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Evaluation of Tomato Germplasm Accessions (*Solanum* spp.) for Identification of Resistant Source for Tomato Leaf Curl Disease

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Abstract

Tomato is a self-pollinated crop (2n = 24). It is one of the important vegetables consumed worldwide. Its production is limited by destructive tomato leaf curl disease (ToLCD). In the present study, 51 germplasm accessions belonging to *Solanum lycopersicum*, *S. esculentum* var. *cerasiforme*, *S. peruvianum*, *S. pimpinellifolium, S. arcanum*, *S. habrochaites* and *S. cheesmanii* with three checks were used to study genetic variability for fruit yield and its attributing traits and to identify resistant source for ToLCD using natural screening technique. In natural screening, five highly resistant (EC 582629, EC 771603, EC 771609, EC 771608, LA 1264) and eight resistant accessions were identified. The accession EC 771608 displayed highly resistant with fruit yield per plant 490.6 g, which can be used as valuable source of resistance against ToLCD in resistance breeding programme in tomato.

Keywords : Screening, Per cent disease incidence, ToLCV, Tomato germplasm

Tomato (*Solanum lycopersicon* L.) is the second most widely consumed vegetable globally and holds immense socioeconomic significance due to its substantial production volume, employment opportunities and nutritional value (Nick and Silva, 2016). It belongs to the *Solanaceae* family and known to be originated from the Peru-Ecuador region (Rick, 1976). Tomato is a self-pollinated crop with a diploid set of chromosomes, 2n = 2x = 24 and is consumed in various forms: fresh, cooked or processed products such as juices, ketchup, sauces, purees and pickles. Tomatoes are rich in vitamins A and C minerals and organic acids. India ranks second in the tomato production and it is mainly cultivated in the states of Madhya Pradesh, Andhra Pradesh, Karnataka, Gujarat and Tamil Nadu (Anonymous, 2023). In Karnataka, although tomato is grown all over, intensive cultivation is noticed in Kolar, Chikkaballapura, Mysore, Chamarajanagar and Chitradurga Districts. In India, it is cultivated in an area of 8.10 lakh ha with production of 193.28 lakh tonnes. In Karnataka, it is cultivated in an area of 0.63 lakh ha with a production of 21.38 lakh tonnes (Anonymous, 2023). About 146 plant viruses belonging to 33 genera are known to infect tomato around the world. Among these viruses, tomato leaf curl disease caused by tomato leaf curl virus (ToLCV) is a destructive disease of tomato in many parts of India (Muniyappa and Saikia, 1983). Tomato leaf curl disease (ToLCD) was first reported in India by Vasudeva and Samraj in 1948. During autumn in North India (Banerjee and Kalloo, 1987) and summer in South India (Saikia and Muniyappa, 1989) leaf curl disease incidence can reach up to 100 per cent with quantitative and qualitative yield losses (Saikia and Muniyappa, 1989; Rai *et al.,* 2013 and Prasanna *et al.,* 2015a).

ToLCV belongs to the genus, *Begomovirus* (Family: *Geminiviridae*) and is known to be transmitted exclusively by whitefly, *Bemisiatabaci* in a persistent-circulative manner (Gronenborn, 2007) and the resistant is controlled by Ty genes. Other than resistance mechanism, Ty gene is also reported to control seed quality in tomato (Tejaswini *et al*., 2022). Management of leaf curl diseases of tomato caused by ToLCV is very difficult due to their wide host range, effective spread by its vector coupled with the difficulty of managing the vector through cultural, biological and chemical means, rapid development of insecticide resistance in vectors and unavailability of resistant cultivars with all the desirable traits. Hence, for effective and eco-friendly management of the diseases, best strategy is to exploit host plant resistance (Nateshan *et al.,* 1996; Lapidot *et al.,* 1997 and Pico *et al.,* 1998). There will be awide range of variation in tomato genotypes for allthe characters right from seedling stage, vegetative stage and reproductive stage (Raghavendra *et al*., 2019). For any resistance breeding program, germplasm screening and identification of source of resistance is pre-requisite to formulate breeding strategy for the improvement of resistance trait. In this view, present investigation was carried out to identify resistance sources of ToLCV using natural screening technique.

Material and Methods

In the present investigation, germplasm accessions of cultivated tomato and wild species were evaluated for identifying resistant source for tomato leaf curl disease (ToLCD). The germplasm accessions of cultivated and related wild species of tomato were procured from national and international institutes *viz.,* National Bureau of Plant Genetic Resource (NBPGR), New Delhi, Indian Institute of Vegetable Research (IIVR), Varanasi, Asian Vegetable Research and Development Centre (AVRDC), Tomato Genetics Resource Center (TGRC), USA. Experiment was carried out at Experimental plots, Department of Genetics and Plant Breeding, University of Agricultural Sciences, GKVK, Bengaluru situated in Eastern dry zone (Zone 5) of Karnataka at an altitude of 930 m above mean sea level within 12°58' North and 77°35' East latitude and longitude, respectively in *summe*r 2023. A total of fifty-one germplasm accessions were used in this study comprised of different species among them 27 were *S. lycopersicum*, 6 were *S. esculentum* var. *cerasiforme*, 3 were *S. peruvianum*, 11 were *S. pimpinellifolium,* 2 were *S. arcanum* and one from each *S. habrochaites* and *S. cheesmanii* species collected from different sources were screened against tomato leaf curl virus disease (ToLCD) under field and glass house condition along with two resistant check varieties *viz.*, Vaibhav and Nandhi and one susceptible check *i.e.,* Arkavikas. During summer 2023*,* 51 accessions including three checks were planted in augmented design (Federer, 1956). Each entry was transplanted in a single row of 5m length with a spacing of 0.60 m (between rows) x 0.45 m (between plants). All recommended agronomic practices and plant protection measures were adopted during the crop growth period to ensure better growth and fruit yield.

Disease Scoring and Identification of Tomato Germplasm Lines for Leaf Curl Disease Resistance

Fifteen days after transplantation disease was scored on individual plants according to scale describe by Banerjee *et al.,* 1987, ranging from 0 to 4 and continued for 90 days at an interval of 15 days (Table 1). Using these scores per cent disease incidence (PDI) and coefficient of infection (CI) was estimated by the following formula.

$$\text{Per cent disease incidence} = \frac{\text{Number of diseased plant}}{\text{Total number of plants observed}}$$

$$CI = PDI \times \text{Response Value (RV)}$$

Results and Discussion

Identification of Resistance Sources of ToLCV Using Natural Screening Technique

The fifty-one accessions along with check varieties were subjected to disease screening as described in material and methods. The symptoms of the disease were observed at 15 days' interval and continued up

TABLE 1

A scale for classifying disease reaction of tomato germplasm lines to tomato leaf curl disease (Banerjee *et al.*, 1987)

Symptoms	Grade	RV	CI	Reaction
No symptoms	0	0	0-4.99	Highly Resistant (HR)
Very mild curling (up to 25% leaves)	1	0.25	5-9.99	Resistant (R)
Curling, puckering of 26-50% leaves	2	0.50	10-19.99	Moderately Resistant (MR)
Curling, puckering of 51-75% leaves	3	0.75	20-39.99	Moderately susceptible (MS)
Severe Curling, puckering of>75% leaves	4	1.00	40-69.99	Susceptible (S) Highly susceptible
			70-100	(HS)

to 90 days and the germplasm accessions were categorized on the basis of coefficient of infection (CI) into Highly Resistant (0-4.99), Resistant (5-9.99), Moderately resistant (10-19.99), Moderately susceptible (20-39.99), Susceptible (40-69.99) and highly susceptible (70-100) following scale suggested by Banerjee *et al.,* 1987. In natural screening for ToLCD, several characteristic symptoms including yellowing of leaves, puckering of the foliage and stunted growth were observed as depicted in Plate 1.

In this screening technique, five highly resistant tomato accessions for tomato leaf curl disease (ToLCD) were successfully identified *viz.,* EC 582629 (*Solanum lycopersicum*), EC 771603 (*Solanum peruvianum*), EC 771609 (*Solanum peruvianum*), EC

No symptoms (LA 2152) | Very mild curling (LA 2102) | Curling, puckering of 26-50% leaves (EC 676796)

Curling, puckering of 51-75 % leaves (WIR 3957) | Severe Curling, puckering of >75%leaves (EC 676790) | Stunted growth (LA1311-14)

Plate 1 : Different ToLCD symptoms observed in field screening

TABLE 2

Disease reactions of tomato germplasm against ToLCD in field screening

Disease reaction	Coefficient of infection (CI)	Number of accessions	Germplasm
Highly resistant (HR)	0-4.99	5	Vaibhav, Nandhi, EC 582629, EC 771603, EC 771609, EC 771608, LA 1264
Resistant (R)	5-9.99	8	EC 514101, EC 68698, EC 25265, LA 2152, LA 1346, LA 0373, EC 771615, LA 1547
Moderately resistant (MR)	10-19.99	16	EC 677078, EC 771588, EC 771598, EC 608271, EC 676922, EC 677075, EC 677063, LA 1311-18, LA 0114, BT-10, EC 771611, LA 1301, LA 1602, EC 676728, EC 677051, EC 610661
Moderately susceptible (MS)	20-39.99	12	WIR 3969, EC 514100, WIR 3957, L-01942, EC 608411, LA 0384, EC 677068, EC 677207, LA 2828, LA 0122, L-02846, EC 631959
Susceptible (S)	40-69.99	10	Arkavikas, EC 676790, EC 676796, Ageta 32, LA 1311-14, LA 2308, LA 2102, LA 2831, LA1479, L-02844

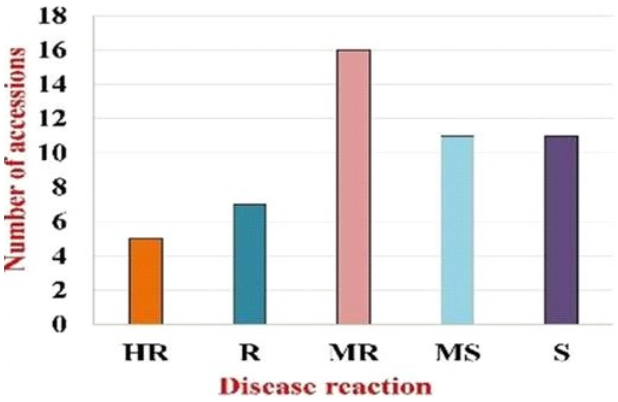

Fig. 1 : Disease reaction of 51 tomato germplasm for ToLCV disease

771608 (*Solanum peruvianum*) and LA 1264 (*Solanum habrochaites*). These highly resistant accessions exhibited CI values ranging from 0 to 4.99, indicating their strong resistance to the disease and also identified eight accessions that demonstrated a good level of resistance to ToLCD with CI values of 5 to 9.99 (EC 514101, EC 68698, EC 25265, LA 2152, LA 1346, LA 0373, EC 771615 and LA 1547). Camara *et al.* (2013) studied on field screening of tomato genotypes for resistance to tomato yellow leaf curl virus disease and obtained 12 resistant varieties out of 40 tomato varieties. Similarly, Vijeth *et al.* (2018) evaluated resistance to Tomato Leaf Curl Virus (ToLCV) in 10 parents and 45 F_1 hybrids and identified four promising tomato hybrids resistant to ToLCV disease.

Apart from the identified resistant accessions in our study, accessions were also categorized into other groups based on their disease response including sixteen moderately resistant, twelve moderately susceptible and ten susceptible accessions (Fig. 1 and Table 2). This comprehensive categorization provides valuable information on the resistance levels of different tomato accessions to ToLCD and is essential for selecting suitable candidates for breeding programs aimed at developing disease-resistant tomato varieties.

The identified highly resistant (EC 771608) and resistant germplasm accessions (EC 771603, EC 771609, LA 2152, LA 1346, LA 1264) can be further validated for the presence of Ty genes using gene specific markers and can be used as resistance source for tomato leaf curl disease in breeding programme.

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