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Response of selected tomato varieties (*Solanum lycopersicum*) to tomato yellow leaf curl virus

Siganka, N. J.

Department of Biotechnology, University of Eldoret, P.O. Box 1125-30100, Eldoret, Kenya
Corresponding author: sigankankori@yahoo.com

Abstract

Lack of tomato varieties that are tolerant to Tomato Yellow Leaf Curl Virus (TYLCV) is the major problem that hinders the control and management of TYLCV severity on tomato plants. The pathogen is transmitted from leaf to leaf by a vector, silver leaf whitefly (*Bemisia tabaci*) and due to the large population of whiteflies, and their ability to develop pesticide resistance, vector seclusion and use of synthetic chemicals to control the disease is not an ideal way of fighting the spread and damage induced by tomato yellow leaf curl virus. Therefore this study focused on screening for the tomato varieties with tolerance to TYLCV. Six different varieties of tomatoes (Prostar F1, Ann F1, Faulu Tomato, Money Maker Tomato, Cal J Tomato and Rio Grande Tomato) were grown in the green house in a Completely Randomized Design with 6 treatments replicated 3 times in pots of medium size 2kgs. One month after transplantation, disease inoculation was done through injection of tomato varieties with a solution made from tomato samples infected by TYLCV. Then careful observation was undertaken to evaluate the severity of the disease in the different tomato varieties. The varieties were then examined at the recommendable stage to identify the tomato varieties that expressed tolerance to tomato yellow leaf curl disease. Data collection started 7 days after inoculation in 7 days interval for 21 days, Parameters assessed were disease severity and the number of flowers. The severity data on a 1-6 scale and the data on the number of flowers were subjected to Analysis Of Variance on Genstat statistical software version 14.1. Significance difference between varieties of tomato was tested at 5% level of significance and means differences separated by Turkey's test. Prostar F1 and Ann F1 were found to be the most tolerant varieties to TYLCV whereas Money Maker and Cal J were moderately tolerant to the virus and Faulu tomato and Rio Grande were the most susceptible varieties to the disease. Farmers and plant breeders should use tolerant varieties e.g. Prostar F1 to improve tomato production.

Key words: Disease, screening, severity, susceptibility, tolerance, varieties

Resume

Le manque de variétés de tomates tolérantes au virus de la boucle jaune des tomates (VBJT) est le principal problème qui entrave le contrôle et la gestion de la gravité du TYLCV sur les plants de tomates. L'agent pathogène est transmis de feuille à feuille par un vecteur, l'aleurode des feuilles d'argent (*Bemisia tabaci*) et en raison de la grande population d'aleurodes, et de leur capacité à développer une résistance aux pesticides, l'isolement des vecteurs et l'utilisation de produits chimiques synthétiques pour contrôler

la maladie n'est pas un moyen idéal de lutter contre la propagation et les dommages induits par le virus de la boucle des feuilles jaunes de la tomate. Par conséquent, cette étude s'est concentrée sur le dépistage des variétés de tomates présentant une tolérance au VBJT. Six variétés différentes de tomates (Prostar F1, Ann F1, Faulu Tomato, Money Maker Tomato, Cal J Tomato et Rio Grande Tomato) ont été cultivées dans la serre dans un design complètement aléatoire avec 6 traitements répétés 3 fois dans des pots de taille moyenne 2kgs. Un mois après la transplantation, l'inoculation de la maladie a été effectuée par injection de variétés de tomates avec une solution à partir d'échantillons de tomates infectés par VBJT. Ensuite, une observation attentive a été entreprise pour évaluer la gravité de la maladie dans les différentes variétés de tomates. Les variétés ont ensuite été examinées au stade recommandé pour identifier les variétés de tomates qui ont exprimé une tolérance à la maladie de la boucle jaune des tomates. La collecte des données a commencé 7 jours après l'inoculation dans un intervalle de 7 jours pendant 21 jours. Les paramètres évalués étaient la gravité de la maladie et le nombre de fleurs. Les données de gravité sur une échelle de 1 à 6 et les données sur le nombre de fleurs ont été soumises à une analyse de variance sur le logiciel statistique Genstat version 14.1. La différence de signification entre les variétés de tomates a été testée à un niveau de signification de 5% et signifie des différences séparées par le test de la Turquie. Prostar F1 et Ann F1 se sont révélées être les variétés les plus tolérantes au VBJT tandis que Money Maker et Cal J étaient modérément tolérantes au virus et que la tomate Faulu et Rio Grande étaient les variétés les plus sensibles à la maladie. Les agriculteurs et les phytogénéticiens devraient utiliser des variétés tolérantes, par exemple Prostar F1 pour améliorer la production de tomates.

Mots-clés: maladie, dépistage, gravité, sensibilité, tolérance, variétés

Introduction

Tomato yellow leaf curl virus is mainly transmitted leaf-to-leaf by a vector, whitefly (*Bemisia tabaci*) in a circulative persistent manner. TYLCV is not mechanically or seed-transmissible. Resistance to TYLCV has been observed in wild tomatoes e.g. *Solanum chmielewski*, *S.chilense*, *S.pimpinellifolium* and *S.habrochaites*. Five resistance genes (Ty-1, Ty-2, Ty-3, Ty-4 and Ty-5) to TYLCV have been mapped and identified from the wild types. Recently, several strategies and techniques have been implemented to engineer TYLCV resistant lines. Most of these strategies and techniques based on the concept of introducing and expressing viral sequences in the host plants in order to interfere with the virus life cycle. Some resistance markers have been used in introgression breeding of tomatoes. However despite all these research work, TYLCV can still be detected in tomato genotypes all over the world (Li *et al.*, 2017). Due to the large population of whiteflies and their ability to develop pesticide resistance. Vector seclusion and use of synthetic chemicals to control the disease is not an ideal way of fighting the spread and damage induced by tomato yellow leaf curl virus.

Limited research has been done to evaluate tomato varieties that are tolerant to TYLCV. Thus, the best way to reduce TYLCV spread and damage is by breeding tomato varieties tolerant to the virus.

Hence development of genetic tolerance in the tomato host is the best solution for any virus problem, and especially for whitefly transmitted viruses such as TYLCV, since it requires no

chemical input or plant seclusion and maybe stable and long-lasting (Shankarapa *et al.*, 2008). Therefore this study aimed at identifying tomato varieties which are tolerant to tomato yellow leaf curl virus so that to avoid the severe damage caused by the pathogen. (Lapidot *et al.*, 2006).

Study objectives

To identify tomato varieties those are tolerant to Tomato Yellow Leaf Curl Virus.

Hypothesis

Ho: There was significance difference in response to TYLCV by the commonly grown tomato varieties in Uasin Gishu.

Materials and methods

Study location: The research study was carried out at the University of Eldoret, school of agriculture and biotechnology greenhouse. University of Eldoret site is located at 2,140 m above sea level and lies between longitude 35 18'E and latitude 0 30'N. This site receives rainfall ranging between 900-1,300 mm with an annual average of 1,124 mm. The soil pH for this area is below 5.0, indicating that the soils are acidic. It was a one season study that commenced in September 2017 – June 2018.

The test crops: Five varieties of tomato (Prostar F1, Ann F1, Faulu Tomato, Money Maker Tomato, Cal J Tomato and Rio Grande Tomato) were obtained from Kenya seed-Eldoret and the University of Eldoret department of seed science.

Experimental design and layout: The six tomato varieties (Prostar F1, Ann F1, Faulu Tomato, Money Maker Tomato, Cal J Tomato and Rio Grande Tomato) were laid according to the standards of the completely randomized design (CRD) inside the greenhouse. The tomato varieties were planted in six pots of medium size, 2kgs and the pots were replicated ten times for each variety.

Disease inoculation and Screening of tomato genotypes. Six tomato varieties (Prostar F1, Ann F1, Faulu Tomato, Money Maker Tomato, Cal J Tomato and Rio Grande Tomato) were screened against tomato yellow leaf curl virus under natural epiphytotic conditions for determining the prevalence and severity of the disease. Disease inoculation was through infestation by the vector, silver leaf whiteflies, *Bemisia tabaci* which transmit the disease in a circulative persistence manner in the process of sucking plant sap from leaves undersurface. High temperatures in the greenhouse favor high whiteflies infestation which leads to high disease incidence. To ensure 100% disease infection, all tomato genotypes were injected with a solution made from the infected tomato samples in the second week after transplantation. No plant protection measures were adopted.

Data collection: The assessment of TYLCV effects on tomato varieties commenced one month after transplantation, observation on disease severity were recorded at an interval of 7 days for 21 days starting from the 7th day after inoculation. Data was collected from each

tomato variety with its replicates. The parameters assessed were, disease severity and number of flowers. The overall disease severity was recorded basing on visual symptoms.

Assessment of TYLCD symptoms. The tomato genotypes analyzed were observed for the presence of TYLCD symptoms. Disease severity was scored using the scale of Horsefall and Barret with modifications. It is ranged on a scale of 1-6 disease severity, where scores of 1-2 were classified as tolerant varieties, 3-4 as moderately tolerant varieties and 5-6 as susceptible varieties. 1=no disease, 2=1%-3% infection, 3=5%-12% infection, 4=12%-25% infection, 5=25%-50% infection and 6=50% infection and above.

Disease severity index

- 1 No visible symptoms.
- 2 Slightly yellowing of leaflet margins on apical leaf.
- 3 Some yellowing and minor curling of leaflet ends.
- 4 Curling and cupping, with some reduction in leaf size of the plant.
- 5 Severe stunting and yellowing of plant with pronounced leaf cupping and curling.
- 6 Plants look pale and stunted with very high curled leaves and pronounced yellowing of leaves accompanied by flower abortion.

Data analysis. The greenhouse experimentation and the disease analysis were carried out according to the standards of the Completely Randomized Design (CRD) .The severity data on a 1-6 scale was subjected to Analysis Of Variance (ANOVA) on Genstat statistical software version14.1. Significance difference between varieties of tomato was tested at 5% level of significance and means differences was separated by Turkey's test.

Results and Discussions

Table 1. Severity of tomato yellow leaf curl virus

VARIETY	DAYS AFTER INOCULATION			VARIETY MEAN	Tukey's test
	7DAI	14DAI	21DAI		
Prostar F1	1.5	2.2	2.5	2.1	a
Ann F1	2.0	2.5	3.0	2.5	a
Money Maker	2.5	3.5	4.2	3.4	b
Cal J	2.5	3.8	4.5	3.6	b
Rio Grande	2.8	4.8	5.8	4.5	c
Faulu Tomato	3.2	5.0	5.5	4.6	c
TIME INTERVAL MEAN	2.4	3.6	4.3	3.4	
Tukey's test	a	b	c		
	Variety	DAI	Variety x DAI		
Probability	<.001	<.001	0.051		
S.E	0.1691	0.1196	0.2929		
S.E.D	0.2392	0.1691	0.4143		
% CV	14.8				

Discussion

Prostar F1 and Anna F1 showed the highest tolerance to Tomato Yellow Leaf Curl Virus with slightly yellowing of leaflet margins on apical leaf. Money Maker & Cal J tomato were moderately tolerant to the disease with some yellowing and minor curling of leaflet ends. Rio Grande and Faulu tomato were highly susceptible to the virus having severe stunting and yellowing of plant with pronounced leaf cupping and curling.

There was significance difference between all varieties except between Prostar F1 and Ann F1, Money Maker and Cal J and Rio Grande and Faulu tomato.

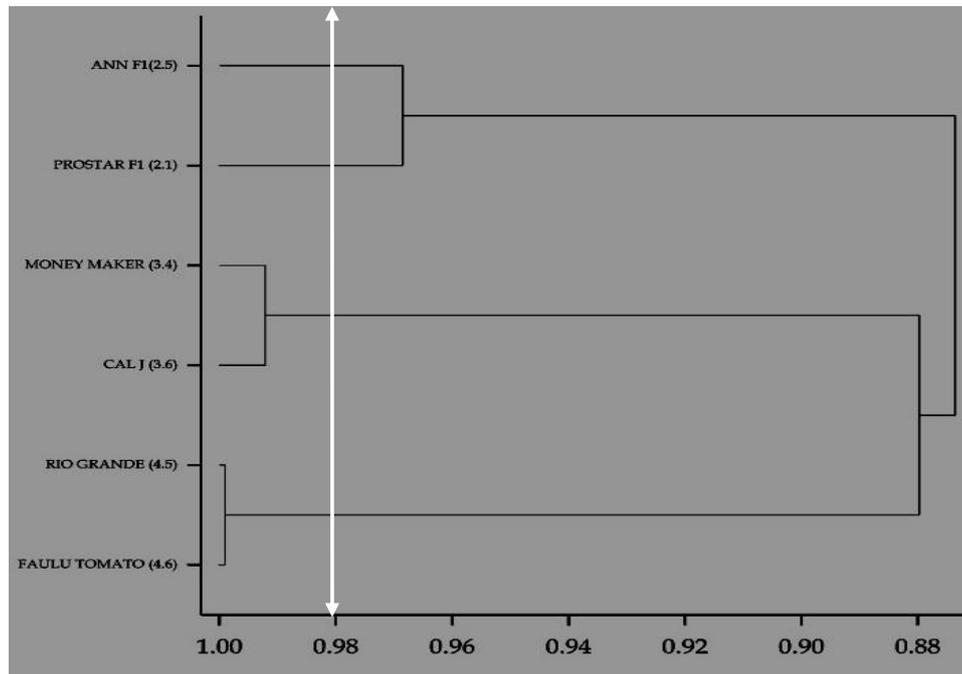


Figure1. A dendrogram showing response of the tomato varieties to TYLCV

Four clusters were formed; first cluster was between Faulu tomato and Rio Grande that had similar susceptibility response to the TYLCV, another cluster was between Money Maker and Cal J that were moderately tolerant to virus; Anna F1 formed a cluster of its own and was tolerant to the disease, lastly was a cluster of Prostar F1 that showed the highest tolerance to the pathogen.

Table 2. Effect of tomato yellow leaf curl virus on flowering

VARIETY	DAYS AFTER INOCULATION			VARIETY MEAN	Tukey's test
	7DAI	14DAI	21DAI		
Prostar F1	34.7	26.7	22.7	28.0	e
Money Maker	25.0	23.0	21.0	23.0	d
Ann F1	22.3	20.7	15.7	19.6	c
Cal J	16.7	13.3	9.3	13.1	b
Faulu Tomato	15.7	12.0	10.0	12.6	b
Rio Grande	12.3	8.3	5.0	8.6	a
TIME INTERVAL MEAN	21.1	17.3	13.9	17.5	
Tukey's test	c	b	a		

	Variety	DAI	Variety x DAI
Probability	<.001	<.001	0.24
S.E	0.75	0.53	1.298
S.E.D	1.06	0.75	1.836
% CV	12.9		

Discussion

Prostar F1 and Money Maker showed the highest rate of flowering despite the disease attack. Number of flowers on Ann F1 and Cal J was moderate while Rio Grande and Faulu tomato had the lowest number of flowers. There was significant difference between all varieties except Faulu tomato and Cal J.

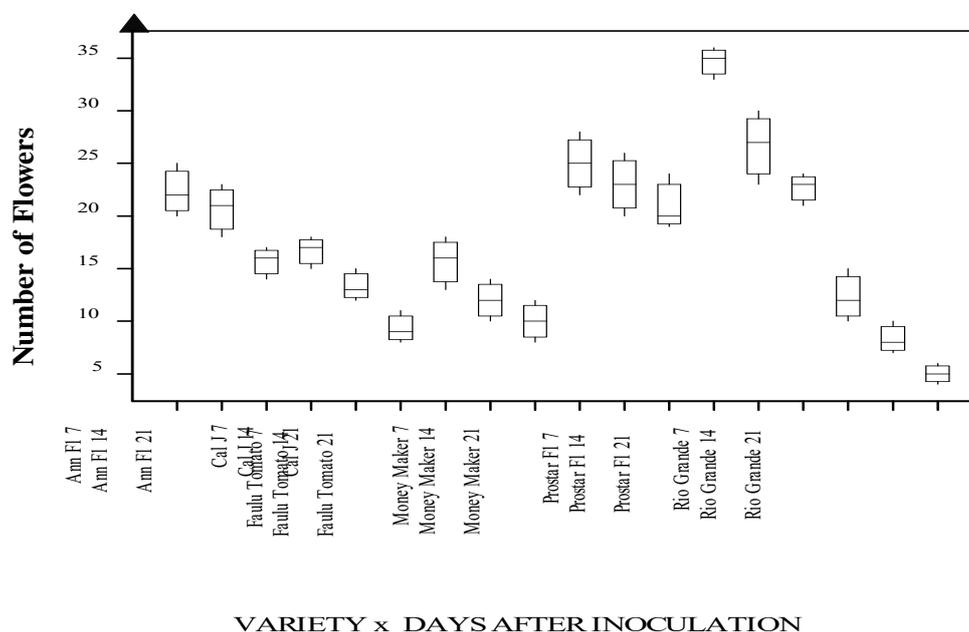


Figure 2. Box-and-whisker plots showing the number of flowers against interaction between varieties and days after inoculation

Box-and-Whiskers were used to show how flowering of different varieties was affected by the virus. Non-overlapping Box-and-Whisker plots show that there were significant differences between the varieties e.g. Prostar F1 and Rio Grande while overlapping Box-and-Whisker indicates that there were no significant differences between the varieties e.g. Cal J and Faulu Tomato.

Conclusion

Prostar F1 and Ann F1 were the most tolerant varieties to TYLCV whereas Money Maker and Cal J were moderately tolerant to the virus and Faulu tomato and Rio Grande were the most susceptible varieties to the disease.

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