SINAI Journal of Applied Sciences 10 (2) 2021 099-106

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

SELECTION AND BREEDING NEW LINES OF TOMATO (*Solanum Lycopersicon* L.) RESISTANCE TO TOMATO YELLOW LEAF CURL VIRUS

Aya S. El-Morsy[1*], M.I. Mahmoud[1], A.I. El-Kassas[1] and A.M. Kansouh[2]

1. Dept. Plant Prod. (Veg.), Fac. Environ. Agric. Sci., Arish Univ., Egypt.
2. Dept. Veg. Plant Breed., Inst. Hort. Res., Agric. Res. Cent., Dokki, Giza, Egypt.

ARTICLE INFO

Article history:
Received: 09/05/2021
Revised: 02/07/2021
Accepted: 08/07/2021
Available online: 08/07/2021

Keywords:
Tomato lines,
homogeneity,
selection,
tomato yellow leaf curl virus

Check for updates

ABSTRACT

Sixteen new lines of tomato (F5) were selected from six F2 generations, which exhibited high homogeneity based on estimated CV % values for plant height, number of leaves/ plant, hardness, shape index, TSS% and Vitam. C content during successive four seasons from 2017/2018 to 2020/2021 in the Experimental Farm, Faculty of Environmental and Agriculture Sciences, Arish University, North Sinai under open field conditions. The experimental work was conducted using a randomized complete block design with three replications. A highly significant differences were observed among the selected lines for all studied characters. Lines that showed the most vigorous growth were DAN-2-2, DAN-3-4, DAN-3-5, 6130-1-1, 6130-3-2, 6130-3-4, 3017-2-1, 3017-2-6, 783N-1-4, TYG-1-3, TYG-2-1, TYG-2-1, TYG-4-1 and KIS-N-2-1. For Mean performance all plants in the lines 6130.1.1, 6130.3.4, 3017.2.1, 3017.2.6, TYG-1-3 and KIS-N-2-1 were resistance to Tomato yellow leaf curl virus. Two lines recorded highest values for total yield, 3017.2.1 and 3017.2.6, while 6130.3.2 and 6130.3.4 where the best for avrage fruit weight.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is widely grown and one of the most economically important vegetable crops worldwide for its nutritional and economic values. Egypt is one of the major tomato production countries. The production of tomato in Egypt was 6751856 ton in 2019 **(FAO, 2019)**. Tomato is easily affected by several biotic stresses including viral diseases which are responsible for significant tomato production losses over the world. Among the viral diseases, tomato yellow leaf curl disease (TYLCV) is one of the serious tomato production constraints in tropical and subtropical regions of the world, including Egypt and it can totally destroy tomato yield **(Picó *et al.,* 1999)**. The disease is induced by a number of Begomovirus species (Family: Geminiviridae), among them, Tomato Yellow Leaf Curl Virus (TYLCV), which is widely spread worldwide **(Fauquet and Stanley, 2005)**.

The virus infects tomato during summer and autumn and can cause up to 100% yield loss. In many tomato-growing areas, TYLCV has become a limiting factor for production, in both the open fields and protected greenhouses (**Picó *et al.,* 1996**). The management of TYLCV in tomato is difficult, expensive, and with limited options. The use of virus-resistant/tolerant tomato cultivars is considered the best way to reduce yield losses inflected by TYLCV. However, little breeding efforts have been made for genetic improvement and F1 hybrid seeds production compared with their made for field crops. Consequently, very few local varieties of tomato are

*** Corresponding author: E-mail address:** ayaelmorsy49@yahoo.com
https://doi.org/10.21608/sinjas.2021.75775.1024

available for cultivation and most of them are selections from the introduced germplasm. Furthermore, the available varieties are poor in quality traits, and therefore are unable to get consumer's attraction. In this concern, **Kansouh (2002) and Ahmed *et al*. (2017)** developed new local lines of tomato by selection from F_2 generations and the selected lines were enough homogenous for all traits since they exhibited low CV (%) values. Genetic resistance of the host plant, on the other hand, requires no chemical application or plant isolation and is potentially stable and long lasting. Therefore, breeding crops which are resistant or tolerant to the virus is considered highly effective in reducing yield losses due to TYLCV **(Morales 2001**; **Lapidot and Friedmann 2002**). Therefore, the objective of this research was to produce promising new lines of tomato resistant for TYLCV derived from six commercial resistant hybrids.

MATERIALS AND METHODS

A field study was carried out at the Experimental Farm, Fac. Environ. Agric. Sci., Arish Univ, North Sinai, Egypt, during four successive seasons from 2017/2018 - 2020/ 2021 to breed new lines of tomato with better vegetative, yield, fruit quality traits and resistance to tomato yellow leaf curl virus (TYLCV) under Arish region. The program start with seeds of six F_2 populations of tomato obtained from six different commercial F1 hybrids; *i.e*., DANYA, 6130, 3017, 783-N, TYG and KIS-N.

In 2017/2018 season, 250 plants from each F_2 were planted, and twenty plants were selected from 600 plants and phenotyped for TYLCV resistance and their seeds were separately collected to form F_3 populations. In 2018/2019 season, 20 selected plants were grown to select the best plants depending on visual observations and selection between and within F_3 populations to the best vegetative, fruit characteristics and TYLCV resistance. Four populations were eliminated and seeds of the remained 16new lines were chosen separately as F_4 populations at 2019/2020.

Visual selection was continued during season 2020/2021 to choose the best plants to develop 16 lines of F_5 populations concerning vegetative, yield, fruit traits and for TYLCV resistance as well as, the check hybrid 448 F_1 which has intermediate resistance (Syngenta Com.) was used to determine the degree of homogeneity in 16 families based on coefficient of variation (CV%) for some traits; *viz*., plant height, number of leaves/ plant, hardness, shape index, TSS% and Vitam. C. At the same season data were recorded for some growth traits, yield and fruit characteristics.

During all seasons seeds were sown in seedling trays on 1st August and transplanted at the first week of September. In the latter two seasons, a randomized complete blocks design (RCBD) with three replications was used, each replicate contained 17 genotypes (16 F_5 populations and the check hybrid 448 F1). The plot area was 15.0 m^2 (12.5m length x1.2 m width). Drip irrigation system was used, each plot had one dripper line and the distance between the double dripper lines centers was 1.20 cm and plants were set 50 cm apart. The chemical analysis of irrigation water over seasons had EC 5.90 dSm^{-1} and pH 7.2. The experimental soil was sandy loam while pH 8.1, EC 1.1 dSm-1, organic matter 0.16% and Ca $(Co_3)2$ 22.55%. The irrigation and fertilization rates, pest control was applied as commonly recommended in Arish Region.

Data Recorded

Five plants from each plot were chosen and labled after 90 days from transplanting to determine plant height (cm), number of branches and number of leaves/plant. Five fruits/plot were taken randomly in the third harvest for measuring, fruit shape index was calculated as follow: fruit length cm (L)/fruit diameter cm (D) **UPOV Guide (2013)**, fruit hardness (kg/ cm^2), counting number of loculs/fruit, pericarp thickness (mm) and total soluble solids percentage (TSS%) was determined by a hand refractometer. Vitamin C content (mg/100 g fresh weight) was determined by titration with 2, 6 Dichlorophenolindophenol as described in **AOAC (1990**). All plants (25) / plot were harvested at the end of the experiment and total yield /plant (kg) and average fruit weight (g) were determined.

Statistical Analysis

The obtained data were subjected to statistical analysis of variance according to **Snedecor and Cochran (1980)** and means separation was done according to **Duncan (1955)**.

RESULTS AND DISCUSSION

Degree of homogeneity are determined depending upon coefficient of variability (CV%) in Table 1 which used to assess the magnitude of variation within every genotype. For plant height, estimated coefficient of variance values ranged from 2.50 to 13.48% for the selected genotypes. Seven genotypes (DAN-2-2, DAN-3-4, DAN-3-5, DAN-3-6, 6130-3-2, 6130-3-4, 3017-2-6) showed CV% values lower than the check cultivar (4.64), indicating high homogeneity in this trait, while three genotypes (6130-1-1, 3017-2-1, KIS-N-2-1) recorded their values close to the check, the remaining ones (6 genotypes (DAN-3-12, DAN-5-1, 783N-1-4, TYG-1-3, TYG-2-1, TYG-4-1) showed high heterogeneity, since they gave CV% values higher than that of the check Cvs. The genotypes DAN-2-2, DAN-3-4, DAN-3-5, DAN-3-6, 6130-3-2, 6130-3-4, and 3017-2-6, exhibited the high uniformity in their plants than other 9 genotypes.

Regarding number of leaves/ plant, two genotypes (DAN-3-12, DAN-5-1) could be considered the highest heterogeneous, where they gave the highest variation within their plants (CV% > 31.77). However, the remaining 14 genotypes showed high homogeneity, since they gave the lowest variations within their plants with CV% values lower than or close to the check cvs. The genotypes 6130-3-4, 3017-2-1, 3017-2-6, and TYG-2-1 recorded the lowest CV% values (10.49, 10.42, 8.69 and 8.18, respectively), indicating that they were more phenotypically uniform than other genotypes.

Concerning hardness, the highest heterogeneity was recorded within plants of the genotypes DAN-3-4, DAN-3-12 and 6130-3-2 whereas they gave CV% values of 9.44, 9.28 and 8.76, respectively higher than check cvs value (8.51). On the other hand, the remaining genotypes (13 ones) recorded CV% values close to/or lower than the check cultivar.

Estimated coefficient of variances for shape index (Table 1), 3017-2-1 one were highly homogenous, since they showed CV% values lower than or close to the check cvs, indicating that they were more uniform than the remaining six genotypes. The genotypes 3017-2-1, TYG-4-1, DAN-3-6, 6130-3-2, DAN-3-5 and 783N-1-4 recorded the lowest CV% values for shape index (1.85, 3.06, 3.24, 3.24, 3.35 and 3.35, respectively).

For total soluble solids percentage (TSS%), the two genotypes DAN-3-4 and DAN-5-1 reflected CV% values higher than the check cvs (8.55), suggesting high heterogeneity within their plants for TSS (%). On the other hand, the remaining selected genotypes become high homogenous, since they showed CV% values lower than or near to the check cultivar.

Table 1. Estimated coefficient of variance (CV %) values for six studied traits in the selected genotypes

Line	plant height (cm)	No. of leaves	Hardness (Kg/cm^2)	Shape index	TSS (%)	Vitam.C (mg/100g)
DAN-2-2	4.54	16.59	4.21	4.08	3.35	4.54
DAN-3-4	2.62	30.58	9.44	4.49	11.64	5.10
DAN-3-5	2.78	21.74	5.97	3.35	7.50	4.78
DAN-3-6	2.50	21.69	7.66	3.24	3.70	5.49
DAN-3-12	5.01	48.39	9.28	5.03	3.40	4.64
DAN-5-1	13.48	36.63	6.38	6.45	11.46	5.83
6130-1-1	4.79	21.74	2.94	3.35	7.78	4.98
6130-3-2	4.00	29.18	8.76	3.24	3.54	5.10
6130-3-4	2.69	10.49	6.64	3.34	5.58	5.23
3017-2-1	4.68	10.42	5.96	1.85	5.07	5.49
3017-2-6	2.66	8.69	7.82	4.22	5.06	4.44
783N-1-4	5.38	17.03	7.11	3.35	7.03	4.98
TYG-1-3	5.73	11.29	7.54	4.83	5.88	4.64
TYG-2-1	5.70	8.18	4.18	4.46	4.77	4.98
TYG-4-1	5.43	14.02	7.35	3.06	1.80	3.78
KIS-N-2-1	4.93	21.19	7.38	5.72	3.72	5.83
Check	4.64	31.77	8.51	4.23	8.55	5.71

As regard to vitamin C, only two genotypes (DAN-5-1 and KIS-N-2-1) recorded values higher than the check genotype (CV% > 5.71). On the other hand, the remaining selected genotypes become high homogenous, since they showed CV% values lower than or near to the check cultivar. In general, degree of homogeneity (CV%) was varied among genotypes in the same trait and from a character to another in the same genotype. From 16 selected genotypes, 14 ones are high homogenous and their plants were uniform in all traits under study compared with check genotype. Therefore, they could be considered as new lines. However, the remaining 2 genotypes (DAN-3-12 and DAN-5-1) were excluded, since they exhibited high CV% compared with those of the check cvs, indicating high heterogeneity for most traits and genetic variability for improvement these lines through a simple selection program.

These results confirmed those founding's by **Kansouh (2002), Ahmed *et al*. (2017)** and **Mona and Mahmoud (2019)** who developed new local lines of tomato by selection from F_2 generations and the selected lines were enough homogenous for all traits since they exhibited low CV% values.

Mean Performance

Result presented in Table 2 show that plant height in the selected lines ranged from 34.67 to 45.7cm. Genotype TYG-1-3 recorded the highest value (45.7cm) followed by TYG-4-1 (44.7cm). Four genotypes (783N-1-4, TYG-1-3, TYG-2-1, TYG-4-1 had plants significantly exceeded the check (43.0 cm).

Table 2. Mean performance of the evaluated breeding lines of tomato for vegetative growth, fruit characteristics, resistance to virus (%) and yield of 17 genotypes of tomato during the harvest stage

Traits / Genotypes	Plant height (cm)	No. of branches/ plant	No.of leaves/plant	Shape index	Hardness (kg/cm^2)	No. of locules	Pericarp thickness (mm)	TSS (%)	Vitam.C (mg/ 100g)	Resistance to virus (%)	Total Yield (g/plant)	Av. fruit weight (gm)
DAN-2-2	42.3a-e	12.67a	68.33ab	1.29b	2.87a	3.0d	0.53c	8.9cd	45.0b	0.10e	880.0h	56.18d
DAN-3-4	34.67 f	7.00bcd	44.00c-e	1.24bc	2.43bc	3.0d	0.70a	6.53g	40.c	0.15d	873.3h	54.66d
DAN-3-5	39.0e	6.33bcd	40.33de	0.87e	1.57f	4.0c	0.70a	10.7a	55.0a	0.10e	1015.0g	52.55d
DAN-3-6	43.0 a-d	6.00bcd	72.67ab	1.19c	1.80e	4.0c	0.53c	9.3bc	45.0b	0.20c	1030.0g	54.27d
6130-1-1	41.3b-e	6.00bcd	40.33de	0.87e	1.90e	4.0c	0.40d	10.7a	40.0c	0.00f	1463.0c	99.86ab
6130-3-2	38.7e	6.67bcd	79.67a	1.18c	1.83e	4.0c	0.40d	9.2c	40.0c	0.10e	1447.0c	100.98a
6130-3-4	39.3de	5.00d	34.67e	1.30b	1.87e	4.0c	0.70a	9.0cd	40.0c	0.00f	1603.0b	100.21ab
3017-2-1	42.0a-e	7.00bcd	66.00ab	0.72g	1.57f	6.0a	0.70a	7.7f	45.0b	0.00f	1799.0a	89.97c
3017.2.6	40.7c-e	7.00bcd	54.33b-d	0.85e	1.80e	6.0a	0.40d	8.6c-e	45.0b	0.00f	1812.0a	93.80bc
783N-1-4	44.0 a-c	12.33a	61.33a-c	0.84ef	2.30cd	5.0b	0.40d	10.7a	40.0c	0.50a	1093.0f	91.11c
TYG-1-3	45.7a	7.67bc	61.33a-c	0.90e	2.17d	5.0b	0.40d	9.1c	45.0b	0.00f	1315.0d	93.95bc
TYG-2-1	43.3a-c	5.67cd	40.00de	0.79fg	1.87e	4.0c	0.40d	10.1ab	40.0c	0.10e	1335.0d	89.02c
TYG-4-1	44.7ab	5.67cd	45.33cde	0.77g	2.30cd	5.0b	0.50c	8.5c-f	55.0a	0.10e	1233.0e	94.85a-c
KIS-N-2-1	42.3a-e	4.67d	40.00de	1.48a	1.90e	4.0c	0.60b	8.2d-f	35.0d	0.00f	1213.0e	95.88a-c
check	43.0a-d	8.33b	56.33b-d	0.97d	2.57b	3.0a	0.60b	7.7ef	45.0b	0.30b	1095.0f	91.66c

- Means followed by the same alphabetical letter (s) within each column are not significantly different at 5% level according to Duncan's Multiple Range Test.

For number of branches/ plant, it was ranged from 5.0 to 12.67 for lines 6130.3.4 and DAN-2-2, respectively (Table 2). The best lines for number of leaves were 6130.3.2, DAN-2-2, DAN-3-6 and 3017.2, these bred lines produced the highest number of leaves /plant with insignificant differences among them or than the check (56.33). Generally, the bred lines 6130-3-2, DAN-2-2, DAN-3-6 and 3017-2 showed high vigorous growth and may be used as parents for this trait in hybridization. Many researchers observed significant differences among genotypes and cultivars for plant height **(Osekita and Ademiluyi, 2014; Reddy *et al*., 2014; Patel *et al*., 2015)** and number of leaves/plant **(Kansouh, 2002; Meena *et al*., 2015**). Three lines showed the highest values for shape index (KIS-N-2-1, 6130-3-4 and DAN-2-2). The line DAN-2-2 recorded higher value for hardness (2.87) than the check hybrid (2.57). Only two lines (3017.2.1 and 3017.2.1) recorded the highest values for number of locules. Pericarp thickness ranged from 0.40 cm to 0.70 cm, the DAN-3-4, DAN-3-5, 6130-3-4 and 3017-2-1 recorded high number for pericarp thickness. For T.S.S. DAN-3-5, 6130.1.1 and 783N-1-4 recorded the high values. As regard to Vitam.C. DAN-3-5 and TYG-4-1 recorded the heist values (55).

All plants in the lines 6130-1-1, 6130-3-4, 3017-2-1, 3017-2-6, TYG-1-3 and KIS-N-2-1 were resistance to tomato yellow leaf curl virus. Two lines recorded highest values for total yield, 3017.2.1 and 3017.2.6, while 6130.3.2 and 6130.3.4 where the best for average fruit weight.

REFERENCES

Ahmed, M.F.; Hamza, H.A.; Ibrahim, I.A.; Nower, A.A. and Alansary, M. (2017). Developing new Egyptian local lines of tomato (*Solanum lycopersicum* L.). Menoufia J. Plant Prod., 2(2): 1- 10.

AOAC (1990). Official Methods of Analysis. Association of Official Analytical Chemists, Washington D.C. USA, 15th Ed., 123-126.

Duncan, B.D. (1955). Multiple Range and multiple F test. Biometrics, 11: 1-42.

FAO (2019). World production of tomato.

Fauquet, C.M. and Stanley, J. (2005). Revising the way we conceive and name viruses below the species level: a review of geminivirus taxonomy calls for new standardized isolate descriptors. Arch. Virol., 150: 2151–2179.

Kansouh, A.M. (2002). Developing high yielding lines of tomato (*Lycopersicon esculentum* Mill) by selection. 2nd Inter. Conf. Hort. Sci., 10-12 Sept. Kafr El-Sheikh, Tanta Univ., Egypt.

Khalil Mona R. and Mahmoud, M.I. (2019). Breeding for developing new indeterminate lines of tomato (*Solanum lycopersicum* L.) by selection. Menoufia J. Plant Prod., 4 : 233 – 245.

Lapidot, M. and Friedmann, M. (2002). Breeding for resistance to white fly-transmitted geminiviruses. Ann. Appl. Bio., 140: 109–127.

Meena, O.P.; Bahadur, V.; Jagtap, A.B.; Saini, P. and Meena, Y.K. (2015). Genetic variability studies of fruit yield and its traits among indeterminate tomato genotypes under open field condition. Afr. J. Agric. Res., 10 (32): 3170-3177.

Morales, F.J. (2001). Conventional breeding for resistance to Bemisia tabaci-transmitted geminiviruses. Crop Prot., 20: 825–834.

Osekita, O.S. and Ademiluyi, A.T. (2014). Genetic advance, heritability and character association of component of yield in some genotypes of tomato [*Lycopersicon esculentum* (Mill.) Wettsd.]. Academia J. Biotechn., 2(1): 006- 010.

Patel, M.S.; Singh, N.; Kumar, A.; Singh, M.K.; Yadav, G.C. and Ghuge, M.B.

(2015). Genetic Variability, heritability and genetic advance of growth and yield components of tomato (*Lycopersicon esculentu*m M.). Environ. and Ecol., 33 (3): 1034-1037.

Picó, B.; Diez, M.J. and Nuez, F. (1996). Viral diseases causing the greatest economic losses to the tomato crop. II. The tomato yellow leaf curl virus-a review. Sci. Hort., 67 (3/4): 151-196.

Picó, B.; Ferriol, M.; Diez, M.J. and Nuez, F. (1999). Developing tomato breeding lines. 118 (6): 537-542.

Reddy, R.; Begum, B.H.; Reddy, A.; Sunil, M. and Reddy, M.P. (2014). Genetic variability and effect relationship for yield and quantitative traits in exotic lines of tomato. Green Farming, 5 (1): 104-107.

Snedecor, G.W. and Cochran, W.G. (1980). Statistical Methods; 7^{th} Ed., Iowa State Univ., Press. Ames. Iowa, USA.

https://www.syngenta.com.eg/products/seeds/vegetables/tomato/determinate-cheyenne-e448

UPOV Guide (2013). International union for the protection of new varieties of plants.TG/44/11 Rev., 1-72.

الملخص العربي

تربيه وانتخاب سلالات جديدة من الطماطم مقاومة لفيروس إصفرار وتجعد أوراق الطماطم

آية الله السيد المرسى[1]، محمود ابراهيم محمود[1]، على ابراهيم القصاص[1]، أحمد محمد قنصوة[2]

1. قسم الإنتاج النباتي (خضر)، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.
2. قسم بحوث الخضر ذاتية التلقيح، معهد بحوث البساتين، مركز البحوث الزراعية، مصر.

انتخبت ستة عشر سلاله جديدة من الطماطم من ستة من الهجن التجارية والتي أظهرت درجة عاليه من التجانس لصفات ارتفاع النبات (سم)، وعدد الافرع على النبات، وعدد الأوراق/نبات، وشكل الثمرة، ونسبه المواد الصلبة الذائبة الكلية خلال الفترة من 2018/2017 الى2021/2020 بالمزرعة البحثية لكلية العلوم الزراعية ألبيئيه، جامعه العريش، شمال سيناء. واستخدام تصميم القطاعات كاملة العشوائية في ثلاث مكررات في تقييم هذه السلالات. وكانت أهم النتائج المتحصل عليها هي تفوق كل من السلالات DAN-2-2، DAN-3-4، DAN-3-5، TYG-1-3، TYG-2-1، TYG-4-1، 6130-3-2، 6130-3-4، 3017 2-1، 3017 -2-6، 387N-1-4، KISN-2-1 في جميع الصفات المدروسة. ووجد تنوع واختلافات معنوية بين السلالات الستة عشر في جميع الصفات المدروسة، وقد أعطت بعض السلالات مثل 3017-2-1 و3017-2-6 تفوقاً فى المحصول الكلى. كما أظهرت تقديرات الاختلافات الوراثية وجود فروق قليله بين معامل الاختلاف المظهري وبين العامل الوراثي، مما يدل على التأثير القليل للعوامل البيئية على الصفات المدروسة، وبالتالي يكون الانتخاب على أساس الشكل المظهري فعالاً ومناسباً لتحسين هذه الصفات. وكانت أعلي القيم المقدرة لمعامل الاختلاف الوراثي والمظهري لصفات الصلابة، وشكل الثمرة والمواد الصلبة الذائبة الكلية، مما يدل على توفر الاختلافات الوراثية بهذه الصفات وأن الانتخاب هو الأفضل لتحسينها وراثياً.

الكلمات الاسترشادية: سلالات طماطم، التجانس الوراثي، انتخاب وفيروس اصفرار وتجعد اوراق الطماطم.

المحكمـــــون:

1- د. محمـــد حـــامد عريشة أستاذ الخضر المساعد، كلية الزراعة، جامعة الزقازيق، مصر.

2- د. هاني محمد سامي حسن أستاذ النباتات الطبية والعطرية المساعد، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.