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Screening of Tomato (*Solanum lycopersicum*) Germplasm against Fusarium Wilt and Tomato Leaf Curl Virus Diseases in Naturally Ventilated Polyhouse

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Screening of tomato germplasm against fusarium wilt and tomato leaf curl virus diseases in naturally ventilated polyhouse.
Place and Duration of Study: The experiment was conducted during *rabi* 2020-2021 under naturally ventilated poly house, which located at Center of Excellence, Dr. Y.S.R. Horticultural University, Venkataramannnagudem.
Methodology: Total 21 tomato genotypes which included 18 germplasm lines and 3 commercial cultivars as a check (Arkavikas, Polyana and BSS 1006) collected from the HRS, Venkataramannagudem which were screened against major diseases of tomato under naturally ventilated polyhouse and to find out resistance source.
Results: Among the 21 genotypes screened against tomato leaf curl virus lowest per cent disease incidence was recorded in VRSL (Venkataramannagudem *Solanum lycopersicum)* -114 (5.88 %), VRSL-134 (6.54 %) and VRSL-136 (6.86 %). Highest per cent disease incidence was recorded in Arka vikas (17.87 %). Among the 21 genotypes screened lowest per cent disease incidence was recorded in VRSL -40 and VRSL-134 (9.79 %). Highest per cent disease incidence was recorded in A.vikas (32.28 %).

Keywords: Germplasm lines; tomato leaf curl virus; fusarium wilt; VRSL.

ABBREVIATION

VRSL: Venkataramannagudem Solanum lycopersicum.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most popular vegetable crop in the world [1], shares a coveted position in India. It is one of the important food and cash crop for many low-income farmers in the tropical countries so also regarded as poor man's apple. Among the vegetable crops tomato ranks the second position in world and rank first among the processing crops. It is a native of tropical America and is cultivated in about 130 different countries. Brazil, China, Cuba, Egypt, Indonesia, Russia, Spain *etc.,* are the leading producers of tomato.

Tomato is one of the versatile vegetable with wide usage in Indian culinary tradition. It is used as a fresh vegetable and also variety of processed products such as ketchup, sauce, canned fruits, puree, paste, *etc*. Tomato is rich source of vitamins and minerals mainly rich in vitamin C. It is a good source of "lycopene" pigment which is largely responsible for the red colour of fruit.

The major limiting factors towards production of optimum yield are considerable biotic stresses caused by fungi, bacteria, viruses, viroids, nematodes and insect-pests in existing varieties and hybrids. Under protected cultivation, tomato is seriously impaired due to increasing infections of early blight (*Alternariasolani*), Fusarium wilt and tomato leaf curl virus (ToLCV) diseases.

Vegetable production in our country is significantly influenced by the seasonality and weather conditions. Extends of abundance and deficiency in production and availability cause fluctuations in the prices and quality of vegetables. Vegetable production at present is also characterized by a strong dependence on chemical plant protection with its all inherent environment and health hazards, both for consumers and growers. The crop productivity is influenced by the genetic characteristics of the cultivar and the management practices including nutrients, water and microclimate. Under open field it is not possible to control the microclimate around the plant. The main advantage of protected cultivation is to create favorable microclimate for the sustained growth of the plant. Protected cultivation gives the more advantage to produce high quality and high yield compared to open field conditions. Another advantage of protected cultivation is timely harvest of the produce as per market demand, particularly during off-season. Considering economic importance of the tomato under protected conditions the present investigation was carried out to identify the resistance tomato germplasm lines against major diseases under naturally ventilated poly house.

2. MATERIALS AND METHODS

A total of 18 tomato germplasm lines were collected from the HRS, Venkataramannagudem and screened against major diseases under naturally ventilated polyhouse. Disease infection was recorded on 18

germplasm lines using standard disease rating scales of respective diseases. Arka Vikas, Polyana and BSS1006 were used as a susceptible cheks.

Table 1. Tomato germplasm lines

1	VRSL 18	**7**	VRSL 42	**13**	VRSL 180
2	VRSL 24	**8**	VRSL 45	**14**	VRSL 182
3	VRSL 28	**9**	VRSL 104	**15**	VRSL 223
4	VRSL 36	**10**	VRSL 106	**16**	VRSL 224
5	VRSL38	**11**	VRSL 114	**17**	VRSL 41
6	VRSL40	**12**	VRSL 134	**18**	VRSL 164

The details of the screening of tomato germplasm lines were as follows.

Crop: Tomato
Location:Centre of Excellence, Venkataramannagudem.
Number of Germplasm: 18
Spacing: 50×40cm
Checks: Arkavikas. Polyana, BSS 1006.
Season: Winter

Table 2. Disease rating scale employed for scoring the fusarium wilt disease of tomato genotypes [2]

Per cent disease incidence	Reaction group	Symbol
0 %	Tolerant	(T)
0.1-10 %	Highly resistant	(HR)
10.1-30 %	Moderately Resistant	(MR)
30.1-50 %	Moderately susceptible	(MS)
50.1-70 %	Susceptible	(S)
70.1-100 %	Highly susceptible	(HS)

Table 3. Disease rating scale employed for scoring the tomato leaf curl virus disease of tomato genotypes [3]

Per cent disease incidence	Reaction group	Symbol
0	Tolerant	(T)
0.1-5 %	resistant	(R)
5.1-10 %	Moderately Resistant	(MR)
10.1-25 %	Moderately susceptible	(MS)
25.1-50 %	Susceptible	(S)
50.1-100 %	Highly susceptible	(HS)

Plate 1. Field view of screening of tomato germplasm lines against fusarium wilt and tomato leaf curl virus diseases in naturally ventilated poly house conditions

3. RESULTS AND DISCUSSION

The experiment was conducted during *rabi* 2021 under naturally ventilated poly house, which located at Center of Excellence, Dr. Y.S.R. Horticultural University, Venkataramannnagudem. Twenty one tomato genotypes which included 18 germplasm lines and 3 commercial cultivars as check (Arka Vikas, Polyana and BSS 1006) were collected from the HRS, Venkataramannagudem and screened against fusarium wilt and tomato leaf curl virus diseases in naturally ventilated polyhouse (Table 1). Disease infection was recorded on 21 genotypes at weekly interval. It was recorded from 1st week of September to 2nd week of February. A total two diseases (1 fungal and 1 viral) *viz.,* Fusarium wilt of tomato (*Fusarium solani*), and tomato leaf curl virus appeared during the course of investigation.

3.1 Toamto Leaf Curl Virus

Based on the reaction of each genotype they were grouped in to different categories for tomato leaf curl virus disease (Table 3) *viz.,* Tolerant (T), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S), and highly susceptible (HS) (Singh 2014). Among the 21 genotypes screened lowest per cent disease incidence was recorded in VRSL - 114 (5.88 %), VRSL-134 (6.54 %) and VRSL-136 (6.86 %). Highest per cent disease incidence was recorded in Arka Vikas (17.87 %) (Table 4 and Fig. 1).

Screening results revealed that out of 21 genotypes screened, genotypes grouped under moderately resistant (MR) and moderately susceptible (MS) only. None of them grouped under immune (I), resistant (R), susceptible (S) and highly susceptible (HS) categories. Total eight lines, namely VRSL-36, VRSL-45, VRSL-104, VRSL-114, VRSL-134, VRSL-182, VRSL-224 and VRSL-164 were grouped under moderately resistant and remaining all genotypes were categorised under moderately susceptible reaction to ToLCV disease (Table 3). Genotypes were grouped based on their response to tomato leaf curl virus disease in naturally ventilated poly house (Table 6).

Many authors reported tomato leaf curl virus is the major limiting factors affecting health and yield of tomato in field, and protected conditions [4-7]. Moreover, the prevalence of insect vector efficiently transmits viruses and severely affects the production system [8]. The resistant genotypes were found to act as natural barrier and disfavor virus incidence [9], (Ray et al. 2017).

3.2 Fusarium Wilt

Among the 21 genotypes screened lowest per cent disease incidence was recorded in VRSL - 40 and VRSL-134 (9.79 %). Highest per cent disease incidence was recorded in Arka Vikas (32.28 %) (Table 4 and Fig. 2). Based on the reaction of each genotype they were grouped in to different categories for fusarium wilt disease *viz.,* immune (I), highly resistant (HR), moderately resistant (MR), moderately susceptible (MS), susceptible (S), and highly susceptible (HS) (Table 2). Results showed that total 21 genotypes screened, all genotypes grouped under highly resistant (HR) and moderately resistant (MR) only. None of them grouped under immune (I), moderate susceptible (MS), susceptible (S) and highly susceptible (HS) categories.

Among 18 lines only two lines, namely VRSL-40 and VRSL-134 were grouped under highly resistant and 18 genotypes, VRSL-18, VRSL-24, VRSL-28, VRSL-36, VRSL-38, VRSL-41, VRSL-42, VRSL-45, VRSL- 104, VRSL- 106, VRSL-114, VRSL- 123, VRSL- 124, VRSL- 164, VRSL-180, VRSL- 182, Polyana and BSS-1006 were categorised under moderately resistant and Arka Vikas grouped under moderate susceptible (MS) reaction to fusarium wilt disease (Table 4). Genotypes were grouped based on their response to fusarium wilt disease in naturally ventilated poly house (Table 5).

Intensive cultivation of a single crop in poly houses led to the emergence of soil-borne plant diseases. In some areas this situation was resulted in huge economic losses to the growers. Fusarium wilt is a serious disease of tomato especially in warmer conditions because the pathogen requires a soil temperature around 28^0 C for its growth and development [10]. It was observed that temperature from 25-33^0 C favours the development of fusarium wilt. These findings were in agreement with early findings of Bawa, [11] and Debbi et al. [12], Rai [13].

Table 4. Screening of tomato germplasm lines against fusarium wilt and tomato leaf curl virus diseases in naturally ventilated poly house conditions

Germplasam lines	% Disease Incidence			
	Fusarium wilt	Disease Reaction	Tomato Leaf curl virus	Disease Reaction
VRSL 18	21.96	MR	14.38	MS
VRSL 24	21.43	MR	10.13	MS
VRSL 28	19.05	MR	10.46	MS
VRSL 36	22.22	MR	6.86	MR
VRSL 38	19.05	MR	14.38	MS
VRSL 40	9.79	HR	11.11	MS
VRSL 42	20.11	MR	13.73	MS
VRSL 45	17.2	MR	8.5	MR
VRSL 104	18.78	MR	9.8	MR
VRSL 106	20.37	MR	12.75	MS
VRSL 114	21.16	MR	5.88	MR
VRSL 134	9.79	HR	6.54	MR
VRSL 180	19.31	MR	15.03	MS
VRSL 182	16.67	MR	7.19	MR
VRSL 223	14.29	MR	11.76	MS
VRSL 224	18.78	MR	9.15	MR
VRSL 41	19.31	MR	12.09	MS
VRSL 164	21.16	MR	7.19	MR
Arka Vikas	32.28	MS	17.97	MS
Polyana	26.85	MR	13.73	MS
BSS 1006	24.87	MR	12.09	MS

** HR=highly resistant MR= moderately resistant MS= moderately susceptible*

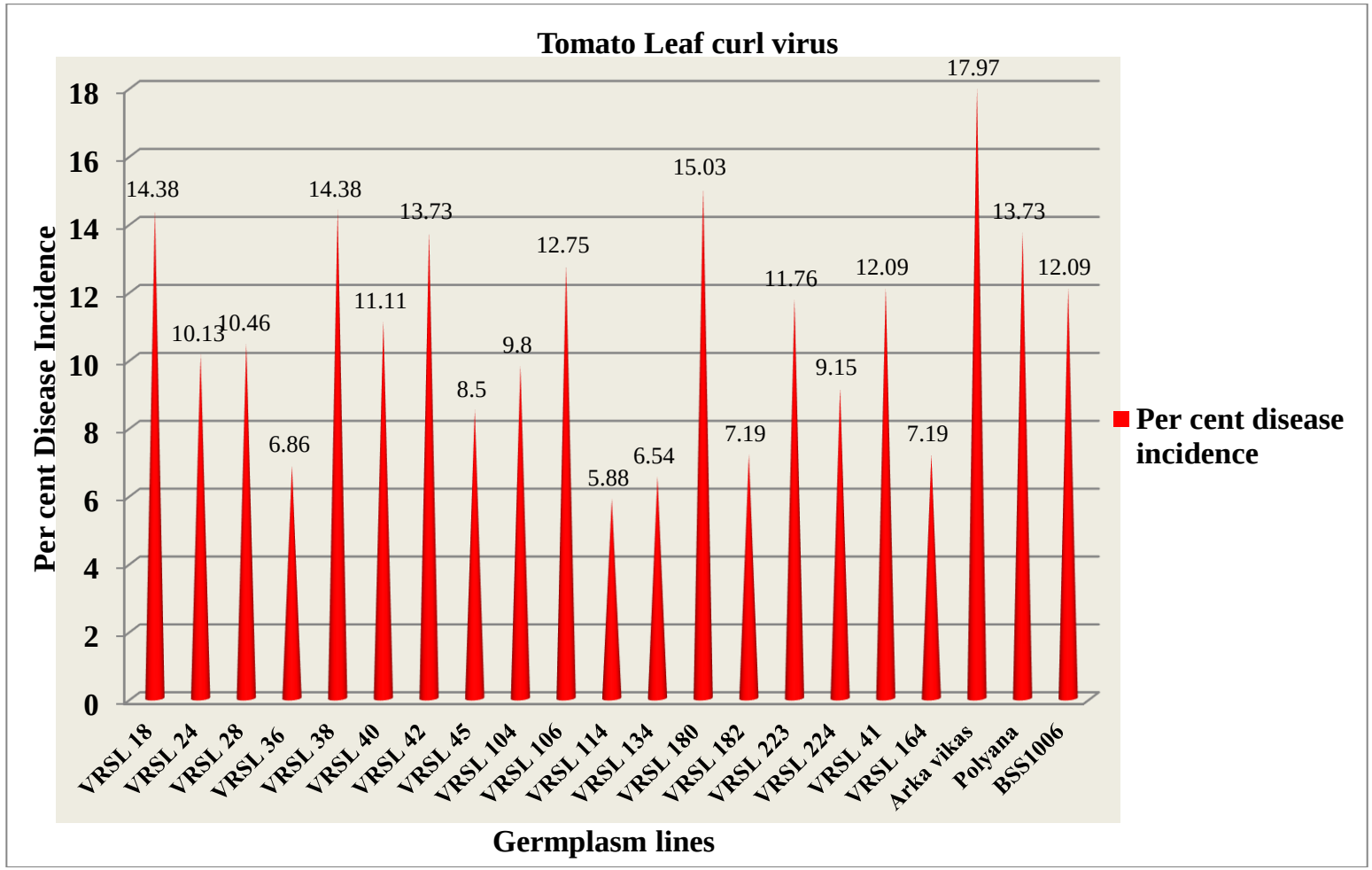

Fig. 1. Screening of tomato germplasm lines against tomato leaf curl virus disease

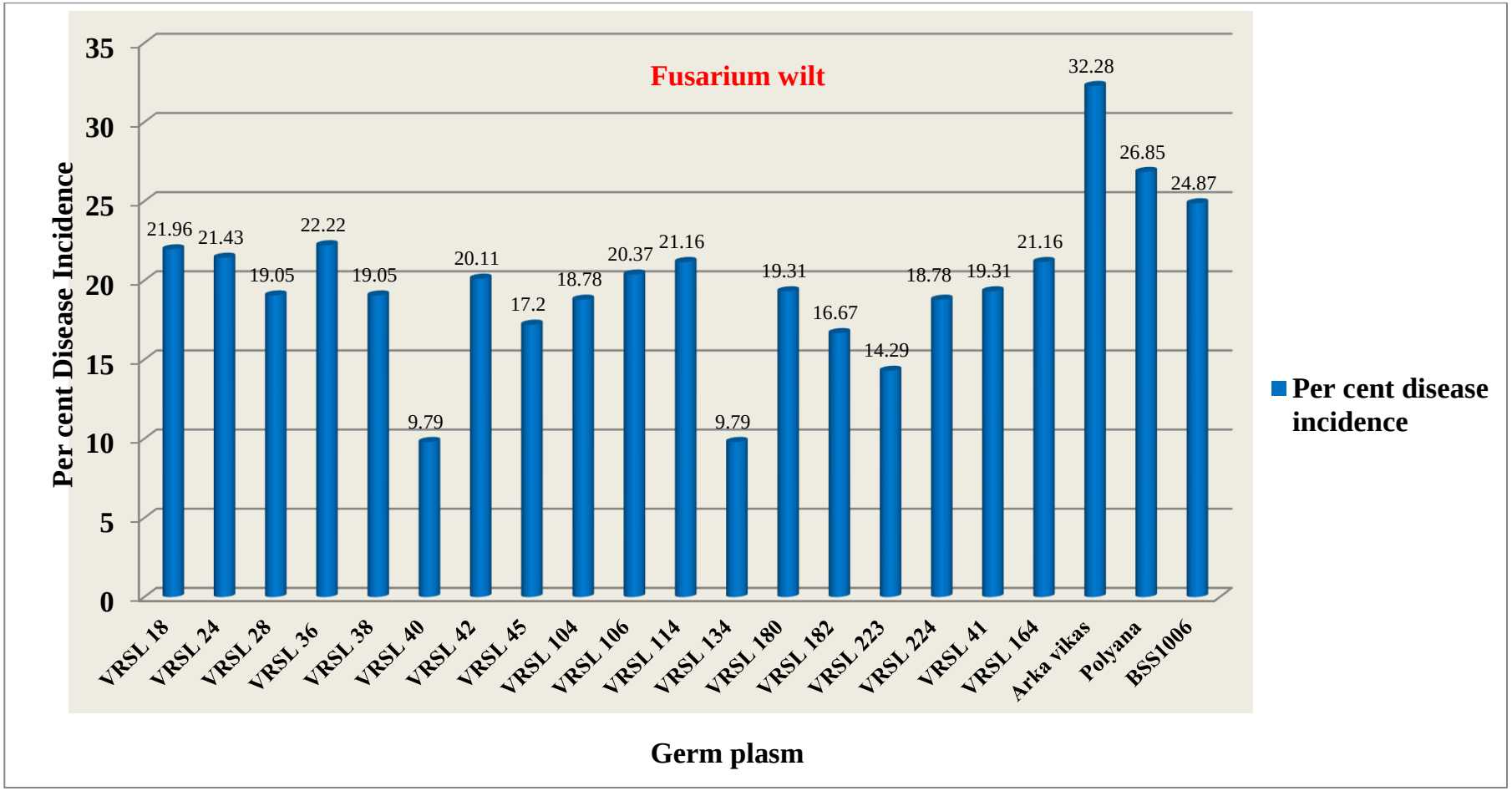

Fig. 2. Screening of tomato germplasm lines against fusarium wilt disease

Table 5. Grouping of various tomato genotypes into different categories on the basis of their response to fusarium wilt disease

Reaction category	Per cent disease incidence	Genotype
Immune (I)	0	**-**
Highly resistant (HR)	1-10	VRSL -40, VRSL -134
Moderately Resistant (MR)	11-30	VRSL -18,VRSL -24, VRSL -28, VRSL -36, VRSL -38, VRSL -41, VRSL -42, VRSL -45, VRSL -104, VRSL -106, VRSL -114, VRSL -123, VRSL -124, VRSL -164, VRSL -180, VRSL -182, Polyana and BSS1006.
Moderately susceptible (MS)	31-50	Arka Vikas
Susceptible (S)	51-70	**-**
Highly susceptible (HS)	71-100	**-**

Table 6. Grouping of various tomato genotypes into different categories on the basis of their response to tomato leaf curl virus disease

Reaction category	Per cent disease incidence	Genotype
Immune (I)	0	**-**
resistant (R)	0.1-5 %	**-**
Moderately Resistant (MR)	5-10 %	VRSL-36, VRSL-45, VRSL-104, VRSL-114, VRSL-134, VRSL-182, VRSL-224 and VRSL-164
Moderately susceptible (MS)	10-25 %	VRSL -18,VRSL -24, VRSL -28, , VRSL -38, VRSL -40 VRSL -42, VRSL -106, VRSL -180, VRSL -223, VRSL -41, Arkavikas, polyana and BSS-1006**.**
Susceptible (S)	25-50 %	**-**
Highly susceptible (HS)	50-100 %	**-**

4. CONCLUSION

In present study it was concluded that out of 21 genotypes screened, total eight lines, namely VRSL-36, VRSL-45, VRSL-104, VRSL-114, VRSL-134, VRSL-182, VRSL-224 and VRSL-164 were grouped under moderately resistant and remaining all genotypes were categorized under moderately susceptible reaction to ToLCV disease. Among 18 lines only two lines, namely VRSL-40 and VRSL-134 were grouped under highly resistant. These resistant lines/varieties can further be exploited in tomato breeding programmes i.e., these can directly be released as commercial cultivars and otherwise these can be used as source resistant parents in various crosses to transfer their resistance against ToMV.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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