

EVALUATION OF TOMATO GENOTYPES AGAINST TOMATO LEAF CURL DISEASE

Kamal Narayan Koshale^{*1}, Jahaar Singh², Sanjay Kumar Ghirtlahre³, Yaspal Singh Nirala⁴, and Veer Singh⁵

¹Assistant Professor, (Plant Pathology), College of Agriculture and Research Station, Raigarh, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.), Email- romi10888@gmail.com

²Assistant Professor, (Plant Pathology), Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.)

³Assistant Professor, (Entomology), Late Dr. RCSD College of Agriculture and Research Station, Korea, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.)

⁴Assistant Professor, (Entomology), Barrister Thakur Chhedilal College of Agriculture and Research Station, Sarkanda, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.)

⁵Assistant Professor, (Plant Pathology), College of Agriculture and Research Station Pratappur, Surajpur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, (C.G.)

ABSTRACT

Tomato leaf curl disease, caused by *Tomato leaf curl virus*, is one of the most destructive diseases of tomato, causing significant yield and economic losses to growers. Various methods have been developed for the management of the disease, but host plant resistance is the most effective and economical. Therefore, a field experiment was conducted to evaluate some tomato genotypes at Horticulture Instruction cum Research Farm, College of Agriculture, IGKV, Raipur, Chhattisgarh. The main objective of the experiment was to identify tomato genotypes showing resistance against tomato leaf curl disease (ToLCD). In both years, among all the genotypes evaluated, none was found to be a resistant genotype. However, one genotype (2015/ToLCVRES-5) was moderately resistant, two (2015/ToLCVRES-1 and 2015/ToLCVRES-4) were moderately susceptible, and the remaining four (2015/ToLCVRES-2, 2015/ToLCVRES-3, H-24 and Punjab Chhuhara) were susceptible to ToLCD.

Key words: Disease, genotype, leaf curl, resistance.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.), a member of the family Solanaceae, is one of the most popular and extensively grown vegetables of both tropics and subtropics of the world (Chaudhary et al., 2010 and Singh et al., 2015). It is a herbaceous, annual, subtropical fruiting plant which is originated in Latin America and has become one of the most widely grown vegetables with ability to survive in diverse environmental conditions (Bora et al., 2012 and Koshale et al., 2020). It is grown in small kitchen gardens, protected structures (greenhouse, glasshouse, polyhouse and walk-in tunnels) and open fields (Koshale et al., 2024a). The name tomato probably derived from the word “Tomat” in the Nahuatl language of Mexico (Manjunatha, 2008). In England, tomato is popularly known as “love of apple” while, in India, it is commonly referred as “poor man’s Orange” (Rai and Yadav, 2005). Worldwide, the tomato ranks second in importance after the potato (Mihretu and Bhalekar, 2016 and Koshale et al. 2024b). While it ranks third in priority after potato and onion in India (Anonymous, 2024).

Tomato is known to be susceptible to more than 200 diseases (Shelat et al., 2014 and Koshale and Khare, 2018), out of which tomato leaf curl disease caused by Tomato leaf curl virus (ToLCV) is one of the most devastating disease which causes substantial yield loss in India and worldwide (Govindappa et al., 2013). The disease affects all stages of the plants causing 38-100 per cent yield loss, depending on the stage of the crop at the time of infection (Srivastav et al., 2011). ToLCV is the most important and destructive viral pathogen in many parts of India which is transmitted by the sweet potato whitefly (*Bemisia tabaci* Gennadius) in persistent circulative non propagative manner (Saikia and Muniyappa, 1989 and Zeshan et al., 2016).

There are several strategies for the management of tomato leaf curl disease (ToLCD) but host plant resistance is most effective and economically cheap input of Integrated Pest Management. During the past twenty years, considerable efforts have been made to develop ToLCV resistant cultivars. Tomato cultivars, however, are not completely resistant to ToLCV. Nevertheless progress in breeding for ToLCV resistance has been slow because of the complex genetics of resistance. Identification of resistant genotypes/lines/ cultivars and exploration of resistant sources in tomato germplasm is very much important for the effective and ecofriendly management of ToLCD.

2. MATERIALS AND METHODS

A sum of seven tomato genotypes along with one susceptible check variety viz. Punjab Chhuhara (Arora, et al., 2011) was evaluated against tomato leaf curl disease during rabi 2015-16 and 2016-17 under natural field conditions at Horticulture Instruction cum Research Farm, College of Agriculture, IGKV, Raipur, Chhattisgarh

to find out resistant genotypes. Seedlings of each genotypes of tomato were raised in nursery beds. Seeds of each genotype were sown in separate rows. Twenty-five days old seedlings were transplanted into main field with 60 cm row to row and 50 cm plant to plant spacing in randomized block design (RBD) and three replications were maintained for each genotype. Standard agronomic practices were followed and no chemicals / pesticides were applied during the period of experiment for the development of sufficient disease pressure.

The observations on percent disease incidence and percent disease index (PDI) were recorded for each genotype from 15 to 90 days after transplanting (DAT) at 15-day intervals. The data on percent disease incidence was calculated by using the formula as suggested by Nene, 1972 (Rajasri and Vijayalakshmi, 2013). The rating of leaf curl disease was recorded for each plant of each genotype by using rating scale of 0-7 suggested by Alegbejo (1995) with minor modifications. The percent disease index (PDI) was calculated for each genotype by implying formulae suggested by Wheeler (1969) thereafter on the basis of reactions different genotypes were classified into different categories viz. Highly resistant (HR), Resistant (R), Moderately resistant (MR), Moderately susceptible (MS) and Susceptible (S).

ToLCV disease rating scale

Grade Rating	Symptoms	PDI	Reaction category
0	No visible disease symptom	0	HR
1	Top leaves curled only	1.0-15.9	R
3	Top leaves curled and slight stunting of plant or All leaves curled without stunting	16.0-25.9	MR
5	All leaves curled and slight stunting of plant	26.0-36.9	MS
7	Severe curling of leaves, stunting of plant and proliferation of auxiliary branches	37.0 and above	S

3. RESULT AND DISCUSSION

3.1 Disease incidence and percent disease index of ToLCD in different tomato genotypes

Considerable variability was observed in incidence of all tomato genotypes evaluated under the study. During 2015-16 disease incidence was varied from 0.0 to 1.67, 1.59 to 14.29, 5.56 to 35.34, 13.49 to 64.79, 19.05 to 89.17 and 30.95 to 94.17 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. However, the calculated percent disease index (PDI) was also varied from 0.0 to 0.95, 0.68 to 7.81, 2.72 to 20.68, 8.05 to 47.73, 12.70 to 69.71 and 12.70 to 69.71 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. The genotype 2015/ToLCVRES-1, 2015/ToLCVRES-2, 2015/ToLCVRES-4, 2015/ToLCVRES-5 and variety H-24 were free from the disease up to 15 days after transplanting while remaining two genotypes were found infected with the disease at 15 DAT (Table 1 and 2).

During 2016-17 disease incidence was varied from 0.0 to 2.52, 0.0 to 15.32, 2.61 to 37.79, 11.48 to 74.23, 24.22 to 96.32 and 35.91 to 99.10 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. However, the percent disease index (PDI) of leaf curl was also varied from 0.0 to 0.60, 0.0 to 7.76, 1.35 to 20.26, 6.55 to 52.52, 15.32 to 67.50, 25.65 to 79.67 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. Only one genotype (2015/ToLCVRES-1) was free from the disease up to 30 days after transplanting and rest all were infected with the disease (Table 1 and 2).

The average incidence and PDI of leaf curl for both the years (2015-16 and 2016-17) displayed that disease incidence was varied from 0.0 to 2.10, 1.19 to 14.81, 4.09 to 36.57, 12.49 to 69.51, 21.64 to 92.75 and 33.43 to 96.64 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. However, the calculated percent disease index (PDI) was varied from 0.0 to 0.78, 0.63 to 7.79, 2.09 to 20.47, 7.30 to 50.13, 14.01 to 68.61 and 19.18 to 74.69 percent at 15, 30, 45, 60, 75 and 90 days after transplanting (DAT) respectively. Four genotypes viz. 2015/ToLCVRES-1, 2015/ToLCVRES-2, 2015/ToLCVRES-4, 2015/ToLCVRES-5 and H-24 were free from the disease up to 15 days after transplanting but in others the disease was first appeared at 15 days after transplanting (Table 1 and 2).

3.2 Reaction of tomato genotypes against tomato leaf curl disease

Among the seven genotypes evaluated during 2015-16, one genotype viz. 2015/ToLCVRES-5 was reported as resistant with percent disease index of 12.70 percent. Two genotypes viz. 2015/ToLCVRES-1 and 2015/ToLCVRES-4 were categorized as moderately resistant with percent disease index of 25.28 and 23.21 percent respectively. Four (2015/ToLCVRES-2, 2015/ToLCVRES-3, H-24 and Punjab Chhuhara) were classified as susceptible genotypes with percent disease index of 52.89, 38.91, 48.57 and 69.71 percent respectively. However none of them was moderately susceptible (Table 2b & 3).

Out of seven genotypes evaluated during 2016-17, none of the genotype was found resistant against ToLCD. However, one genotype viz. 2015/ToLCVRES-5 was regarded as moderately resistant with percent disease index of 25.65 percent and rest others (2015/ToLCVRES-1, 2015/ToLCVRES-2, 2015/ToLCVRES-3, 2015/ToLCVRES-4, H-24 and Punjab Chhuhara) showed susceptible reaction with percent disease index of 48.67, 67.00, 58.97, 39.08, 70.00 and 79.67 percent respectively (Table 2b & 3).

It was revealed from the mean data of both experimental years (2015-16 and 2016-17) that none of the genotype was found resistant against ToLCD. However, one (2015/ToLCVRES-5) was found as moderately resistant

genotype with percent disease index of 19.18 percent. Two genotypes (2015/ToLCVRES-1 and 2015/ToLCVRES-4) were reported as moderately susceptible genotypes with percent disease index of 36.98 and 31.15 percent respectively. Remaining four (2015/ToLCVRES-2, 2015/ToLCVRES-3, H-24 and Punjab Chhuhara) were found to be susceptible with percent disease index of 59.95, 48.94, 59.29 and 74.69 percent respectively (Table 2b & 3).

H-24, a tomato cultivar derived from Hissar Arun $\times$ *S. habrochaites* f. *glabratum*, was found to be susceptible to TLCV disease in the present study, but was previously reported as resistant or moderately resistant against TLCV (Kalloo & Banerjee, 1990, 2000 and Tripathi and Varma, 2002). This was also confirmed by Koshale, et. al, 2026. Arora, et al. (2011) screened twelve tomato genotypes, two resistant checks (56-14-7 and 58-11-1-1), two susceptible checks (Punjab Upma and Punjab Chhuhara) and eight advanced lines (11-22, 2-20-2, 6-23, 4-4-1-1, 7-4-5, 8-3-2, 8-5-2-1 and 1-2-3), for disease incidence of tomato leaf curl viral disease (ToLCVD). All eight advanced lines showed zero per cent infection and were found to be resistant to ToLCV and Punjab Upma and Punjab Chhuhara were susceptible. Singh, (2014) reported that among thirty two tomato genotypes screened for its resistance/ susceptible reaction against tomato leaf curl disease, one wild accession, H-88-78-1 was immune without producing any symptoms of leaf curl disease, three genotypes viz. Hissar Lalima, TLBRH-6 and NS-515 were resistant and eight viz. Hissar Anmol, Kishi Vishesh, Kashi Amrit, Kashi Sharad, KS-17, KS-118, Avinash-2 and US-1008 were moderately resistant to ToLCV.

REFERENCE

1. Alegbejo, M. D. (1995). Screening of tomato accessions for resistance to leaf curl virus. *Journal of Agricultural Technology*, 3, 65-68.
2. Anonymous. (2024). *Agricultural Statistics at a Glance 2023*. Government of India, Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare, Economics, Statistics & Evaluation Division.
3. Arora, N., Kaur, S. & Sharma, A. (2011). Identification of Tomato leaf curl virus (ToLCV) resistant genotypes based on disease incidence, scanning electron microscopic and molecular studies. *Plant Disease Research*, 26(1), 76-81.
4. Bora, G. C., Devi, J., Gogoi, S., Deka, A., Bhattacharyya, A. K. & Paswan, L. (2012). Evaluation of varieties of tomato (*Lycopersicon esculentum*) for resistance to leaf curl virus in North East India. *Current Advances in Agricultural Sciences*, 4(1), 50-52.
5. Chaudhary, S., Gulati, P., Srivastava, G. P. & Tewari, J. P. (2010). Screening for natural occurrence of Tomato leaf curl virus (TLCV) in Devipatan mandal of Tarai region of Uttar Pradesh. *International Journal of Plant Protection*, 3(1), 147-150.
6. Govindappa, M. R., Bhemannan, M., Hosmani, A. & Ghante, V. N. (2013). Bio-efficacy of newer insecticides against Tomato leaf curl virus disease and its vector whitefly (*Bemisia tabaci*) in tomato. *International Journal of Applied Biology and Pharmaceutical Technology*, 4(3), 226-231.
7. Kalloo, G. & Banerjee, M. K. (1990). Transfer of tomato leaf curl virus resistance from *Lycopersicon hirsutum* f. *glabratum* to *L. esculentum*. *Plant Breeding* 105, 156-159.
8. Kalloo, G. & Banerjee, M. K. (2000). H-24: Moderately leaf curl resistant variety of tomato (*Lycopersicon esculentum* Mill.). *Vegetable Science* 27, 117-120.
9. Koshale, K. N. & Khare, C. P. (2018). Seasonal occurrence of prevalent diseases of tomato under field conditions. *International Journal of Chemical Studies*, 6(5), 2002-2006.
10. Koshale, K. N., Anant, P. and Khare, C. P. (2020). Occurrence of different diseases of tomato under field condition in Raipur. *International Journal of Chemical Studies*, 8(3), 1704-1708.
11. Koshale, K. N., Anant, P. & Khare, C. P. (2024a). Occurrence of various diseases of tomato under protected conditions. *Progressive Research: An International Journal*, 19(Special), 267-272.
12. Koshale, K. N., Anant, P. and Khare, C. P. (2024b). Evaluation of tomato varieties for resistance against Tomato leaf curl virus in Raipur, Chhattisgarh. *Frontiers in Crop Improvement*, 12(2), 113-118.
13. Koshale, K. N., Kumar, V., Singh, V., Kurre, R. & Mannade. (2026). Evaluation of tomato genotypes for resistance to tomato leaf curl virus disease in Chhattisgarh. *AMA, Agricultural Mechanization in Asia, Africa and Latin America*, 57(06), 22519- 22529.
14. Manjunatha, L. (2008). Studies on bud blight disease of tomato caused by Groundnut bud necrosis virus, M. Sc (Ag.) Thesis, University of Agricultural Sciences, Dharwad (India).
15. Mihretu, F. G. & Bhalekar, M. N. (2016). Evaluation of tomato genotypes for yield potential. *Vegetable Science*, 43(1), 96-100.
16. Nene, Y. L. (1972). A survey of viral diseases of pulse crops in Uttar Pradesh. *G.B. Pant Univ. Agric. Technol. Pantnagar Res. Bull.*, 4, 911.
17. Rai, N. & Yadav, D. S. (2005). *Advances in Vegetable Production*. Researchco Book Centre, New Delhi, pp. 481.
18. Rajasri, M. & Vijayalakshmi, K. (2013). Screening of Tomato Genotypes Against Tomato leaf curl virus. *Indian Journal of Plant Protection*, 41(2013), 91-94.
19. Saikia, A. K. & Muniyappa, V. (1989). Epidemiology and control of Tomato leaf curl virus in Southern India. *Journal of Tropical Agriculture*, 66, 350-354.

20. Shelat, M., Murari, S., Sharma, M. C., Subramanian, R. B., Jummanah, J. & Jarullah, B. (2014). Prevalence and distribution of Tomato leaf curl virus in major agroclimatic zones of Gujarat. *Advances in Bioscience and Biotechnology*, 5, 1-3.
21. Singh, K. (2014). Evaluation of tomato genotypes and its reaction against ToLCV causing leaf curl disease in tomato (*Solanum lycopersicon* L.). *Journal of Experimental Biology and Agricultural Sciences*, 2(1S), 120-125.
22. Singh, R. K., Rai, N., Singh, M., Singh, R. & Kumar, P. (2015). Effect of climate change on Tomato leaf curl virus (ToLCV) disease in tomatoes. *Indian Journal of Agricultural Sciences*, 85(2), 142-144.
23. Srivastav, S. K., Ansari, N. A. & Tewari, J. P. (2011). Eco-friendly management of tomato leaf curl disease. *International Journal of Plant Protection*, 4(2), 321-323.
24. Tripathi, S. & Varma, A. (2002). Identification of sources of resistance in *Lycopersicon* species to Tomato leaf curl geminivirus (ToLCV) by agroinoculation. *Euphytica*, 129, 43-52.
25. Wheeler, B. E. J. (1969). *An Introduction to Plant Diseases*. John Wiley and Sons Limited. London. 301.
26. Zeshan, M. A., Khan, M. A., Ali, S. & Arshad, M. (2016). Phenotypic evaluation of tomato germplasm for the source of resistance against Tomato leaf curl virus disease. *The Journal of Animal & Plant Sciences*, 26(1), 194-200.

Table 1a: Percent incidence of tomato leaf curl disease in different genotypes

Entry/ variety	Percent disease incidence at 15-day intervals (DAT)								
	15			30			45		
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean
2015/ToLCVRES-1	0.00	0.00	0.00	2.38	0.00	1.19	5.56	2.61	4.09
2015/ToLCVRES-2	0.00	0.00	0.00	3.27	1.74	2.51	12.30	10.47	11.39
2015/ToLCVRES-3	0.79	0.79	0.79	5.65	2.54	4.10	14.53	12.04	13.29
2015/ToLCVRES-4	0.00	0.00	0.00	2.38	0.79	1.59	10.31	9.80	10.06
2015/ToLCVRES-5	0.00	0.00	0.00	1.59	0.81	1.20	6.35	7.34	6.85
H-24	0.00	0.00	0.00	8.23	4.39	6.31	20.51	14.53	17.52
Punjab Chhuhara	1.67	2.52	2.10	14.29	15.32	14.81	35.34	37.79	36.57

Table 1b: Percent incidence of tomato leaf curl disease in different genotypes

Entry/ variety	Percent disease incidence at 15-day intervals (DAT)								
	60			75			90		
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean
2015/ToLCVRES-1	17.46	17.46	17.46	37.30	51.84	44.57	53.17	65.51	59.34
2015/ToLCVRES-2	37.20	40.58	38.89	74.37	84.84	79.61	81.00	88.65	84.83
2015/ToLCVRES-3	36.18	37.49	36.84	56.39	66.14	61.27	69.30	78.64	73.97
2015/ToLCVRES-4	19.26	19.08	19.17	34.42	41.78	38.10	44.79	53.70	49.25
2015/ToLCVRES-5	13.49	11.48	12.49	19.05	24.22	21.64	30.95	35.91	33.43
H-24	33.46	29.99	31.73	71.59	76.99	74.29	82.92	90.60	86.76
Punjab Chhuhara	64.79	74.23	69.51	89.17	96.32	92.75	94.17	99.10	96.64

Table 2a: Evaluation of tomato genotypes against tomato leaf curl disease

Entry/ variety	Percent disease index at 15-day intervals (DAT)								
	15			30			45		
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean
2015/ToLCVRES-1	0.00	0.00	0.00	1.47	0.00	0.74	2.83	1.35	2.09
2015/ToLCVRES-2	0.00	0.00	0.00	2.10	0.48	1.29	7.38	5.71	6.55
2015/ToLCVRES-3	0.34	0.34	0.34	3.35	1.34	2.35	7.15	5.88	6.52
2015/ToLCVRES-4	0.00	0.00	0.00	1.70	0.57	1.14	5.55	5.60	5.58
2015/ToLCVRES-5	0.00	0.00	0.00	0.68	0.58	0.63	2.72	3.61	3.17
H-24	0.00	0.00	0.00	4.70	2.38	3.54	12.07	7.71	9.89
Punjab Chhuhara	0.95	0.60	0.78	7.81	7.76	7.79	20.68	20.26	20.47

Table 2b: Evaluation of tomato genotypes against tomato leaf curl disease

Entry/ variety	Percent disease index at 15-day intervals (DAT)									Reaction (at final observation)		
	60			75			90					
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean
2015/ToLCVRES-1	10.88	10.47	10.68	25.28	34.12	29.7	25.28	48.67	36.98	MR	S	MS
2015/ToLCVRES-2	26.09	27.48	26.79	52.89	58.23	55.56	52.89	67	59.95	S	S	S
2015/ToLCVRES-3	25.37	26.77	26.07	38.91	44.44	41.68	38.91	58.97	48.94	S	S	S
2015/ToLCVRES-4	12.38	11.98	12.18	23.21	27.38	25.3	23.21	39.08	31.15	MR	S	MS
2015/ToLCVRES-5	8.05	6.55	7.3	12.7	15.32	14.01	12.7	25.65	19.18	R	MR	MR
H-24	23.91	20.06	21.99	48.57	50.84	49.71	48.57	70	59.29	S	S	S
Punjab Chhuhara	47.73	52.52	50.13	69.71	67.5	68.61	69.71	79.67	74.69	S	S	S

Table 3: Classification of tomato genotypes in different reaction categories

Year	Reaction category	No. of entry/ variety	Name of entry/ variety
Mean (2015-16 & 2016-17)	Resistant	0	-
	Moderately resistant	1	2015/ToLCVRES-5
	Moderately susceptible	2	2015/ToLCVRES-1, 2015/ToLCVRES-4
	Susceptible	4	2015/ToLCVRES-2, 2015/ToLCVRES-3, H-24, Punjab Chhuhara
2016-17	Resistant	0	-
	Moderately resistant	1	2015/ToLCVRES-5
	Moderately susceptible	0	-
	Susceptible	6	2015/ToLCVRES-1, 2015/ToLCVRES-2, 2015/ToLCVRES-3, 2015/ToLCVRES-4, H-24, Punjab Chhuhara
2015-16	Resistant	1	2015/ToLCVRES-5
	Moderately resistant	2	2015/ToLCVRES-1, 2015/ToLCVRES-4
	Moderately susceptible	0	-
	Susceptible	4	2015/ToLCVRES-2, 2015/ToLCVRES-3, H-24, Punjab Chhuhara