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Research Article

Screening of Tomato Genotypes against Early blight (*Alternaria solani*) and Tomato Yellow Leaf Curl Virus in Natural Conditions

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ABSTRACT

The tomato (Solanum lycopersicum L.) is one of the most widely consumed vegetables in the world. Tomatoes are adversely affected by a multitude of infections caused by fungi, bacteria, viruses, nematodes, and abiotic factors. Early blight disease caused by Alternaria solani and Tomato leaf curl virus have been a serious problem in tomato growing areas, particularly in humid tropical, subtropical, and temperate regions of the world. 97 genotypes were screened for 2 diseases at 60 DAT. 31 showed high resistance, 32 genotypes were showed resistant, 17 showed moderately resistant no genotypes found highly resistant, 16 showed resistant reaction, 12 genotypes were found moderately resistant for the Early blight at 90 DAT. At 60 DAT, 38 genotypes showed highly resistance, 16 showed resistance reaction, 17 were moderately resistance. During 90 DAT, 17 genotypes showed highly resistance reaction, 27 were resistant, 13 were moderately resistant against leaf curl. The genotypes showed resistant reaction were TGP 60, TGP 27, TGP31, TGP77, TGP63 and TGP65 to early blight reaction. TGP96, TGP8, TGP36, TGP80, TGP88, TGP13 and TGP 21 genotypes were highly resistant reaction against leaf curl virus.

Key words: *Incidence, Resistant, Susceptible, Severity.*

INTRODUCTION

The tomato (*Solanum lycopersicum* L.) is one of the most widely consumed vegetables in the world, second only to potatoes. It belongs to the Solanaceae family and is a good source of vitamin A, vitamin C, and minerals. It is grown in almost every country and in many nations around the world. In terms of importance, it is second only to potatoes. According to FAO 2019 estimates, tomato was grown on nearly 50.30 lakh hectares worldwide, with an annual production of 180.76 million tonnes and a productivity of 35.9 t/ha.

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China is the world's leading tomato producer. Other major tomato producing countries include India, Turkey, the United States, and Egypt (FAOSTAT, 2020). Madhya Pradesh, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Telangana and Gujrat are the major tomato growing states in India.

Tomatoes are adversely affected by a multitude of infections caused by fungi, bacteria, viruses, nematodes, and abiotic factors (Balachand, 1992). Early blight disease caused by *Alternaria solani* has been a serious problem in tomato growing areas, particularly in humid tropical, subtropical, and temperate regions of the world. Early blight is caused by an airborne and soil-dwelling organism (Datar & Mayee, 1981). High temperatures and extended periods of leaf wetness from dew, rain, and cluttered plantation have been favourable for disease development. Disease symptoms appeared on all aboveground plant parts, particularly its leaves, stems, petioles, flowers, and fruits (Pandey et al., 2002). The yield loss caused by early blight has been increasing as the disease's prevalence has increased due to changes in environmental conditions. Early blight can result in a 78 percent loss in fruit yield (Singh, 1985; & Datar & Mayee, 1981).

In addition to fungal and/or bacterial diseases, there are pests and viral diseases, the most important and dangerous of which is Tomato yellow leaf curl virus (TYLCV) (Pico et al., 1996; & Moriones & Navas-Castillo, 2000). Tomato leaves curl and turn yellow as an outcome of TYLCV. The virus, which is propagate by the whitefly *Bemisia tabaci* Gennadius, is classified as a "Geminivirus" (Cohen & Harpaz, 1964; Czosnek et al., 1989; Czosnek & Laterrot, 1997; & Fauquet et al., 2003). The symptoms become much more severe as the variety is becoming more susceptible and the edapho-climatic conditions are becoming more difficult. When the virus is transmitted before flowering, harvests are almost totally none. If transmission occurs after flowering, the few flowers that form yield very small fruits, resulting in a 75 % (Anon, 1998). The first case of tomato leaf cure virus was discovered in the eastern Mediterranean, and it was later reported to be a major problem in the Middle East, African continents, south-east Asia, and southern Europe (Abhary et al., 2007). It is the tomato leaf cure virus, which is a devastating problem for tomato production in northern India, causing up to 99–100% losses and has become a major impediment for tomato producers (Singh et al., 2008).

MATERIALS AND METHODS

Experiment was conducted in Horticultural experimental block, RLBCAU, Jhansi. To screen tomato genotypes against early blight and Leaf curl disease. Nighty seven genotypes of tomato were used in this experiment which was sown in three rows with 2 replications and maintaining planting distance of 60cm between rows and 50cm between plants. Plants were individually evaluated for disease scoring in each genotypes using 0-5 disease scale as given by Pandey, 2003.

Grade	Symptoms
0	Free from infection
1	One or two necrotic spots on a few lower leaves of plants
2	A few isolated spots on leaves, covering nearly 5-10% of the surface area of the plant
3	Many spots coalesced on the leaves, covering 25% of the surface area of the plant
4	Irregular, blighted leaves and sunken lesions with prominent concentric rings on the stem, petiole, and fruit covering 40-50%
5	Whole planted blighted

In order to assess symptom severity of leaf curl, an observation scale with 5 classes was adopted (Lapidot et al., 1997; & Anon, 2006).

Grade	Symptoms
0	no symptoms.
1	slight leaf curl.
2	substantial curl with or without yellowing.
3	substantial curl with substantial yellowing.
4	substantial curl + yellowing + stunting or death of the plant

Percent disease index was calculated by the formula given by (McKinney, 1923; & Pandey et al., 2002).

$$Percent\ disease\ index = \frac{sum\ of\ numerical\ rating}{Total\ number\ of\ sample\ taken\ X\ Maximum\ grade} X\ 100$$

Disease reaction classes for infection based on percent disease severity in tomato given by Peteira et al. 2002.

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

RESULTS AND DISCUSSIONS

97 genotypes were screened for resistance against early blight and tomato leaf curl in natural conditions. Percentage disease index was calculated based on incidence occurred during 60 days and 90 days. Tomato genotypes showed various reactions. During 60th day, out of 97 genotypes, 31 showed high resistance, 32 genotypes were showed resistant, 17 showed moderately resistant, 11 showed susceptible and 7 showed highly susceptible were shown in table 1. Where as in case of 90 days severity in 97 genotypes of tomato, no genotypes found highly resistant, 16 showed resistant reaction, 12 genotypes were found moderately resistant, 24 were found susceptible and 45 genotypes were highly susceptible were shown in table 2. The disease incidence was less during vegetative stages. The disease was severely spread after flowering, covered whole leaf, stem, petiole and even on the surface of berry. Target board symptoms were also produced later on coalesced to from blighted appearance. The severity of *Alternaria* before flowering varies from 0- 64%. But after flowering stage the disease severity varies from 16-100%. The genotypes which showing high resistance during 60 DAT were showing resistance reaction during 90th day. The genotypes showed resistant reaction were TGP 60, TGP 27, TGP31, TGP77, TGP63, and TGP65 to early blight reaction. Sel-35 (TLBRH-6 X Konbilahi) and Sel-19 (TLBRH-6 X Konbilahi) genotypes were highly resistant, while 7 were resistant, 14 were moderately resistant, 16 were susceptible, and 6 were highly susceptible. The outcome was found to be similar for both years. The disease caused a yield loss ranging from 2.15 percent in highly resistant genotypes to 42.75 per cent in highly susceptible genotypes (Meitei et al., 2014). Screening genotypes for early blight resistance earlier was carried out by Choulwar et al. (1990), Fageria et al. (1998), Lohithaswa et al. (1998) and Suryavanshi et al. (2000).

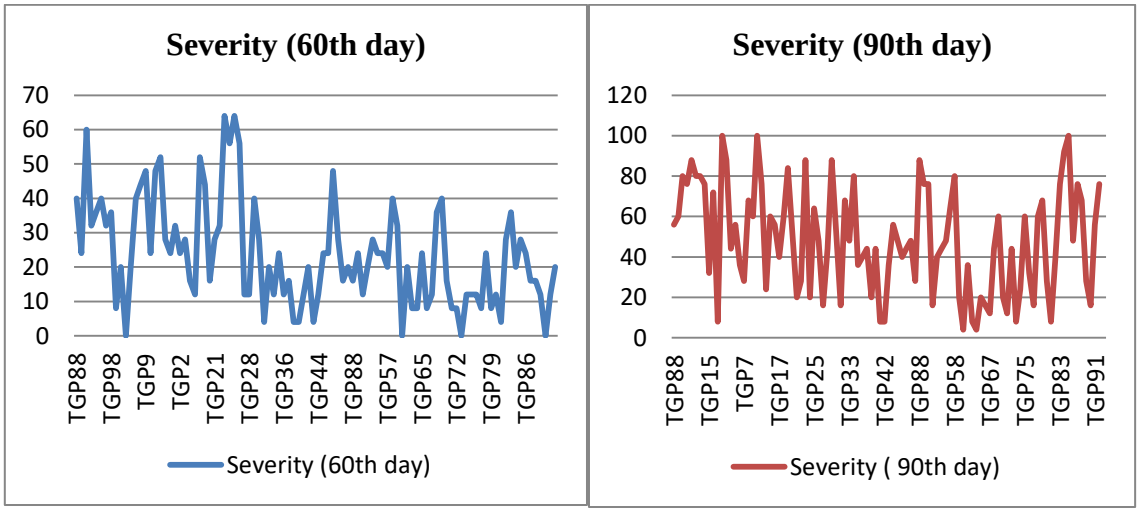
Table 1: Tomato genotypes showing different disease reaction against Early blight during 60 DAT

SL. no	Disease rating	Genotypes
1	Highly resistant (31)	TGP60, TGP73, TGP90, TGP31, TGP38, TGP40, TGP42, TGP81, TGP15, TGP63, TGP64, TGP66, TGP71, TGP72, TGP77, TGP79, TGP17, TGP27, TGP28, TGP33, TGP36, TGP88, TGP44, TGP52, TGP67, TGP74, TGP75, TGP76, TGP80, TGP89, TGP91
2	Resistant(31)	TGP16, TGP20, TGP37, TGP49, TGP88, TGP70, TGP87, TGP14, TGP13, TGP12, TGP32, TGP41, TGP50, TGP53, TGP57, TGP61, TGP84, TGP92,

		TGP96, TGP8, TGP4, TGP2, TGP35, TGP45, TGP46, TGP51, TGP55, TGP56, TGP65, TGP78, TGP86
3	Moderately resistant (16)	TGP5, TGP1, TGP21, TGP30, TGP48, TGP54, TGP82, TGP85, TGP98, TGP97, TGP3, TGP22, TGP59, , TGP98, TGP68, TGP83
4	Susceptible (11)	TGP88, TGP96, TGP11, TGP29, TGP58, TGP69, TGP10TGP19, TGP9, TGP7, TGP47
5	Highly susceptible (7)	TGP6, TGP18, TGP24, TGP26, TGP97, TGP23, TGP25

Table 2: Tomato genotypes showing different disease reaction against Early blight during 90 DAT

SL. no	Disease rating	Genotypes
1	Highly resistant	
2	Resistant (16)	TGP27, TGP31, TGP53, TGP77, TGP90, TGP21, TGP24, TGP59, TGP60, TGP63, TGP64, TGP65, TGP70, TGP2, TGP67, TGP74
3	Moderately resistant (12)	TGP7, TGP22, TGP50, TGP71, TGP89, TGP15, TGP40, TGP76, TGP8, TGP44, TGP61, TGP66
4	Susceptible (24)	TGP13, TGP17, TGP37, TGP41, TGP42, TGP47, TGP54, TGP73, TGP81, TGP82, TGP10 TGP28, TGP38, TGP48, TGP55, TGP68, TGP72, TGP26,TGP33, TGP46, TGP49, TGP56, TGP80, TGP86
5	Highly susceptible (45)	TGP20, TGP30, TGP88, TGP16, TGP36, TGP45, TGP91, TGP96, TGP5, TGP1, TGP18, TGP69, TGP78, TGP25, TGP57, TGP6, TGP32, TGP79, TGP88, TGP14, TGP75. TGP98, TGP98, TGP3, TGP51, TGP52, TGP83, TGP87, TGP92, TGP97, TGP96, TGP97, TGP35, TGP58, TGP19, TGP88, TGP11, TGP23,TGP29,TGP88 TGP84, TGP 12,TGP4,TGP85



Graph 1: Severity of early blight of Tomato at 60 DAT and 90DAT

Tomato yellow curl virus also a major disease in solanaceous crops was majorily transmitted to other plants by Whitefly (*Bemasia tabaci*). The same genotypes were used to secreening for resistance against leaf curl virus disease. Percentage disease was calculated based on the severity/ incidence occurred at 60 DAT and 90 DAT. At 60 DAT, 38 genotypes showed highly resistance, 16 showed resistance reaction, 17 were moderately resistance. 12 were susceptible and 14 were highly susceptible during vegetative growth were showed table 3. The number of susceptible genotypes were increased after flowering and fruiting stage. During 90 DAT, 17 genotypes showed highly resistance reaction, 27 were resistant, 13 were moderately resistant, 10 were susceptible and remaining 31 genotypes showed highly susceptible reaction were shoed in table 4. Disease prevails before flowering stage and attack the all the leaves, leaves become curl, yellowish vigorous production of small leaf lets and less production of flowers which makes plants partial or fully sterile. TGP96, TGP8, TGP36, TGP80, TGP88, TGP13 and TGP 21 genotypes were highly resistant reaction both 60 DAT and 90 DAT. Twenty-two tomato genotypes from diverse geological origins were evaluated for resistance to tomato leaf curl virus in both fields over two years during different seasons (rainy and winter) along with artificial conditions. The genotypes 'H 88-78-1', 'H 88-78-2', and 'H 88-78-3'78-2' and 'H 88-87' were highly resistive in the field. However, only 'H 88-78-1' later proven to be very effective. Two genotypes 'H 88-78-2' and 'H 88-87' were moderately resistant (Singh et al., 2010). Under glasshouse and field conditions, 34 tomato genotypes resistant/tolerant to TYLCV-I were tested for resistance to ToLCV-[Ban4]. Lines 902 and 910, which

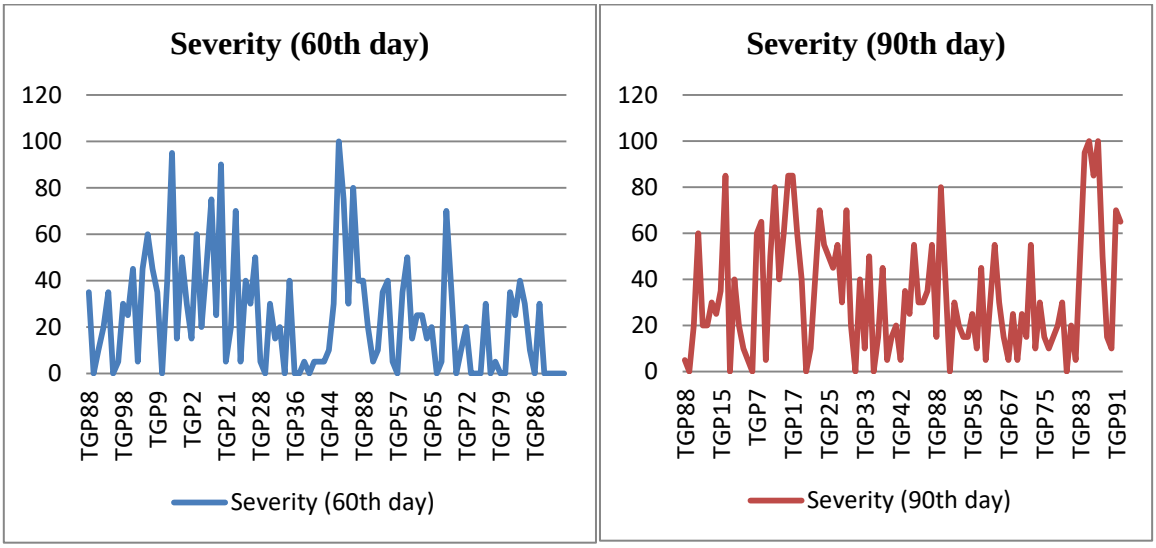
were resistant to TYLCV-Is, were only tolerable to ToLCV-[Ban4] and accession *Lycopersicon peruvianum* CMV Sel. INRA, which was resistant to ToLCV-[Ban4], was only tolerable to TYLCV-I. (Gowda et al., 2003). TLCVD is caused by a complex of at least five TYLCV strains that have emerged as a result of recombination (Kirthi et al., 2002).

Table 3: Tomato genotypes showing different disease reaction against Tomato leaf curl during 60 DAT

SL. no	Disease rating	Genotypes
1	Highly resistant (37)	TGP96, TGP8, TGP29, TGP33, TGP36, TGP37, TGP40, TGP57, TGP66, TGP70, TGP73, TGP74, TGP75, TGP77, TGP79, TGP80, TGP86, TGP88, TGP89, TGP90, TGP91, TGP92, TGP97, TGP 13, TGP21, TGP24, TGP28, TGP38, TGP88, TGP42, TGP52, TGP56, TGP78, TGP97, TGP53, TGP67, TGP85
2	Resistant(16)	TGP5, TGP2, TGP31, TGP98, TGP16, TGP22, TGP32, TGP4, TGP51, TGP72, TGP15, TGP19, TGP44, TGP61, TGP71, TGP82
3	Moderately resistant (17)	TGP98, TGP3, TGP26, TGP30, TGP45, TGP48, TGP64, TGP65, TGP76, TGP84, TGP87, TGP88, TGP9, TGP54, TGP58, TGP69, TGP81
4	Susceptible (12)	TGP7, TGP25, TGP35, TGP50, TGP88, TGP55, TGP83, TGP14, TGP12, TGP10, TGP17, TGP63
5	Highly susceptible (14)	TGP4, TGP27, TGP59, TGP60, TGP11, TGP1, TGP23, TGP68, TGP18, TGP47, TGP49, TGP20, TGP6, TGP46

Table 4: Tomato genotypes showing different disease reaction against Tomato leaf curl during 90DAT

SL. no	Disease rating	Genotypes
1	Highly resistant (17)	TGP96, TGP8, TGP20, TGP31, TGP36, TGP53, TGP80, TGP88, TGP13, TGP9, TGP5, TGP10, TGP21, TGP33, TGP61, TGP76, TGP90
2	Resistant(27)	TGP37, TGP40, TGP88,TGP88, TGP56, TGP57, TGP75, TGP77, TGP89, TGP97, TGP88, TGP96, TGP11, TGP30, TGP55, TGP67, TGP69, TGP78, TGP81, TGP98,TGP42,TGP45, TGP58, TGP66, TGP68, TGP70, TGP82
3	Moderately resistant (13)	TGP97, TGP28, TGP47, TGP48, TGP54, TGP63, TGP65, TGP71, TGP74, TGP79, TGP15, TGP44,TGP49
4	Susceptible (10)	TGP 12, TGP2, TGP19,TGP22,TGP32, TGP52, TGP26, TGP38, TGP59, TGP60
5	Highly susceptible (31)	TGP4, TGP35, TGP73, TGP83, TGP88, TGP24, TGP27, TGP46, TGP50, TGP64, TGP72, TGP98, TGP1, TGP 18, TGP6, TGP92, TGP23, TGP25, TGP29,TGP91, TGP3, TGP51, TGP14, TGP16, TGP17, TGP86, TGP7, TGP41,TGP84, TGP85,TGP87



Graph 2: Severity of Tomato leaf curl at 60 DAT and 90DAT

CONCLUSION

The purpose of this study was to document the performance of the genotypes against the prevailing diseases under natural conditions. The experimental materials comprised 97 genotypes, including both from public and private sectors, collected from various parts of the country were used in a randomised block design for evaluation. The results were summarised and it was concluded that the genotypes TGP 60, TGP 27, TGP31, TGP77, TGP63, and TGP65 exhibited resistance to early blight response. While genotypes TGP96, TGP8, TGP36, TGP80, TGP88, TGP13 and TGP21 genotypes showed a significant level of resistance to leaf curl virus. The resistance genotypes were further used for screening and breeding purposes.

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Conflict of Interest

The author(s) declares no conflict of interest.

Author Contribution

All authors contributed equally to establishing the topic of the research and design experiment.

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