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Evaluation of Different Germplasm and Insecticides against Tomato Leaf Curl Virus Affecting Tomato

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A B S T R A C T

Tomato leaf curl disease caused by tomato leaf curl virus (ToLCV) is a major limiting factor in tomato cultivation in Jammu region of Jammu and Kashmir. Screening of different germplasm collected from different sources against the disease showed that out of fifteen germplasm, Mahaveer and Avinash-2 were found resistant, Samrudhi F1 and Namdhari 82535 were found moderately resistant while eleven germplasm *viz.* Heem Sohna, Sonali, Rupali, NS 816, NS 812, Pusa Ruby, Indus 1030, Arti, DVRT-2, Hybrid no. 15 and local showed susceptible reaction. Different insecticide (imidacloprid, thiamethoxam, dimethoate, acetamiprid, profenofos and oxy-demeton methyl) were evaluated against tomato leaf curl disease under field condition and it was found that at 70 DAT seed treatment + seedling dip + foliar application of imidacloprid showed lowest disease intensity followed by foliar application of imidacloprid, seed treatment with imidacloprid, foliar application of thiamethoxam, foliar application of dimethoate, foliar application of acetameprid, foliar application of methyl-o-demeton and foliar application of profenofos treatments, respectively.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is a herbaceous fruiting plant belonging to the family Solanaceae. It originated in Latin America and has become one of the most popular and widely cultivated vegetable crops of the world with ability to survive in diverse environmental conditions. It is universally treated as "protective food" and provides almost all types of vitamins and minerals in quite fair amount. In the world, tomato is cultivated over an area of 46.15 lakh hectares with an annual production of 1279.9 lakh tonnes and the productivity of 27.73 tonnes per hectare. In India, it occupies an area of about 5.35 lakh hectares producing over 93.62 lakh tonnes with the productivity of 17.5 tonnes per hectare (Anonymous, 2006), while in Jammu region of Jammu & Kashmir the area under tomato cultivation is 1,280 hectare with the production of 23,550 metric tonnes and productivity of 18.40 tonnes per hectare (Anonymous, 2011). Although area under tomato cultivation is high, the crop is suffering from large number of disease, among them tomato leaf curl disease caused by tomato leaf curl virus (ToLCV) is a major limiting factor in tomato cultivation. In India the virus caused 100 % infection and yield losses up to 90 % (Muniyappa, 2003; Reddy *et al*., 2011 and Shankarappa *et al*., 2008).

Tomato leaf curl virus disease (ToLCVD) is characterized by yellowing of leaf edges, upward leaf cupping, puckering, twisting of leaves, followed by marked reduction in leaf size. The diseased plants look pale and stunted due to shortening of internodal length with more lateral branches resulting in a bushy appearance (Vasudeva and Sam Raj, 1948). The disease is transmitted by whitefly (*Bemisia tabaci)* of the Family *Aleyrodidae* (Cohen and Nitzany, 1966) in a persistent and circulative manner and not mechanically or seed transmissible (Green *et al.*, 1987). Considering the importance of the crop, evaluation of different germplasm and insecticides were done under field conditions for the management of the disease.

Materials and Methods

Screening of tomato germplasm

Fifteen germplasm of tomato (Samrudhi F-1, Heem Sohna, Sonali, Rupali, Mahaveer, NS 812, NS 816, Pusa ruby, Avinash-2, Indus 1030, Namdhari 82535, Arti, DVRT-2, Hybrid no 15 and local variety), collected from different sources were screened against tomato leaf curl virus under natural epiphytotic conditions for determining resistance against the disease. No plant protection measures were adopted. Observations on disease incidence were recorded at 15 days interval starting from 40 days after transplanting by using the scale given by Sharma and Sharma (1984) (Table 1).

Disease scoring

Percent disease incidence was recorded and calculated by using the following formula:

$$\text{Percentage of Disease Incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Chemical control: The field experiment was conducted at research farm, Division of Plant Pathology, Sher-e-Kashmir Agricultural Sciences and Technology, Jammu in a Randomized Block Design with nine treatments and three replication including untreated control with a susceptible variety (Pusa Ruby), three sprays were done for management of the disease under field conditions. The first spray was given at the appearance of the disease symptoms followed by two sprays at 15 days interval. In case of control only water was sprayed.

Percent disease intensity was calculated by using 0-4 scale (Lapidot and Friedmann, 2002) (Table 2).

Observations

Percentage of disease intensity of tomato leaf curl virus in treated and untreated plots was calculated by using standard formula (McKinney, 1923).

$$\text{Percentage of Disease Index (PDI)} = \frac{\text{Sum of all numerical rating}}{\text{Maximum disease grade} \times \text{Total number of plants observed}} \times 100$$

Statistical analysis

The experiment data was analyzed by using standard methods to test the significance (Gomez and Gomez, 1984).

Results and Discussion

Screening

Identification of resistant genotype is one of the important aspects in management of ToLCV disease. In the present study, screening experiment was taken up to access the incidence of the disease in different germplasm (Samrudhi F-1, Heem Sohna, Sonali, Rupali, Mahaveer, NS 812, NS 816, Pusa ruby, Avinash-2, Indus 1030, Namdhari 82535, Arti, DVRT-2, Hybrid no 15 and local variety) under field conditions (Table 3). It

was observed that disease incidence ranged from 0.00 to 66.66 per cent at 70 days after transplanting. Further it was found (Table 4) that out of 15 germplasm, two germplasm viz. Mahaveer, Avinash-2 were found resistant (R), Samrudhi F1 and Namdhari 82535 were found moderately resistant (MR) while Heem Sohna, Sonali, Rupali, NS 812, NS 816, Pusa ruby, Indus 1030, Arti, DVRT-2, Hybrid no 15 and local were found susceptible (S).

The screening of different genotypes of tomato for managing the tomato leaf curl disease has been also reported by Hassan *et al*., (1984); Banerjee and Kalloo (1987); Pilowsky and Cohen (1990); Zakay *et al*., (1991); Muniyappa *et al*., (2000); Sajeed Ali *et al*., (2002); Maruthi *et al*., (2003); Singh (2014) and Zeshan *et al*., (2016).

Evaluation of insecticides against tomato leaf curl virus (ToLCV) under field conditions

Attempts were also made to develop management strategies using different chemicals such as imidacloprid, thiamethoxam, dimethoate, acetamiprid, profenofos and methyl-o-demeton to manage the disease intensity under field conditions. The different insecticides were evaluated to know their efficacy by controlling the vector *Bemisia tabaci* which is responsible for spread of the disease. From the results, the application of imidacloprid (seed treatment+ seedling dip+ foliar application) at 70 DAT was found most effective treatment in maintaining the disease intensity of 8.14 %. The other combinations of imidacloprid were also effective in reducing the disease intensity at different days after transplanting. The other chemical *viz.* thiamethoxam, dimethoate, acetamiprid, profenofos and oxy-demeton methyl were also found effective in reducing the disease intensity as compared to untreated plots (Table 5).

The minimum disease intensity of 8.14 % was recorded in seed treatment + seedling dip + foliar application of imidacloprid followed by foliar application of imidacloprid (9.62 %), seed treatment with imidacloprid (11.10 %), foliar application of thiamethoxam (11.84%), foliar application of dimethoate (12.59 %), foliar application of acetameprid (13.33 %), foliar application of methyl-o-demeton (13.33 %) and foliar application of profenofos (14.07 %), whereas per cent disease intensity in control was (30.73%).

Yassin *et al*., (1975), also reported that the application of insecticidal spray delayed the development of leaf curl disease on transplanted tomato and slow down the progress of disease. The application of different insecticides to reduce the incidence of tomato leaf curl disease by checking the whitefly population was also reported by Sastry and Singh (1973); Butter and Rataul (1973); Rajasri *et al*., (2009); Singh and Prajapati (2014). Manson *et al*., (2000), conducted an experiment on inhibition of transmissions of ToLCV by using thiamethoxam as soil drench and foliar spray and found that a good level of protection against the disease was given by soil drenching (up to 22 days) than foliar spray. Further, they also reported that the thiamethoxam activity in preventing ToLCV transmission by *B. tabaci* was simply due to killing action and not by anti feedant/repellent action.

Efficacy of imidacloprid to check tomato leaf curl virus under field conditions was also reported by Ahmed *et al*., (2001), who found that the repeated sprays of imidacloprid reduced disease incidence and the treated plots consistently had higher yields than control plots.

Table.1 Scale for grading varietal response of tomato germplasm against tomato leaf curl disease

Percent disease incidence	Grade	Reaction group
0-10%	Resistant	R
>10-30 %	Moderately resistant	MR
> 30-70 %	Susceptible	S
>70-100 %	Highly susceptible	HS

(Sharma and Sharma, 1984)

Table.2 Disease severity index

0	No visible symptoms.
1	Slight yellowing of leaflet margins on apical leaf.
2	Some yellowing and minor curling of leaflet ends.
3	Curling and cupping, with some reduction in leaf size of plant.
4	Severe stunting and yellowing of plant with pronounced leaf cupping and curling.

Table.3 Screening of different germplasm of tomato against tomato leaf curl virus under field conditions

S.No	Germplasm	Disease Incidence (%)			Grade
		40 DAT	55DAT	70DAT	
1	Samrudhi F1	22.22	25.92	29.62	MR
2	Heem sohna	29.62	33.33	37.03	S
3	Sonali	33.33	40.74	40.74	S
4	NS 812	40.74	48.14	48.14	S
5	Pusa ruby	59.25	62.96	66.66	S
6	Mahaveer	0	0	0	R
7	Rupali	48.14	51.85	55.55	S
8	Indus 1030	33.33	37.03	40.74	S
9	Namdhari 82535	22.22	23.33	25.92	MR
10	DVRT-2	37.03	44.44	44.44	S
11	N.S.-816	44.44	48.14	50.00	S
12	Avinash-2	0	0	0	R
13	Arti	48.14	51.85	59.25	S
14	Hybrid no 15	25.92	29.62	33.33	S
15	Local	50.00	59.25	62.96	S

Table.4 Summary of disease reaction of different germplasm against tomato leaf curl virus under field conditions

Reaction	Disease Incidence (%)	No. of entries	Germplasm
Resistant	0	2	Avinash-2, Mahaveer
Moderately resistant	1-30	2	Samrudhi F1, Namdhari 82535
Susceptible	>30- 70	11	Heem Sohna, Sonali, Rupali, NS 812, NS 816, Pusa Ruby, Indus 1030, Arti, DVRT-2, Hybrid no 15 and local variety
Highly Susceptible	>70- 100	0	----

Table.5 Evaluation of different Insecticides against tomato leaf curl virus (ToLCV) under field conditions in variety Pusa Ruby

Treatment	Percent Disease Intensity		
	40 DAT	55 DAT	70 DAT
Foliar appilicaton of Profenofos	7.40 (15.74)	11.85 (20.11)	14.07 (22.00)
Foliar application of Methyl-o-demeton	9.62 (18.04)	11.10 (19.39)	13.33 (21.40)
Foliar application of Dimethoate	7.40 (15.74)	11.10 (19.39)	12.59 (20.75)
Foliar application of Thiamethoxam	6.66 (14.81)	7.40 (15.74)	11.84 (20.04)
Foliar application of Imidacloprid	5.92 (14.01)	8.14 (16.53)	9.62 (17.89)
Foliar application of Acetamiprid	10.36 (18.75)	11.11 (19.46)	13.33 (21.40)
Seed treatment with Imidacloprid	6.66 (14.81)	8.33 (17.24)	11.10 (19.39)
Seed treatment+Seedling dip +foliar application with Imidacloprid	4.44 (11.89)	5.18 (13.08)	8.14 (16.53)
Control	24.07 (29.36)	27.40 (31.51)	30.73 (33.63)
SE (m)	0.98	0.95	1.02
CD (P=0.05)	2.99	2.88	3.08

Gajanana *et al*., (2006) also reported that root dipping of tomato seedlings in imidacloprid just before transplanting followed by spraying at 15 days after planting gave greater reduction in incidence of tomato leaf curl virus. The overall view of the table suggest that at 40 DAT and 70 DAT there was no significant variation in disease intensity in the

plots treated with seed treatment + seedling dip + foliar application of imidacloprid, foliar application of imidacloprid and seed treatment of imidacloprid.

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