLASM TO EARLY BLIGHT DISEASE

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In a study to find out the reaction of certain tomato genotypes to early blight, it was found that the genotypes IHR 1939, IHR 1816, IHR 1954 and IHR 1968 showed resistance at both seedling and adult plant stages. IHR 1817 had relatively low levels of resistance at seedling stage. Of these five resistant lines, IHR 1939 derived from *L. pimpinellifolium* displayed higher level of early blight resistance at both seedling (42.91 per cent CDI) and adult (37.86 per cent CDI) plant stages.

Key words : Tomato, *Lycopersicon esculentum*, resistance, early blight disease

Tomato (*Lycopersicon esculentum* Mill), one of the most important vegetable crops grown in many parts of the world, is infested by fungi, bacteria, viruses, nematodes and insects. One of the most destructive diseases of tomato in tropical and sub-tropical regions of India is early blight caused by *Alternaria solani* Sorauer. The disease severity affects the **kharif** season (June-September) crop., grown commonly in the states of Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh and West Bengal. High humidity and ineffective fungicides due to continuous heavy downpour complement disease severity. Even under irrigated conditions, susceptible F_1 hybrids can be severely damaged by early blight incurring a loss of about 50 to 80 per cent (Mathur and Shekhawat, 1986). Deploying disease resistant cultivars is preferred because it is considered to be the most economical from the growers point of view. Success of such an approach depends on the identification of stable resistant sources on one hand on its subsequent utilization in breeding on the other. Hence, a study was undertaken to find out genotypes resistant to the early blight disease.

Table 1. Number of tomato genotypes used in screening against *A. solani*

Sl.No.	Accession Number	Species/EC number/Donor No.	Sources
1	IHR 1949	*L. peruvianum* EC308447	AVRDC, Taiwan
2	IHR 1939	*L. pimpinellifolium* L4394	NBPGR, New Delhi
3	IHR 1816	*L. esculentum* NCEBR-1	Beltsville
4	IHR 1954	*L.e.* var. *cerasiform* L128	AVRDC, Taiwan
5	IHR 1946	*L. esculentum* L594	AVRDC, Taiwan
6	IHR 1946	*L. hirsutum* L3684	AVRDC, Taiwan
7	IHR 1972	*L. peruvianum* L734	AVRDC, Taiwan
8	IHR 1945	*L. hirsutum* L3683	AVRDC, Taiwan
9	IHR 1948	*L. peruvianum* L671	AVRDC, Taiwan
10	IHR 1973	*L. hirsutum* L1042	AVRDC, Taiwan
11	IHR 1966	*L. pumpinellifolium* L101	AVRDC, Taiwan
12	IHR 1817	*L. esculentum* NCEBR-2	Beltsville
13	IHR 1970	*L. hirsutum* L634	AVRDC, Taiwan
14	IHR 1961	*L. peruvianum* EC312339	AVRDC, Taiwan
15	IHR 1783	PI 128650	Royal Sluis, Netherlands
16	IHR 1952	*L.e.* var. *cerasiforme* L130	AVDC, Taiwan
17	IHR 1940	*L. pimpinellifolium* L4396	AVRDC, Taiwan
18	IHR 1818	*L. esculentum* EC23243	Beltsville
19	IHR 1944	*L. hirsutum* L3234	AVRDC, Taiwan
20	IHR 1950	*L. peruvianum* L438	AVRDC, Taiwan
21	IHR 1943	*L. hirsutum* L733	AVRDC, Taiwan
22	IHR 1749	PI 182844	AVRDC, Taiwan
23	IHR 1873	*L. esculentum*	Peto Seeds
24	IHR 1969	*L. peruvianum* L631	AVRDC, Taiwan
25	BWR 1	*L. esculentum*	IIHR, Bangalore
26	IHR 1967	*L. esculentum* L165	AVRDC, Taiwan
27	IHR 1974	*L. cheesmani* L 1696	AVDC, Taiwan
28	IHR 1820	*L. esculentum* EC232433	Beltsville
29	IHR 1951	*L.e.* var. *cerasiforme* L3682	AVRDC, Taiwan
30	IHR 1953	*L. e.* var. *cerasiforme* L129	AVRDC, Taiwan
31	IHR 1955	*L. e.* var. *cerasiforme* L131	AVRDC, Taiwan
32	IHR 1950	*L. peruvianum* L438	AVRDC, Taiwan
33	IHR 1880	*L.e.* var *cerasiforme*	NBPGR, New Delhi
34	IHR 1975	*L. esculentum* L1951	AVRDC, Taiwan
35	IHR 1941	*L. pimpinellifolium* L674	AVRDC, Taiwan
36	Pusa Ruby	*L esculentum*	IARI, New Delhi
37	IHR 1627	*L. esculentum* Pl182778	NBPGR, New Delhi
38	Arka Saurabh	*L. esculentum*	IIHR, Bangalore
39	IHR 1956	*L. e.* var. *cerasiforme* L132	AVRDC, Taiwan
40	IHR 1942	*L. pimpinellifolium* L679	AVRDC, Taiwan
41	IHR 1951	*L. cnessmani* L3682	AVRDC, Taiwan
42	IHR 1947	*L. peruvianum* L669	AVRDC, Taiwan
43	IHR 1842	*L. esculentum* Manikit	NBPGR, New Delhi
44	IHR 1746	P 118241	AVRDC, Taiwan
45	IHR 1958	*L. pennelli* L132	AVRDC, Taiwan

MATERIAL AND METHODS

The material used in the present investigation comprised 45 tomato genotypes which include wild and related species of *Lycopersicon.* They were collected from the germplasm respository maintained at the Division of Vegetable Crops, Indian Institute of Horticultural Research, Hessarghatta, Bangalore. The list of the genotypes studied are presented in Table 1. Screening was done independently at seedling and adult plant stages during November 1991 to January 1992, and were further confirmed in **kharif** (June-September 1992) reason. For screening at seedling stage, the genotypes were sown in seed pans filled with pot mixture drenched with 0.2 per cent Captaf before sowing to protect the seedlings from soil borne pathogens. Plants were inoculated with spore suspension of *A. solani* at the 3- leaf stage (one month old) and again after 3 days to meet sufficient inoculum load for the infection to take place inside a polythene cage with high humidity by maintaining water continuously in the trenches. For screening at adult plant stage, the seeds of each genotype was sown in a nursery beds (6m × 1m, 20cm ht). Transplanting was done when the seedlings were 40 days old, at a spacing of 90 cm between and 30 cm within the rows. The suspectible cultivars Arka Saurabh and Pusa Ruby were planted as infector rows along the border as well as after every fifth row. The pathogen inoculation was done 30 days after transplanting with a mechanical sprayer 3 to 4 hr (5-6 pm) before darkness. The severity of the damage was estimated on all the plants of each accession using three disease parameters viz., number of lesions per leaflet, lesion size and per cent defoliation. Five leaves were drawn randomly from each plant to count the number of lesions. Five lesions were selected randomly to estimate the diameter from each plant. Per cent defoliation was estimated from each plant using the modified method suggested by Horsfall ad Barratt (1945).

Score	Description		
	Number of lesions per leaflet	Lesion diameter	Per cent defoliation
1	Symptomless leaflet	No lesions	0-10
2	1 or 2 (< 10% leaf area was necrotic)	< 0.2 cm	11-25
3	Numerous lesions (10-25% area was necrotic)	0.2 to 0.5 cm	26-50
4	< 50% leaflet area covered by necrotic spots (26-49% leaf area was necrotic)	> 0.5 to 0.75 cm	51-75
5	50-100% area was necrotic	> 0.75cm	> 75

While selecting the genotypes as resistance to early blight, a cumulative disease index (CDI) was calculated using the formula :

$$CDI = \frac{\sum \text{of individual ratings of the three disease parameters}}{\text{Maximum disease score} \times \text{Number of leaves sampled}} \times 100$$

The CDI of 45 genotypes screened were compared statistically using Duncan's Multiple Range Test (Gomez ad Gomez, 1976).

RESULTS AND DISCUSSION

The results were based on pure spray of inoculum which consisted only of *A. solani* and was confirmed under microscope. A wide range in the reaction of different genotypes to *A. solani* was observed, but none of the genotypes exhibited complete resistant or near immunity. Complete resistance or near immunity was rarely observed in foliar diseases (Vanderplank, 1963) and in tomato, no immunity to early blight is known (Barksdale, 1971). Varying levels of resistance to early blight have been commonly observed among tomato genotypes (Andrus *et al.*, 1942). Andrus (1953) pointed out that low levels of resistance to certain disorders were often sufficient to mean the difference between a poor and a good crop, since a delay of a few hours in the build-up of inoculum can make the difference between susceptible and resistant plants with a market crop.

Among the 45 accessions of wild and related species of *L. esculuntum* tested for resistance against *A. solani*, the following 12 accessions viz., IHR 1949 (*L. peruvianum* EC 308447), IHR 1939 (*L. pimpinellifolium* L 4394), IHR 1816 (*L. esculentum* NCE BR-1), IHR 1954 (*L. esculentum* var. *cerasiforme* L 128), IHR 1968 (*L. esculentum* L594), IHR 1946 (*L. hirsutum* L3684), IHR 1972 (*L. peruvianum* L 734), IHR 1945 (*L. hirsutum* 13683), IHR 1948 (*L. puruvianum* L671), IHR 1973 (*L. hirsutum* L 1082), IHR 1966 (*L. pimpinellifolium* L 101) and IHR 1817 (NEBR-2) possessed resistance to leaf lesions of early blight at seedlings stage. While 11 accessions viz., IHR 1816 (*L. eseulentum* NCEBR-1), IHR 1961 (*L. peruvianum* EC 312339), IHR 1973 (*L. hirsutum* L1042), IHR 1954 (*L. esculentum* var. *cerasiforme* L128), IHR 1939 (*L. pimpinellifolium* L4394), IHR 1817 (*L. esculentum* NCEBR-2), IHR 1945 (*L. hirsutum* L3683), IHR 1968 (*L. esculentum* L594), IHR 1949 (*L. peruvianum* EC 308447), IHR 1948 (*L. peruvianum* L671) and IHR 1969 (*L. peruvianum* L631) exhibited resistance at adult plant stages. Resistance to early blight at both seedling and adult plant stages was noticed in IHR 1939, IHR 1816, IHR 1954 and IHR 1968. IHR 1817 had relatively low levels of resistance at seedling stage. The resistant line IHR 1939 derived from *L. pimpinellifolium* displayed higher level of early blight resistance at both seedling (42.91 per cent CDI) and adult (37.86 per cent CDI) plant stages. In the above mentioned five resistant lines, the observed levels of resistance helped to maintain foliage cover over the fruits until harvest even when inoculum potential was high, while susceptible lines were defoliated as and when they were infected, eventually exposing the fruits also to the pathogens.

Table 2. Reaction of tomato genotypes against *A. solani* at seedling stage

Sl. No.	Accession Number	Percent of disease index (PDI %)			Cumulative Disease Index (%)*
		Lesion No.	Lesion Size	Defoliation	
1	IHR 1949	42.28	44.59	26.55	42.91 k
2	IHR 1939	42.28	43.83	39.21	42.96 k
3	IHR 1816	42.65	49.58	39.21	45.91 jk
4	IHR 1954	46.87	48.37	39.21	47.34 ijk
5	IHR 1968	46.87	48.37	39.21	47.36 ijk
6	IHR 1946	48.08	48.48	50.75	48.37 hijk
7	IHR 1972	51.10	50.34	50.74	50.75 ghijk
8	IHR 1945	49.80	53.70	39.21	51.71 fghijk
9	IHR 1948	52.33	52.27	50.74	52.31 efghijk
10	IHR 1973	51.92	53.04	50.74	52.49 efghijk
11	IHR 1966	51.32	54.31	63.41	53.16 efghijk
12	IHR 1817	52.33	56.33	50.74	54.22 defghij
13	IHR 1970	55.91	60.64	39.21	57.58 cdefghij
14	IHR 1961	55.25	59.71	50.74	57.67 cdefghij
15	IHR 1783	54.32	61.99	63.44	58.63 cdefghi
16	IHR 1952	60.50	61.11	26.55	59.89 cdefgh
18	IHR 1818	59.71	62.69	50.74	60.93 cdefg
19	IHR 1944	61.72	60.17	63.41	61.10 cdefg
20	IHR 1950	55.96	66.86	63.41	61.23 cdefg
21	IHR 1943	61.52	61.11	50.75	61.23 cdefg
22	IHR 1749	60.17	61.99	63.41	61.23 cdefg
23	IHR 1873	57.58	65.85	63.41	62.40 cdefg
24	IHR 1969	66.59	58.47	63.41	62.40 cdefg
25	BWR 1	63.41	61.99	63.41	63.11 bcdef
26	IHR 1967	64.94	51.18	63.41	63.11 bcdef
27	IHR 1974	65.85	62.42	31.21	63.46 bcdef
28	IHR 1820	58.47	70.32	63.41	64.11 bcde
29	IHR 1951	63.84	66.39	63.41	65.04 bcd
30	IHR 1953	63.84	66.39	63.41	65.08 bcd

(Table contd. on next page)

Sl. No.	Accession Number	Percent of disease index (PDI %)			Cumulative Disease Index (%)*
		Lesion No.	Lesion Size	Defoliation	
31	IHR 1955	66.94	65.39	39.21	65.15 bcd
32	IHR 1950	95.85	64.57	63.41	65.08 bcd
33	IHR 1880	63.84	66.31	63.41	65.41 bcd
34	IHR 1975	65.32	64.35	63.41	65.41 bcd
35	IHR 1941	67.99	64.35	50.75	65.57 bcd
36	.Pusa Ruby	65.39	65.39	63.41	65.68 bcd
37	IHR 1627	65.09	66.62	63.41	65.80 bcd
38	Arka Saurabh	65.39	65.39	63.41	65.97 bcd
39	IHR 1956	67.42	67.42	63.41	66.29 bc
40	IHR 1942	65.85	69.09	63.41	67.61 bc
41	IHR 1951	67.42	70.23	50.70	68.18 bc
42	IHR 1947	66.47	73.12	63.41	69.65 bc
43	IHR 1842	70.59	77.44	63.41	75.54 b
44	IHR 1746	89.96	89.96	89.96	89.95 a
45	IHR 1958	89.96	89.96	89.96	89.95 a

*Significant test based on Ducan's multiple range test at 5%

Table 3. Reaction of different tomato genotypes against *A. solani* at adult stage of the plant

Sl. No.	Accession Number	Per cent disease index (PDI %)			Cumulative Disease Index (%)*
		Lesion No.	Lesion size	Defoliation	
1	IHR 1816	33.43	36.85	39.21	35.94 l
2	IHR 1961	33.43	38.04	39.21	36.36 l
3	IHR 1973	33.19	41.53	26.55	36.52 l
4	IHR 1954	33.43	39.21	39.21	37.14 l
5	IHR 1939	40.96	36.85	26.55	37.86 l
6	IHR 1817	49.00	39.79	50.75	39.21 kl
7	IHR 1945	39.21	39.21	39.21	39.21 jkl
8	IHR 1968	30.64	40.38	50.75	39.21 jkl
9	IHR 1972	49.00	39.79	50.74	39.21 jkl
10	IHR 1972	46.12	42.69	50.74	39.21 jkl
11	IHR 1748	38.04	40.37	50.74	40.14 ijkl
12	IHR 1969	39.21	42.83	26.55	40.24 ijkl
13	IHR 1943	35.65	42.68	50.74	40.24 ijkl

(*Table contd. on next page*)

Sl. No.	Accession Number	Percent of disease index (PDI %)			Cumulative Disease Index (%)*
		Lesion No.	Lesion Size	Defoliation	
14	IHR 1947	40.38	40.38	39.21	40.24 ijkl
15	IHR 1946	42.68	40.38	39.21	40.24 ijkl
16	IHR 1880	38.04	40.38	50.75	40.25 ijkl
17	IHR 1873	44.98	42.69	26.55	42.39 hijk
18	IHR 1940	40.38	42.69	50.75	42.39 hijk
19	IHR 1783	46.12	40.38	39.21	43.42 jhij
20	IHR 1941	43.83	42.69	50.75	43.94 jhij
21	IHR 1875	41.54	42.69	63.41	43.94 jhij
22	IHR 1942	42.69	43.83	50.75	43.94 jhij
23	IHR 1955	43.83	42.68	50.74	43.94 jhij
24	IHR 1956	44.98	40.38	43.41	44.46 fghi
25	IHR 1952	44.99	44.98	39.21	44.46 fghi
26	IHR 1957	47.27	44.98	39.21	44.46 fghi
27	IHR 1950	46.12	44.98	50.75	46.29 fgh
28	IHR 1944	44.98	44.98	63.41	46.52 fgh
29	IHR 1970	50.74	43.83	39.21	46.53 fgh
30	IHR 1949	51.92	46.12	26.55	47.04 fgh
31	IHR 1946	50.74	43.83	50.74	47.56 efg
32	IHR 1942	49.58	46.12	50.75	48.14 efg
33	IHR 1953	49.58	51.92	63.41	49.19 def
34	IHR 1966	51.92	46.13	50.75	49.19 def
35	BWR-1	53.11	44.98	63.41	50.23 cde
36	IHR 1818	53.11	47.27	50.75	50.23 cde
37	IHR 1951	59.32	48.42	39.21	52.34 bcde
38	IHR 1820	51.92	53.12	63.41	53.42 bcd
39	Pusa Ruby	43.41	46.12	43.41	54.92 abcd
40	IHR 1958	63.41	48.42	50.74	54.92 abcd
41	Arka Saurabh	63.41	46.12	63.41	55.10 abc
42	IHR 1974	59.32	51.92	63.41	56.20 abc
43	IHR 1967	56.76	56.76	63.41	57.35 ab
44	IHR 1627	59.32	56.76	63.41	58.49 ab
45	IHR 1950	63.41	55.53	63.41	59.65 a

*Significant test based on Ducan's multiple range test at 5%

The availability of sources of resistance to early blight in wild and related species have been reported by several workers. Accessions of *L. hirsutum*, *L. peruvianum* and *L. cheesmanii* have been reported to possess resistance to

early blight (Locke, 1949; Barksdale, 1969; Gardner, 1984, 1988; Maiero *et al.*, 1990; Kalloo, 1991). Resistance to early blight has also been observed in the cultivated species, *L. esculentum*, (Andrus *et al.*, 1942; Reynald and Andrus, 1945; Lodha, 1977; Barksdale and Stoner, 1977; Kalloo and Banerjee, 1991).

The resistant lines identified in this study viz., IHR 1939, IHR 1816, IHR 1954 and IHR 1968 can be used in future breeding programme to produce F_1 tomato hybrids having resistance to early blight or can be used to isolate resistant genotypes with better yield and other morphological features from the segregating generations of the crosses involving these resistant lines.

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