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## MANAGEMENT OF TOMATO LEAF CURL VIRUS THROUGH NON-CHEMICALS IN RELATION TO ENVIRONMENTAL FACTORS

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### ABSTRACT

*Tomato leaf curl virus* (TLCV) is one of the most devastating and widely distributed viruses in the tomato crop, transmitted through whitefly in nature. Disease incidence and severity of TLCV were monitored on four tomato varieties/lines. Tomato leaf curl disease was managed through three non-chemical treatments viz., compost, nutrient enrich compost and multi-nutrients. The incidence of TLCV was found in the range of 57% to 70%. Among all the tomato varieties/lines, VRI-49 was moderately resistant, Nagina and Money Maker were susceptible, and VRI-20 was found to be highly susceptible against TLCV. Compost (44.02±3.26c) was the most effective way to suppress the progression of disease severity. Environmental factors (Max. and Min. temperatures, Relative humidity and Rainfall) showed significant correlation with disease development. Treatments were able to suppress the disease development even in the presence of favorable environmental conditions. The increase in relative humidity increased the disease progression significantly.

**Keywords:** TLCV, Disease progression, Tomato, Non-chemicals and environment

### INTRODUCTION

Vegetables are inevitable for human's diet and tomato crop gain importance because it's abundant use in everyday life. Like other crops tomato is also under the attack of many diseases caused by different pathogens. Among them, viral diseases are major constraints in tomato production (Chavan *et al.*, 2015). Characteristic symptoms of tomato viruses are stunting, crinkling, small fruits or no fruits. Die back of infected plants has been found in severe cases (Raj *et al.*, 2005). *Tomato leaf curl virus* (TLCV) is one of the most devastating viruses that causes heavy losses in yield of tomato crop around the globe. TLCV was firstly reported in the 1980s in Sudan and is

transmitted through whitefly (*Bemisia tabaci*) as insect vector in nature (Sugano *et al.*, 2011). It is a circular single stranded DNA *Geminivirus* belongs to family *Geminiviridae* (Gottlieb *et al.*, 2010). Preliminary studies regarding incidence, transmission, detection and characterization have been carried out in the different part of the world (Rybicki, 2015). Different viral diseases in Pakistan are; *Tomato leaf curl virus* (TLCV), *Tomato mosaic virus* (ToMV), *Potato virus X* (PVX), *Cucumber mosaic virus* (CMV), *Tomato yellow top virus* (TYTV), *Tomato spotted wilt virus* (TSWV) and *Tomato ring spot virus* (TRSV) (Mughal, 1985). During a survey in tomato fields of Hyderabad district, Sindh, Pakistan, 68% of tomato fields were infected with different kinds of viruses. The mean incidence of different viral diseases of winter tomato; *Tomato mosaic virus* (ToMV) 34.38%, CMV 12.92%, TLCV 15.08%, and TYTV 8.26% were

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recorded on the basis of symptoms in Malakand agency (Hassan *et al.*, 1993). The epidemics of TLCV in relation to increase in whitefly population on tomato has been reported (Maluta *et al.*, 2014). Chemicals and botanicals/plant extracts have been used to control the insect vector during the management of plant viruses. Moreover, non-chemical approaches are also the eco-friendly. Non-chemical approaches including micronutrients and botanicals have been used to manage plant virus (Ali *et al.*, 2014). The incidence of TLCV can be reduced through different chemicals and using certain practices in the field (Chakraborty *et al.*, 2003). Another approach practiced in protected culture is Ultraviolet absorbing plastic films; have presented good results (Antignus *et al.*, 2001). Another approach named as Rouging was also highly recommended and plants exhibiting early symptoms can be detached to decrease the inoculation source inside the fields (Polston *et al.*, 2007). Non-chemical approaches to control the diseases are not only eco-friendly but also the need of time. Continual prevalence of viral diseases is considered to be the major cause of low tomato production. There is the scarcity of information regarding incidence and

management of TLCV available in Pakistan as well as in the world. Therefore, present study was carried out a) to record the disease incidence and b) to manage the infected crop through nutrients and composts.

**MATERIALS AND METHODS**

The trial was carried out at the research area of University College of Agriculture, University of Sargodha, Pakistan. The nurseries of four varieties (VRI-20, VRI-49, Nagina and Money maker) were raised in earthen pots having sandy loam soil added with one part of farm yard manure (FYM). The soil was sterilized with Formalin (1:340) prior filling the pots to inhibit the growth of soil borne plant pathogens. At 3-5 leaves stage tomato plants were transplanted into the field. Seed beds were prepared. The plant to plant distance of 9 inches and row to row 2 feet were maintained. All the recommended agronomic practices were carried out during the trial.

**Disease Incidence and severity:** On the basis of visual symptoms, disease incidence was calculated after the interval of fifteen (15) days as follows until two weeks before harvesting.

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

Disease severity was calculated according to Lapidot *et al.*, (2001) the disease rating scale with slight modifications as follows:

Rating scale	Severity Range	Response
0	No symptoms	Highly Resistant (HR)
1	mild curling (25 % leaves)	Resistant (R)
2	Curling, puckering (26-50 % leaves).	Moderately Resistant (MR)
3	Curling, puckering of 51-75 % leaves	Susceptible (S)
4	Severe stunting and yellowing, pronounced leaf cupping and curling; growth of plant stopped.	Highly Susceptible (HS)

Nutritional Management: Four treatments;

T1= Control (Nothing applied except water),

T2= Compost,

T3= Nutrient Enriched Compost (NEC). (Applied in form of granules in the soil near the base of plants),

T4= 2.5 % Multi-nutrients. Multi-nutrients were applied as the foliar spray.

Meteorological data (minimum and maximum temperatures, rainfall and relative humidity for the whole period of trial (from sowing till harvesting of the crop) was collected from the weather station of In-service agriculture training institute. The trial was carried out in a randomized complete block design (RCBD) with three replications. The collected data was subjected to statistical analysis using “R” software for Windows”.

**RESULTS**

**Incidence and disease severity of TLCV:** The disease incidence was in the range of 57% to 70%. The highest disease incidence was recorded in VRI-20 (70%) followed by Nagina (66%) and Money Maker (63%). The least disease incidence (57%) was recorded in VRI-49 (Table 1). The disease severity was recorded on the basis of disease rating scale where VRI-49 showed moderately resistant (MR) response while VRI-20 was highly

susceptible (HS), Whereas Nagina and money maker were susceptible (S) against TLCV (Table 2).

**Impact of treatments on disease severity:** Application of the four treatments on Tomato varieties showed significant results. Those treatments suppress the progression in disease severity. Among all the treatments, compost (T2) was found to be the most significant in reducing the progression of disease severity. The effect of Nutrient Enriched Compost (T3) was at par with that of compost. The progression of TLCV disease severity for nutrients (T4) and control (T1) hardly had any difference among each other (Table 3). The statistical analysis also revealed that

progression in TLCV disease severity was significantly reduced due to the application of compost (44.02±3.26c) as compared to control where the disease was progressing with the passage of time (55.38±3.28a). The effect of NEC and multi-nutrients was not significantly different among each other with standard deviations in mean values of 50.69±3.15ab and 54.16±2.63b respectively. Nutrients showed the suppression of disease progression in three varieties (Money Maker, Nagina and VRI-20) which were susceptible. The least suppression in disease severity progression was found in moderately resistant variety VRI-49 (45.91±3.18c) (Table 3).

Table 1. Incidence of TLCV on four varieties/line of tomato

Varieties	Total plants observed	Infected plants	Incidence (%)
VRI-49	120	69	57%
VRI-20	120	84	70%
Money Maker	120	76	63%
Nagina	120	80	66%

Table 2. Incidence of TLCV on four varieties/lines of tomato

Varieties	Severity Index	Reaction
VRI-49	2	Moderately resistant (MR)
VRI-20	4	Highly Susceptible (HS)
Money Maker	3	Susceptible (S)
Nagina	3	Susceptible (S)

Table 3. Impact of different treatments/varieties on disease severity of TLCV on four tomato varieties/lines

Varieties	Treatment				Means ±S.D
	Control	Compost	NEC	Nutrients	
Money Maker	53.33	47.22	51.66	48.88	50.27.16±3.06b
Nagina	53.33	46.66	49.44	53.33	50.69±3.28b
VRI-49	45.88	35.55	46.66	55.55	45.91±3.18c
VRI-20	69.00	46.66	55.00	58.88	57.47±2.88a
	55.38±3.28a	44.02±3.26c	50.69±3.15ab	54.16±2.63b	

Means within a column followed by the same letter are not significantly different according to Least Significant Difference Test  $P = 0.05$ .

**Relationship of environmental factors with TLCV disease severity:** The environmental factors showed significant effect on TLCV in relation to all varieties. There was decrease in disease severity with the increase in maximum and minimum temperature. The linear regression model explained this relation,

where the value of R is -0.82\*\*\* for maximum temperature and -0.77\*\*\* for minimum temperature. While rainfall showed a significant positive correlation with a value of R 0.34\*\*\*. Relative humidity was positively correlated to TLCV disease severity (Figure 1).

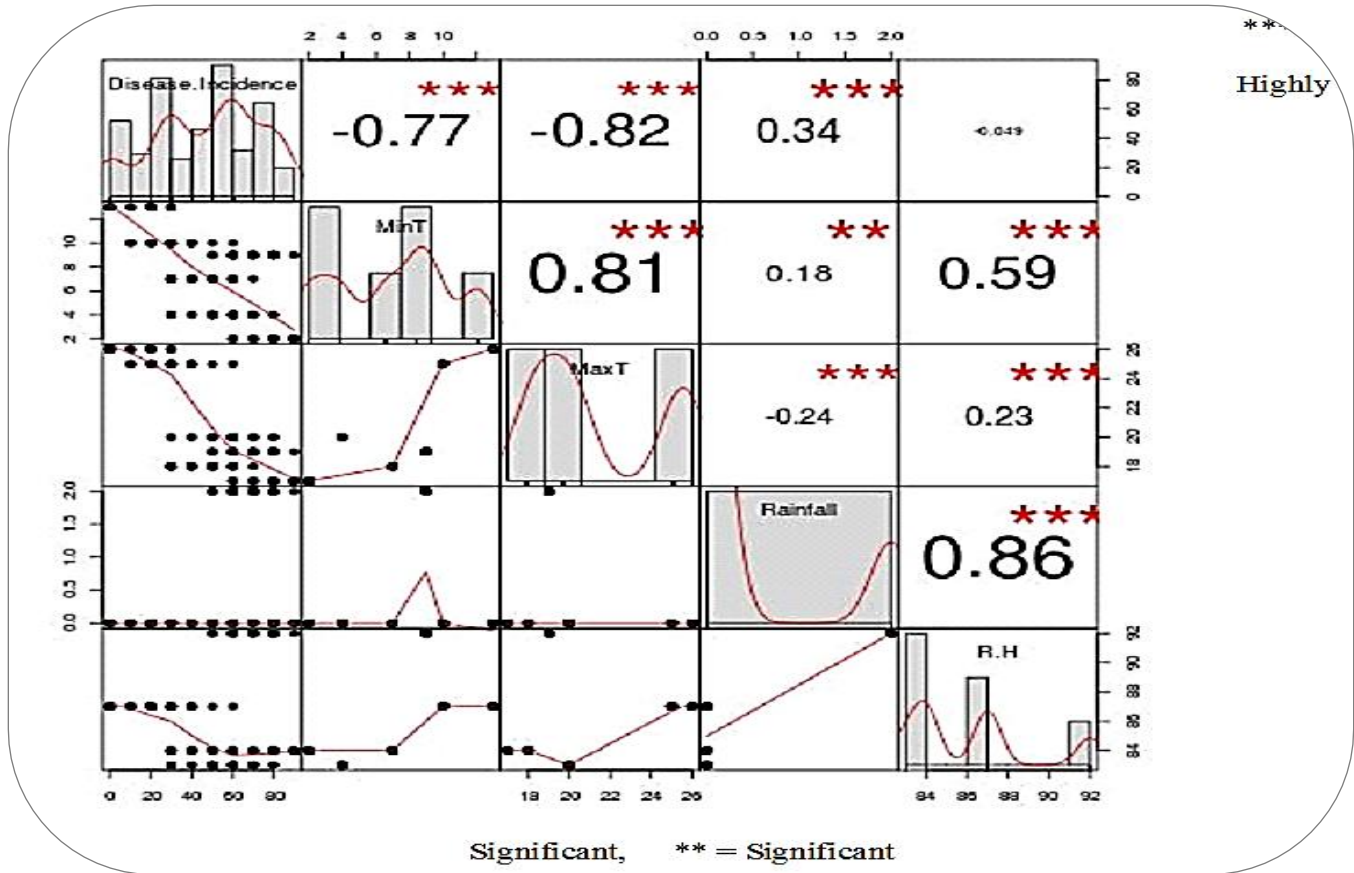


Figure 1. Relationship of environmental factors with disease severity

**DISCUSSION**

TLCV is one of the most prevalent virus diseases in the tomato field. It is an emerging *Gemini virus* in the tomato crop. The scarcity of information is available regarding incidence and management of TLCV. The incidence of virus disease was up to 70% in the field conditions. The treatments showed significant response towards TLCV and were able to suppress the disease severity in the field. Compost was the most effective with lowest disease severity value. The organic manures and composts have a direct effect on suppressing the disease by stimulating competing micro-organisms and also able to induce resistance in the plant against diseases (Shafique *et al.*, 2016; Hoitink, 2006). In our findings, compost plays a vital role in suppressing TLCV and results were similar to previous findings in relation to suppress different diseases (Ali *et al.*, 2014; Ghorbani *et al.*, 2006). Compost and some other manure against chili diseases were applied to check the efficacy. Compost was able to reduce the disease incidence of, another virus, chili leaf curl as compared to control (Hassan *et al.*, 2013). The application of compost against

virus diseases has a significant impact. In our results, compost was also proved to be significant in reducing the progression in disease incidence as compared to control (Chandrasekaran, 2005; De *et al.*, 2005). The application of potassium has also been used to reduce the whitefly population. It was observed that whitefly population decreased by the application of a high dose of potassium which ultimately responsible for the increase in cotton leaf curl disease severity (Hassan *et al.*, 1993). Epidemiology also plays the vital role in spread and development of the disease. Therefore, progression in disease incidence was correlated with environmental factors like maximum temperature, minimum temperature, relative humidity and rainfall. The maximum and minimum temperature had positive correlation while relative humidity and rainfall had a negative correlation with the disease but in our results maximum and minimum temperature was negatively correlated and relative humidity is positively correlated. The impact of environmental factors on TLCV has not been studied extensively. OYVMV and whitefly population were correlated with environmental factors.

There was positive correlation between humidity and minimum temperature, While, rainfall had negative correlation for tomato viruses that is contradicting to our results (Hassan *et al.*, 1993). Negative correlation was found between maximum temperature and whitefly infestation in relation to viral disease. There was significant correlation between relative humidity and whitefly and disease severity. Our results were in accordance with Ali *et al.*, (2005) who found the non-significant correlation between rainfall and okra yellow vein mosaic virus. The relative humidity supports the virus disease development. Our results were similar to previous research (Kadian, 1989). There was statistical significant correlation of environmental factors with *Tomato mosaic virus* (ToMV) during the screening of different tomato varieties ToMV. Our results in relation to environmental factors did not match except rainfall (Imran *et al.*, 2013). According to them there was decrease in disease severity with the increase in rainfall. The contradiction in our results with previous trend is due to the application of treatments to manage the TLCV disease. The direct information for the management of TLCV is not available in literature so continuous trials in future to develop the epidemiological model are the aspect to be studied. As treatments had their effect on disease development so it is highly possible that progression in the disease severity in relation to environmental factors was altered in our trial as compared to previous trend found in literature, where they studied the environmental factors on the untreated crops. It is also therefore concluded that nutritional management of TLCV was not affected by environmental factors and non-chemicals/organic amendments should be encouraged to manage the diseases.

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