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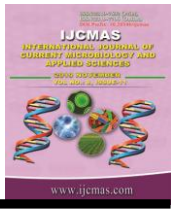

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Performance Assessment of Native Tomato Genotypes to Late Blight Disease under Natural Epiphytotics

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A B S T R A C T

A field study conducted to evaluate the native tomato genotypes for their resistance to late blight under natural epiphytotics conditions was carried out during 2017-18 and 2018-19. Twenty native tomato genotypes were collected from different tomato growing areas of Nagaland, Manipur and Arunachal Pradesh. Characteristics of tomato genotypes revealed that most of the collected genotypes were indeterminate in nature except Pusa Ruby (semi-determinate), Arka Rakshak, F_1 hybrid (determinate) and T_2 (determinate). The late blight disease severity was assessed visually on stems, leaves and fruits of all plants of each replication following scale 0-5, when total late blight infestation had occurred in the control plot. Disease severity data revealed that least PDI was recorded in T_3 (16.81) and T_{17} (35.99) whereas highest PDI was recorded in Arka Rakshak, with 89.72. This experimental result revealed that most of the genotypes (20 genotypes) reacted as highly susceptible, while T_3 (16.81 PDI) and T_{17} (35.99 PDI) was found resistant and tolerant respectively. These results clearly indicate that a good source of resistance to late blight is available in the genotype T_3 (cherry tomato). The resistant genotype thus obtained through this experiment shows a potential disease resistance trait contributor for tomato breeding against late blight disease.

Introduction

Late blight disease of tomato caused by *Phytophthora infestans* (Mont.) de Bary is devastating and wide spread in nature. It is an economically important disease of tomato worldwide including India (Son *et al.*, 2008). Worldwide losses were estimated to $170

billion annually and thus the pathogen was considered as a threat to global food security (Latijnhouwers *et al.,* 2004; Wu *et al.,* 2012). This disease can cause total destruction of all plant parts within a week or two when weather conditions are favourable (Agrios, 1997). And also could causes up to 100 % crop losses if not controlled (HCDA, 1996). Yield losses up to 79 % from late blight damage have been reported from India (Arora *et al.,* 2014; Chowdappa *et al.,* 2015). *P. infestans* has intensified its genetic variation in recent years, comprising isolates that are highly aggressive and highly virulent. Some isolates are resistant to phenylamides fungicide even (Goodwin *et al.,* 1996). In order to subdue this trait, it is imperative to explore and find durable resistance. Several commercial tomato cultivars commonly grown in Nagaland are highly susceptible to late blight disease and show considerable yield losses under disease conducive conditions. The present investigation was carried out in Nagaland for the first time to determine the level of resistance in native tomato genotypes against late blight and its possible utilization in breeding programs to develop late blight disease resistant cultivars.

Materials and Methods

Collection of tomato genotypes

Ripened fruits of 20 native tomato genotypes were collected from different tomato growing areas of Nagaland, Manipur and Arunachal Pradesh. Known susceptible hybrid (Arka Rakshak, F_1) and susceptible variety (Pusa Ruby) seeds were also collected from IIHR, Bangalore and local market, Dimapur, respectively.

Field experiment

Field experiment was conducted during the tomato growing seasons (September-January) of 2017-18 and 2018-19 at the research farm of the Department of Plant Pathology, SASRD, Nagaland University, Medziphema Campus, Nagaland. The present experiment site is located in the foothills of Nagaland and situated at 25° 45´ 45´´ North latitude and 93° 51´ 45" East longitudes at an elevation of 310 m above mean sea level. The site is in a sub-humid tropical with high humidity and moderate temperature (12-32 °C), having moderate to high rainfall (2000-3000 mm) and R.H. of 70-80 %.

Two commercial susceptible cultivars of tomato, Pusa Ruby (semi-determinate type) and Arka Rakshak, F_1 (determinate type) were used in the experiment as control check.

Seeds of 22 genotypes were sown in the nursery beds (line sowing in spacing of row to row, 8 cm and seed to seed, 1 cm and depth, 1 cm) on the second week of September and transplanted into the field on the second week of October during both years.

The field experiment was laid out in a randomized block design (RBD) with three replications (Gomez and Gomez 1984). Each plot was 1.95 m x 2.0 m (raised plot) with three rows. Each row was spaced 65 cm apart. The distance from plot to plot was 50 cm and from plant to plant 50 cm. Four plants per row and 12 plants per plot were maintained. Common cultural practices were followed during the cropping period.

Fruit yield

The yield of ripened fruits harvested at different dates from all plants was computed and their average per plant was noted in gram.

Disease severity

The disease severity was assessed visually on stems, leaves and fruits of all plants of each

replication following scale 0-5 (Irzhansky and Cohen, 2006; table.1) when total late blight infestation had occurred in the control plot under natural epiphytotics conditions. The severity grades were converted into percentage disease index (PDI) for analysis (Wheeler, 1969).

PDI = (Sum of numerical rating / No. of plant scored x maximum score in scale) x 100.

Statistical analysis

Analysis of variance (ANOVA) was performed using the WASP 2.0 (WebAgrilStatPackage) software. None of the data was transformed.

Results and Discussion

Characterization of tomato genotypes

Characterization of 22 tomato genotypes and their collection locations are mentioned in table 2. Result revealed that most of the collected genotypes were indeterminate in nature except Pusa Ruby (semi-determinate), Arka Rakshak, F_1 hybrid (determinate) and T_2 (determinate).

Fruit shape of collected genotepes were oblong oval (Arka Rakshak F_1), flattish round (Pusa Ruby), small round cherry type (T_2, T_3, T_4, T_9, T_{16}, T_{17}, T_{18}, T_{19} and T_{20}), round medium size (T_5), plum type (T_6, T_{10}, T_{11} and T_{14}), pointed small grape type (T_7), small round (T_8, T_{12}, T_{15}), round (T_{13}) and Heirloom (T_{21}).

Various research workers collected and characterized different genotypes of tomato, genotypes with spherical, smooth fruit especially John Bear, Main Crop, Sunshine, Victory and Matchless (Bondartzeva, 1926), which were reported to possess resistance to late blight of tomato. Yimchunger *et al.*, (2018) also recorded different shapes of cherry tomato from Nagaland. They reported that shape among the traits like round, oblong, heart shape was noticed in different genotypes. They also mentioned that variations in different shape of fruit are influenced by the genetic makeup of the genotype.

Fruit yield

The yield of ripened fruits harvested at different dates from all plants was computed and their average per plant was recorded in gram. The data concerning to yield of tomato genotypes is depicted in table 3.

The data revealed that Arka Rakshak, F_1 hybrid recorded highest yield (3433.55 g plant^{-1} and 105.65 t ha^{-1}) followed by T_5 (645.35 g plant^{-1} and 19.85 t ha^{-1}) and T_{21} (628.61 g plant^{-1} and 19.34 t ha^{-1}). The lowest yield was recorded in T_{19} with 268.15 g plant^{-1} and 8.25 t ha^{-1}.

These results are in conformity with the findings of Swaroop and Suryanarayana (2005), Ahmed *et al.*, (2007), Doreswamy *et al.*, (2011), Dar and Sharma (2011) and Narolia *et al.*, (2012). Bhati, (2017) also evaluated tomato genotypes for growth, yield and quality traits under foothills condition of Nagaland. It is evident from this study that there was significant difference in yield attributes among various genotypes.

It was revealed from this study that yield per hectare profoundly affected by the genotypes. Maximum yield was recorded in genotype of TODVAR-8 (46.62 t ha^{-1}) followed by TODVAR-1 (33.14 t ha^{-1}). The minimum yield was recorded by genotype H-86 (12.41 t ha^{-1}).

Table.1 Rating scale (0-5) for the assessment of late blight disease severity in tomato

Rating	PDI	Description	Reaction
0	0	No visible symptoms apparent.	Immune
1	0.01-10	A few minute lesions to about 10 % of the total leaf area is blighted and usually confined to the 2 bottom leaves.	Highly resistant
2	10.01-25	Leaves on about 25 % of the total plant area are infected.	Resistant
3	25.01-40	Leaves on about 50 % of the total plant area are infected.	Tolerant
4	41.01-60	Leaves on about 75 % of the total plant area are infected.	Susceptible
5	> 60.01	Leaves on whole plant are blighted and plant is dead.	Highly Susceptible

Table.2 Characterization of tomato genotypes and their collection location

Genotypes Code	Type	Fruit type	Growth habits	Collected from	District	State
T_0	Arka Rakshak, F_1 hybrid	Oblong oval	Determinate	IIHR	Bangalore	Karnataka
T_1	Tomato cv. Pusa Ruby	Flattish round	Semi-determinate	Local market	Dimapur	Nagaland
T_2	Cherry tomato	Small round	Determinate	Horticulture farm, SASRD, Medziphema	Dimapur	Nagaland
T_3	Cherry tomato	Small round	Indeterminate	Near C.V. Raman Hostel, SASRD, Medziphema	Dimapur	Nagaland
T_4	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Kohima town	Kohima	Nagaland
T_5	Tomato	Round medium size	Indeterminate	Daily vegetable market, Risethsi	Kiphre	Nagaland
T_6	Tomato	Plum type	Indeterminate	Daily vegetable market, Merema	Kohima	Nagaland
T_7	Tomato	Pointed small Grape type	Indeterminate	Daily vegetable market, Phekerkriema	Kohima	Nagaland
T_8	Tomato	Small round	Indeterminate	Daily vegetable market, Merema	Kohima	Nagaland
T_9	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Tsiesema	Kohima	Nagaland
T_{10}	Tomato	Plum type	Indeterminate	Daily vegetable market, Wokha town	Wokha	Nagaland

T_{11}	Tomato	Plum type	Indeterminate	Daily vegetable market, Pfutsero	Phek	Nagaland
T_{12}	Tomato	Small round	Indeterminate	Daily vegetable market, Wokha town	Wokha	Nagaland
T_{13}	Tomato	Round	Indeterminate	Daily vegetable market, Pfutsero	Phek	Nagaland
T_{14}	Tomato	Plum type	Indeterminate	Daily vegetable market, Kohima town	Kohima	Nagaland
T_{15}	Tomato	Small round	Indeterminate	Daily vegetable market, Kohima town	Kohima	Nagaland
T_{16}	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Kohima town	Kohima	Nagaland
T_{17}	Cherry tomato	Small round	Indeterminate	Daily vegetable market, D' sector, Itanagar	Papum Pare	Arunachal Pradesh
T_{18}	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Keishamthong	Imphal West	Manipur
T_{19}	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Moa gate	Senapati	Manipur
T_{20}	Cherry tomato	Small round	Indeterminate	Daily vegetable market, Pisum Oinam Leikai	Imphal West	Manipur
T_{21}	Tomato	Heirloom	Indeterminate	Daily vegetable market, Risethsi	Kiphre	Nagaland

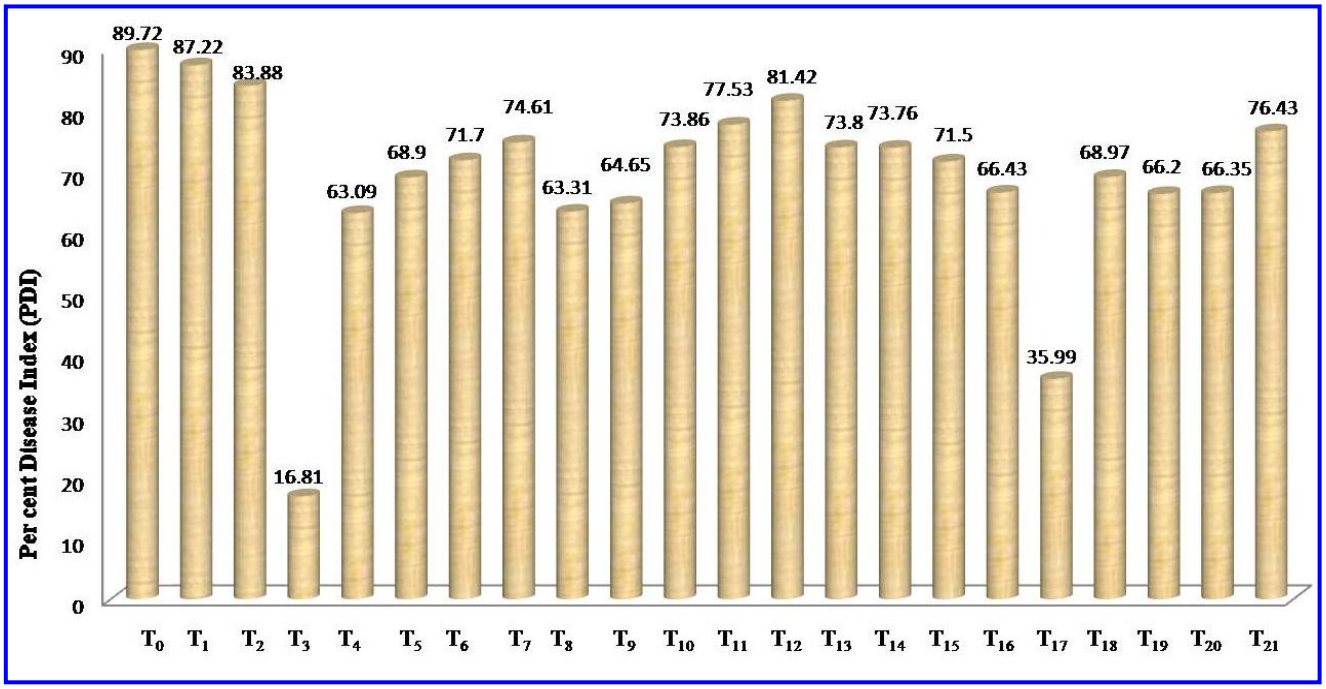
Table.3 Late blight disease severity, disease reaction and fruit yield of tomato genotypes under natural epiphytotics conditions

Genotypes	Disease severity at 124 DAS (PDI)				Fruit yield (g plant^{-1})			Calculated Fruit yield (t ha^{-1})		
	2017-18	2018-19	Pooled	Disease reaction	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_0 Arka Rakshak F_1 (Control)	92.22	87.22	89.72	**HS**	3450.44	3416.67	3433.55	106.17	105.13	105.65
T_1 Pusa Ruby (Control)	84.44	90.00	87.22	**HS**	275.56	271.33	273.44	08.48	08.35	08.41
T_2	88.88	78.89	83.88	**HS**	327.50	276.67	302.08	10.08	08.51	09.29
T_3	22.65	10.98	16.81	**R**	329.50	256.00	292.75	10.14	07.88	09.01
T_4	47.01	79.18	63.09	**HS**	286.67	311.67	299.17	08.82	09.59	09.20
T_5	53.87	83.94	68.90	**HS**	634.03	656.67	645.35	19.51	20.20	19.85
T_6	55.44	87.96	71.70	**HS**	418.73	393.33	406.03	12.88	12.10	12.49
T_7	62.75	86.48	74.61	**HS**	504.63	423.33	463.98	15.53	13.02	14.27
T_8	58.63	68.00	63.31	**HS**	541.41	446.67	494.04	16.66	13.74	15.20
T_9	50.73	78.57	64.65	**HS**	371.69	343.33	357.51	11.44	10.56	11.00
T_{10}	67.97	79.76	73.86	**HS**	514.78	463.33	489.05	15.84	14.26	15.05
T_{11}	73.96	81.11	77.53	**HS**	340.75	355.33	348.04	10.48	10.93	10.70
T_{12}	76.39	86.46	81.42	**HS**	462.86	408.67	435.76	14.24	12.57	13.40
T_{13}	67.39	80.22	73.80	**HS**	339.41	285.67	312.54	10.44	08.79	09.61
T_{14}	60.00	87.53	73.76	**HS**	300.67	291.33	296.00	09.25	08.96	09.10
T_{15}	66.07	76.94	71.50	**HS**	331.81	306.67	319.24	10.21	09.43	09.82
T_{16}	53.52	79.35	66.43	**HS**	334.61	266.67	300.64	10.29	08.20	09.24
T_{17}	38.33	33.65	35.99	**T**	238.85	325.33	282.09	07.35	10.01	08.68
T_{18}	59.61	78.34	68.97	**HS**	254.82	293.33	274.07	07.84	09.02	08.43
T_{19}	53.70	78.70	66.20	**HS**	282.97	253.33	268.15	08.71	07.79	08.25
T_{20}	51.59	81.11	66.35	**HS**	284.02	283.33	283.67	08.74	08.72	08.73
T_{21}	71.67	81.20	76.43	**HS**	693.89	563.33	628.61	21.35	17.33	19.34
SEm±	4.06	3.30	2.52	-	57.25	38.44	36.03	1.76	1.19	1.11
C.V. (%)	11.41	7.50	6.33		18.49	13.05	12.25	18.94	13.35	12.26
CD (P=0.05)	11.59	9.42	7.19	-	163.40	109.70	102.83	5.03	3.41	3.17

HR = Highly resistant, **R** = Resistant, **T** = Tolerant, **S** = Susceptible and **HS** = Highly susceptible.

Fig.1 Late blight disease reaction of tomato genotypes, T_0 (Arka Rakshak F_1, highly susceptible) and T_3 (Cherry tomato, resistance)

Fig.2 Late blight disease severity (Pooled PDI) of tomato genotypes under natural epiphytotics conditions



Disease severity

In all, 22 genotypes were screened against the late blight disease under natural epiphtotic condions in field and disease reaction was recorded at 124 DAS and presented in table 3.

The data of disease severity revealed that least PDI was recorded in T_3 (16.81) and T_{17} (35.99) whereas highest PDI was recorded in Arka Rakshak, F_1 control with 89.72 (Fig. 2).

This experimental result revealed that most of the genotypes (20 genotypes) reacted as highly susceptible, while T_3 (16.81 PDI) and T_{17} (35.99 PDI) was found resistant and tolerant respectively under natural epiphytotics conditions. These results clearly indicate that a good source of resistance to late blight is available in the genotype T_3 (Fig. 1). The resistant genotype thus obtained through this experiment shows a potential disease resistance trait contributor for tomato breeding against late blight disease.

This is in line with the findings of Islam *et al.,* (2001) who evaluated 15 advanced lines of tomato against late blight under natural epiphytotics conditions. The highest late blight severity was found in V-215 and V-52 and the lowest in V-378. Two lines were found resistant (V-259 and V-426), two moderately resistant (V-385 and V-187), two tolerant (V-422 and V-282), four moderately susceptible (V-378, V-138, V-258 and BARI-10), three were susceptible (V-330, V-201 and Manik) and two highly susceptible (V-52 and V-215), but none were found highly resistant. Khalid *et al.,* (2012) also evaluated 82 tomato genotypes against late blight using whole plant assays. None of the test genotypes were immune or highly resistant. The overall screening results indicate that TMS-2 is a good source of resistance and it can be useful for the development of tomato hybrid cultivars resistant to late blight.

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