SINAI Journal of Applied Sciences 10 (2) 2021 089-098

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

PRODUCTION OF NEW TOMATO HYBRIDS RESISTANT 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,
heterosis,
mid-parents

Check for updates

ABSTRACT

Seven different tomato lines; viz, AL-1-4-1-7, HEL- 21-18, RED-8-2, EUR-6-1, D-7-4-1, JUM-14-16 and NADY-1- 2, were crossed in 7×7 half diallel mating design. The study was conducted in the experimental farm of, Faculty of Environmental and Agriculture Science, Arish University, North Sinai, Egypt to produce superior hybrids tolerant to Tomato Yellow Leaf Curl Virus (TYLCV). For heterotic effect, heterosis over mid-parents, better parent and check hybrid were detected in many traits, *q.e.*; plant height, No. of leaves, Fruit set (%) in first three clusters, hardness, T.S.S., total yield/plant and average fruit weight. For plant height heterosis, 12 crosses exhibited significant positive values ranging from 5.83% in the cross (4x7) to 23.8% in the cross (1x5) over the check hybrid. For number of leaves/plant 15 ones reflected mid-parents heterosis with significant values ranging from 8.23% for 1x6 to 59.4% for 2x6, suggesting dominance toward the high number/plant. Hybrids with good hardness were (1x7,2x4,2x7,3x4, and 4x7), total yield (1x5, 2x6, 2x7,4x5,4x7,5x6,5x7, and 6x7), and they were also found to have tolerance to heat stress and TYLCV under North Sinai conditions.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important popular and extensively used vegetable crop **(Toor and Savage, 2005)**. It ranks second among vegetables, following potato in both acrage area and production. Egypt is one of the major tomato production countries, producing 6751856 ton in 2019 **(FAO 2019).**

Tomato crop is easily affected by several biotic stresses including viral diseases which are responsible for significant production losses of tomato around the world. Among the viral diseases, tomato yellow leaf curl virus (TYLCV) is one of the serious tomato production constraints in tropical and subtropical regions of the world. In Egypt, TYLCV can dramatically reduce tomato yield (**Picó *et al.*, 1999**). **Fauquet and Stanley (2005)** reported that 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 during the summer and autumn, and can cause up to 100% yield lossesin both the field and in protected greenhouses **(Picó *et al.*, 1996)**. In nature, TYLCV is transmitted exclusively by the sweet potato whitefly *Bemisia tabaci* (Genn.) in a persistent-circulative manner (G**ronenborn, 2007**). *B. tabaci* is an invasive pest with global importance since more than 175 countries officially report the presence of *B. tabaci*. In: Invasive Species Compendium[1]). *B. tabaci* is a complex consisting of at least 24 distinct species (**De Barro *et al.*, 2011**). The *Bemisia* Middle East-Asia Minor 1 (MEAM1/B) and Mediterranean (MED/Q) are regarded as the most invasive and

*** Corresponding author: E-mail address:** ayaelmorsy49@yahoo.com
https://doi.org/10.21608/sinjas.2021.75774.1023

damaging species, and these are also the species that transmit TYLCV to tomato (**De Barro *et al.*, 2011; Ning *et al.*, 2015**).

The management of TYLCV in tomato is difficult, expensive, and with limited options. There is demand for developing high yielding cultivars and or hybrids worldwide. Hybrids are usually known to be characterized by good quality characters and high yield. Therefore, tomato hybrids were, extensively used in commercial production (**Shalaby 2012; Solieman *et al*., 2013).** The use of virus-resistant/tolerant tomato cultivars is considered the best way to reduce yield losses induced by TYLCV inflection.

Recently hybrids spread were increased in all countries, since hybrid seeds are better than open- pollinated varieties for earliness, yield, fruit quality, TYLCV resistance, *etc*. The breeder's goal is to develop new hybrids characterized by high yield with good traits and disease tolerance. Heterosis breeding as a tool for genetic improvement in tomato has been studied by several researchers. Heterosis over better parent for plant height, total yield and TSS%, was induced by **Dev *et al*., (1994)** for total fruit number, **Kumar *et al*., (1997)**, as well as, for total yield and TSS% **Youssef 1997; Salib (1999)**, for total yield (**Khalil, 2009)**.

Since the discovery of hybrid vigour by **Shull (1908),** a tremendous progress was observed in the development of potential hybrids in tomato. Heterosis in tomato was first observed for higher yield and a greater number of fruits. Since then heteroses for yield, its components and quality traits were extensively studied by **Kurian *et al*. (2001), Mondal *et al.* (2009), Ahmed *et al*. (2011), Shalaby (2012**), **Kumar *et al*. (2012) and Al-Daej (2018)**.

The aim of this stydy was to produce promising tolerant hybrids for TYLCV. because of the advantages of tomato hybrids *i.e.* uniformity in shape and size, increased vigor, early maturity, high yielding and resistance to specific pests and pathogens (**Allard, 1960; Hageman *et al*. 1967**).

MATERIALS AND METHODS

Field experiments were carried out at the Experimental Farm Fac. Environ. Agric. Sci., Arish Univ., North Sinai, Egypt to produce superior hybrids tolerant to TYLCV. In the first season (2017/2018), crossing among seven tomato lines; *viz*, AL-1-4-1-7, HEL- 21-18, RED-8-2, EUR-6-1, D-7-4-1, JUM-14-16 and NADY-1- 2, was made in 7X7 a half diallel mating design. In the second season (2018/ 2019), the parents and their resultant F1 hybrids comperd with commercial F1-hybrid 448 (Syngenta Company) as check hybrid were evaluated in open field for growth, yield and fruit quality as well as virus resistance. The genetic materials used in the study were obtained from Prof. Dr. Ahmed Mahmoud Kansouh (Prof. of Vegetable Crops, Self-Pollinated Vegetables Dept. Hort. Inst. Agric. Res. Cent.).

Seeds of seven parents and 21 hybrids were sown in seedling trays on 25th August in the second season (2018/2019). The seedlings were transplanted 45 days after sowing on 9th October. The genotypes were distributed in a randomized complete block design with three replications. The plot area was 18 m^2 (15m long X 1.2m width). Tomato genotypes were irrigated using drip irrigation system, the distance between two dripper lines was1.2 m and 50 cm between plants in the same line. The other normal agriculture practice were done according to requirements of tomato crop production.

Data Recorded

Vegetative growth

After 60 days from transplanting, five plants were randomly chosen from each plot to determine the following traits:

1. Plant height (cm)
2. Number of leaves/ plant

Fruit set and fruit yield

1. Fruit set percentage in the first three clusters
2. Total yield (kg/plant) was calculated from all harvested fruit; for whole season,
3. Average fruit weight (g) by dividing total fruit weight by total fruit number
4. Hardness (kg/cm^2) was measured by using a needle type pocket penetrometer.
5. Total soluble solids (TSS%) using a hand refractometer according to **AOAC (1990).**

Heterosis was calculated over mid-parents and better parents according to **Mather and Jinks (1971)**, as well as over the check hybrid.

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

Results in Table 1 show that, 14 crosses out of 21 ones significantly surpassed their mid-parents for plant height, suggesting degrees of dominance toward the high parent. On the other hand, the remaining crosses (7 ones) showed no dominance, since they exhibited insignificant and significant negative values of heterosis. For heterosis over better parent, 6 crosses showed significant positive heterosis values, indicating over dominance for the taller parent. The other six crosses recorded insignificant positive values, indicating complete dominance for the high parent and two showed partial dominance to low parent, where they recorded significant negative values.

Plant height is an important trait for plant reproductive success, which correlated with various other traits. As regard to heterosis over the check hybrid, 12 crosses exhibited significant positive values ranging from 5.83% in the cross (4x7) to 23.8% in the cross (1x5). Similar results were observed by **Dev *et al*. (1994), Zanata (1994) and Abd Allah (1995)** for plant height.

For number of leaves/ plant, obtained results presented in Table 1 show that, six F1 hybrids had insignificant heterosis values based on mid-parents (M.P), indicating no dominance for this trait. However, the remaining 15 ones reflected mid-parents heterosis with significant values ranging from 8.23% for 1x6 to 59.4% for 2x6, suggesting dominance toward the high number/plant. Estimated heterosis values relative to better parent (B.P.) in these 15 crosses showed over dominance for the high number of leaves/plant in ten crosses. Since they gave significant positive values ranging from 2.92% for (1x2) to 42.6% for (3x6), three crosses showed complete dominance for the high number of leaves/ plant, however 2 crosses show partial dominance.

Heterosis over the check hybrid (C.H.) was detected in 9 crosses with significant positive values ranging from 4.12% (5x6) to 47.9% (5x7). These results agreed with those of Z**anata (2002), Kansouh and Masoud (2007) and Kansouh (2013)** who showed heterosis over mid-parents, better parent and commercial hybrid for this trait. For fruit set (%), there were 5 crosses recorded significant positive values suggesting dominance, two of them showed over dominance for high parent, on the other hand, three crosses showed complete dominance and the rest crosses (16 ones) reflected no dominance for fruit set%. Similar results were obtained by **Pradheep *et al*. (2006)** of tomato plants. Most obtained crosses (16 ones) exhibited heterosis over the check hybrid, where they gave significant positive values for this trait.

With regard to total yield/plant, results in Table 2 show that 15 crosses recorded significant positive values of heterosis over mid-parent ranging from 0.32% (4x6) to 69.58% (6x7) indicating dominance, while 6 crosses showed no-dominance for this trait, since they recorded insignificant heterosis values relative to their mid-parents.

Table 1. Percentage of heterosis over mid-parent (M.P) better parent (B.P) and check hybrid (C.H) for some vegetative traits in F_1 generation of tomato plants.

Crosses	Plant height				No. of leaves				Fruit set (%) in first three clusters			
	Heterosis (%)				Heterosis (%)				Heterosis (%)			
	M.P.	B.P.	CH.	Dom.type	M.P.	B.P	CH.	Dom.type	M.P.	B.P	CH.	Dom.type
P1xP2	20.0**	14.5**	15.4**	O.D	23.3**	2.92**	26.8**	O.D	0.0	0.0	36.4**	N.D
P1xP3	34.2**	12.2**	13.1**	O.D	49.2**	10.5**	36.1**	O.D	0.0	0.0	36.4**	N.D
P1xP4	19.2**	17.9**	21.5**	O.D	35.7**	17.6**	44.8**	O.D	0.0	0.0	36.4**	N.D
P1xP5	9.15**	-1.82	23.8**	C.D	-8.46**	-24.2**	42.3**	N.D	13.5**	0.0	36.4**	C.D
P1xP6	-2.96	-5.75*	0.77	N.D	8.23**	-23.0**	-5.15**	P.D	-9.57**	-13.3**	18.2**	N.D
P1xP7	0.0	0.0	0.77	N.D	-5.01**	-24.7**	-7.22**	N.D	-12.2**	-20.0**	9.09*	N.D
P2xP3	32.3**	15.1**	5.38**	O.D	17.8**	1.25	-16.5**	C.D	-4.17	-4.17	30.7**	N.D
P2xP4	8.30**	2.24*	5.38**	O.D	11.0**	6.28**	-4.12**	O.D	-30.0**	-30.0**	-4.55	N.D
P2xP5	-29.3**	-39.0**	-23.1**	N.D	-24.4**	-45.6	2.06	N.D	-20.5**	-30.0**	-4.55	N.D
P2xP6	15.5**	7.19**	14.6**	O.D	59.4**	30**	7.21**	O.D	4.35	0.0	36.4**	N.D
P2xP7	6.4**	1.55	2.31	C.D	56.7**	46.9	21.1**	C.D	9.75**	0.0	36.4**	C.D
P3xP4	16.2**	-3.73*	0.77	P.D	30.3**	8**	-2.58**	O.D	-30.0**	-30.0**	-4.55	N.D
P3xP5	4.76**	-19.5**	1.54	P.D	-29.9**	-53.9**	-13.4**	N.D	-20.5**	-30.0**	-4.55	N.D
P3xP6	24.2**	1.44	8.46**	C.D	51.9**	42.6**	-15.5**	O.D	4.38	0.0	36.4**	N.D
P3xP7	17.8**	-1.53	0.77	C.D	45.9**	32.9**	-4.12**	O.D	-12.2**	-20.0**	9.09*	N.D
P4xP5	-6.04**	-14.6**	7.69**	N.D	-31.7**	-49.5**	-5.16**	N.D	-9.19*	-20.0**	9.09*	N.D
P4xP6	-5.49**	-7.19**	0.77	N.D	26.1**	-0.57	-10.3**	C.D	-26.9**	-30.0**	-4.55	N.D
P4xP7	3.39*	2.24	5.38**	C.D	35.9**	22.3**	10.3**	O.D	9.75**	0.0	36.4**	C.D
P5xP6	-13.5**	-20.1**	0.77	N.D	-13.1**	-44.5**	4.12**	N.D	19.2**	9.09*	36.4**	O.D
P5xP7	-3.05**	-12.8**	9.99**	N.D	13.9**	-21.2**	47.9**	P.D	26.3**	21.6**	36.4**	O.D
P6xP7	3.70*	0.72	7.69**	C.D	48.5**	27.9**	-7.73**	O.D	-7.99*	-12.7**	9.09*	N.D
Average	6.14**	-16.23**	5.68**		12.5**	-42.9**	7.19**		-5.01**	-11.79**	20.3*	
LSD												
0.05	1.37	1.58			1.37	1.58			0.06	0.07		
0.01	1.96	2.26			1.95	2.26			0.09	0.10		

Table 2. Percentage of heterosis over mid-parent (M.P) better parent (B.P) check hybrid (C.H) for total yield and average fruit weight in F_1 generation of tomato plants

Croses	Total yield / plant				Average fruit weight			
	Heterosis (%)				Heterosis (%)			
	M.P.	B.P	CH.	Dom. type	M.P.	B.P	CH.	Dom. type
P1xP2	-1.96	-9.09	-6.25	N.D	-8.10	-11.42	-8.65	N.D
P1xP3	21.87**	18.18**	21.87**	O.D	3.96**	0.04	11.59**	C.D
P1xP4	17.15**	-3.03	0.0	C.D	3.13**	-1.74	1.33	C.D
P1xP5	30.53**	6.06**	9.37**	O.D	10.89**	3.34**	6.57**	O.D
P1xP6	20.81**	0.0	3.12**	C.D	10.73**	1.33	4.49**	C.D
P1xP7	5.66**	-15.15	-12.5	C.D	1.89*	-7.88	-5.01	C.D
P2xP3	4.73**	0.0	-3.13	C.D	-2.66	-9.59	0.86	N.D
P2xP4	-17.7	-27.3	-35.9	N.D	-6.36	-7.48	-11.47	N.D
P2xP5	-12.09	-23.9	-32.9	N.D	0.32	-3.15	-7.33	N.D
P2xP6	48.50**	31.20**	15.62**	O.D	21.17**	14.80**	9.84**	O.D
P2xP7	49.39**	27.67**	12.51**	O.D	20.93**	13.13**	8.24**	O.D
P3xP4	-20.17	-32.24	-34.36	N.D	-18.86	-25.47	-16.85	N.D
P3xP5	-12.83	-27.42	-29.69	N.D	-11.215	-20.16	-10.94	N.D
P3xP6	4.50**	-11.29	-14.06	C.D	0.38	-11.29	-1.04	N.D
P3xP7	-11.77	-27.42	-29.69	N.D	-8.60	-20.16	-10.94	N.D
P4xP5	27.79**	24.84**	-15.63	O.D	3.36**	0.97	-5.70	C.D
P4xP6	0.32**	0.33*	-32.18	O.D	2.82**	-1.45	-7.97	C.D
P4xP7	44.14**	38.71**	-6.25	O.D	15.19**	8.99**	1.79	O.D
P5xP6	51.45**	47.93**	0.0	O.D	14.48**	12.26**	0.0	O.D
P5xP7	68.36**	65.80**	6.87*	O.D	17.78**	13.98**	1.53	O.D
P6xP7	69.58**	63.19**	10.31*	O.D	21.02**	19.41**	2.24*	O.D
Average	16.73**	-11.01	-8.23		3.89**	-11.95	-1.78	
LSD								
0.05	3.31	3.82			0.66	0.76		
0.01	4.74	5.47			0.95	1.09		

Table 3. Percentage of heterosis over mid-parent (M.P) better parent (B.P) check hybrid (C.H) for Hardness and TSS (%) in F1 generation of tomato plants

Croses	Hardness				TSS (%)			
	Heterosis (%)				Heterosis			
	M.P.	B.P	CH.	Dom. type	M.P.	B.P	CH.	Dom. type
1x2	-7.59**	-13.1**	-17.1**	N.D	22.6**	17.3**	3.39	O.D
1x3	-14.1**	-15.1**	-17.1**	N.D	-10.9**	-15.5**	-16.9**	N.D
1x4	8.51**	-8.93**	-13.1**	P.D	1.51	-2.88	-14.4**	N.D
1x5	-2.99**	-3.57**	-7.95**	N.D	-5.68	-13.6**	-8.47	N.D
1x6	21.1**	2.38**	-2.27**	O.D	-7.85	-12.5*	-22.9**	N.D
1x7	35.7**	35.7**	29.5**	O.D	14.4**	6.73	-5.93	C.D
2x3	12.5**	4.65**	2.27**	O.D	-0.95	-9.91*	-11.4**	N.D
2x4	32.8**	17.6**	-1.14**	O.D	5.79	5.79	-14.8**	N.D
2x5	7.01**	1.20**	-4.55**	O.D	-10.0*	-20.8*	-16.1**	N.D
2x6	7.57**	-4.05	-19.3**	P.D	3.98	3.16	-16.9**	N.D
2x7	35.4**	27.4**	21.6**	O.D	31.9**	28.4**	3.39	O.D
3x4	34.3**	11.6**	9.09**	O.D	22.3**	11.2*	9.32*	O.D
3x5	13.6**	11.6**	9.09**	O.D	-17.8**	-20.8**	-16.1**	N.D
3x6	31.9**	10.5**	7.95**	O.D	-4.53	-13.8**	-15.3**	N.D
3x7	-16.5**	-17.4**	-19.3**	N.D	3.39	-8.19*	-9.75*	N.D
4x5	14.3**	-3.62**	-9.09**	P.D	-12.7**	-23.2**	-18.6**	N.D
4x6	23.5**	22.4**	-19.3**	O.D	5.04	4.21	-16.1**	N.D
4x7	47.5**	23.8**	18.2**	O.D	10.3*	7.37	-13.6**	C.D
5x6	9.22**	-7.23**	-12.5**	P.D	-3.89	-16.0**	-11.0*	N.D
5x7	10.2**	9.52**	4.54**	O.D	11.6**	-4.01	1.69	P.D
6x7	4.22**	-11.91**	-15.9**	P.D	-17.2**	-18.7**	-35.6**	N.D
Average	13.9**	-0.42**	-2.68**		1.48**	-16.7**	-11.7**	
LSD								
0.05	0.04	0.05			0.53	0.61		
0.01	0.06	0.07			0.76	0.88		

From 15 crosses showed heterosis over mid-parents, 10 ones reflected significant positive values of heterosis over better parent, suggesting over dominance for high productivity, the remaining 5 ones exhibited insignificant values, indicating complete dominance.

As for heterosis over the check hybrid seven crosses (1X3, 1X5, 1X6, 2X6, 2X7, 5X7 and 6X7) displayed significant and highly significant positive values ranging from 3.12 to 21.87%.

As regard to Average fruit weight, obtained results (Table 2) show that most studied crosses (13 ones) significantly exceeded their respective mid-parent values, suggesting dominance toward average fruit weight. However, the other crosses (8 ones) exhibited no-dominance for this trait. These results agreed with the findings of **Kansouh (2013)**. Over dominance to high average fruit weight was detected in seven crosses where they recorded significant positive values over the better parent, however six crosses showed complete dominance which they gave insignificant values. Out of 21 crosses, only six ones significantly exceeded the check hybrid, since they gave significant positive values of heterosis based on check hybrid.

Out of 21 crosses, 17ones showed significant positive values surpass three mid parents indicating dominance for hardness, only 12 of them showed over dominance toward better parent however, eight crosses exhibited heterosis over check hybride.

For TSS% 6 crosses recorded positive heterosis values ranging from 10.3% (4x7) to 31.9% (2x7) indicating dominance (Table 3), 3 of them showed over dominance while the remaining crosses showed complete dominance (3 crosses). Heterosis over mid-parents and better parent was also observed by **Abd Allah (1995)** for plant height and TSS%. Only one cross (3X4) out of 21 ones recorded heterosis over the check hyprid with 9.32%.

Conclusion

We can conclude that from this study introduce hybrids with good hardness (1x7,2x4,2x7,3x4, and 4x7), total yield (1x5, 2x6, 2x7,4x5,4x7,5x6,5x7, and 6x7), and they also are tolerance to TYLCV under north Sinai conditions.

REFERENCES

AOAC (1990). Association of Official Agricultural Chemists. Official Methods of Analytical Chemists. 12th Ed. Washington, DC, USA.

Abd Allah, E.M. (1995). Genetic studies in tomato. Ph.D. Thesis, Minia Univ., Egypt.

Ahmad, S.; Quamruzzaman, A.K.M. and Islam, M.R. (2011). Estimation of heterosis in tomato (*Solanum lycopersicum* L.). Bangladesh J. Agril. Res. 36 (3): 521- 527.

Al-Daej, M.I. (2018). Line x Tester analysis of heterosis and combining ability in tomato (*Lycopersicume sculentum* Mill) fruit quality traits. Pak. J. Biol. Sci., 21: 224-231.

Allard, R.W. (1960). Principles of Plant Breeding. New York: John Wiley and Sons.

De Barro, P.J.; Liu, S.S.; Boykin, L.M. and Dinsdale, A.B. (2011). *Bemisia tabaci*, a statement of species status. Annu. Rev. Entomol., 56: 1–19.

Dev, H.; Rattan, R.S. and Thakur, M.C. (1994). Heterosis in tomato (*Lycopersicon esculentum* Mill). Hort.-J., 7 (2): 125-132.

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

FAO Database. (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.

Gronenborn, B. (2007). The tomato yellow leaf curl virus genome and function of its proteins," in Tomato Yellow Leaf Curl Virus Disease, Management, Molecular Biology, Breeding for Resistance, Ed. Czosnek H. (Dordrecht: Springer), 10: 67–84.

Hageman, R.H.; Leng, E.R. and Dudley, J.W. (1967). A biochemical approach to corn breeding. Adv. Agron., 19: 45-86.

Kansouh, A.M. (2013). Developing new tomato hybrids at Middle Delta regions of Egypt. Egypt J. Appl. Sci., 28(11): 744-758.

Kansouh, A.M. and A.M. Masoud (2007). Manifestation of heterosis in Tomato (Lycopersicon esculentum Mill) by line x tester analysis. Alex. J. of Agric. Res., 52(1): 75-90.

Khalil, Mona R. (2009). Studies on the inheritance and types of gene action for some tomato characters. Ph.D. Thesis, Fac. Agric., Minufiya Univ., Egypt.

Kumar, R.; Srivastava, K.; Somappa, J.; Kumar, S. and Singh, R.K. (2012). Heterosis for yield and yield components in Tomato (*Solanum lycopersicum* Mill). Elect. J. Plant Breed. 3: 800-805.

Kumar, T.P.; Tewari, R.N. and Pachauri, D.C. (1997). Line x tester analysis for processing characters in tomato. Veg.-Sci., 24 (1): 34-38.

Kurian, A.; Peter, K.V. and Rajan, S. (2001). Heterosis for yield components and fruit characters in tomato. J. Tropical Agric. 39: 5-8.

Mather, K. and Jinks, J.L. (1971). Biometrical Genetics. The study of continuous Variation. Chapman and Hall, London. XII, 382.

Mondal, C.; Sarkar, S. and Hazra, P. (2009). Line xTester analysis of combining ability in tomato (*Solanum lycopersicum* Mill.). J. Crop Weed., 5: 53-57.

Ning, W.; Shi, X.; Liu, B.; Pan, H.; Wei, W. and Zeng, Y. (2015). Transmission of Tomato yellow leaf curl virus by *Bemisia tabaci* as affected by whitefly sex and biotype. Sci. Rep., 10: 5-10.

Picó, B.; Diez, M.J. and Nuez, F. (1999). 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.

Pradheep, K.; Veeraragavathatham, D. and Auxcilia, J. (2006). Heterosis and combining ability studies in tomato (*Lycopersicon esculentum* Mill.) with an emphasis to virus resistance. Madras Agric. J., 93 (7-12): 239-247.

Toor, R.K. and Savage, G.P. (2005) Antioxidant Activity in Different Fractions of Tomatoes. Food Research International, 38, 487-494.

Salib, F.S. (1999). Genetical studies on some morphological and physiological characters of tomato varieties (Lycopersicon esculentum Mill.). Ph.D. Thesis, Ain Shams Univ., Egypt.

Shalaby, T.A. (2012). Line x tester analysis for combining ability and heterosis in tomato under late summer season conditions. J. Plant Prod. Mansoura Univ., 3: 2857-2865.

Shull, G.H. (1908). The Composition of a Field of Maize. Journal of Heredity, 4, 296-301.

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

Solieman, T.H.I.; El-Gabry, M.A.H. and Abido, A.I. (2013). Heterosis, potence ratio and correlation of some important characters in tomato (*Solanum lycopersicum* L.). Sci. Hort., 150: 25-30.

Youssef, S.M.S. (1997). Studies on some intervarietal crosses and hybrid vigor in tomato. M.Sc. Thesis, Ain Shams Univ., Egypt.

Zanata, O.A.A. (1994). Heterosis and gene action in varietal crosses of tomato in late summer season. M.Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

Zanata, O.A.A. (2002). Heterosis in tomato (*Lycopersicon esculentum* Mill.) and possibilities of producing F1 hybrid for commercial. Ph. D. Thesis, Mansoura Univ., Egypt.

الملخص العربي

إنتــــاج هجــــن طمـــاطـــم جـديـدة مقـــاومة لفيـــروس اصفـــرار وتجعــد أوراق الطمـــاطـــم

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.

تم اجراء التزاوج بين سبع سلالات متنوعة من الطماطم في تصميم تزاوج نصف ديالللي 7 × 7 في المزرعة التجريبية في كلية العلوم الزراعية البيئية، جامعة العريش، شمال سيناء، مصر لإنتاج هجن متفوقة مقاومة لفيروس اصفرار وتجعد أوراق الطماطم. ظهرت قوة الهجين بالنسبة لمتوسط الابوين، الاب الأفضل، والهجين المقارن لصفات، ارتفاع النبات، عدد الأوراق، نسبة العقد (%) في العناقيد الثلاثة الأولى، الصلابة، المجموع الكلي للنبات، متوسط وزن الثمرة. واوضحت النتائج ان هذه الهجن تفوقت على الهجين المقارن فى صفة الصلابة (1 × 7، 2 × 4، 2 × 7، 3 × 4، 4 × 7)، واظهرت هذه الهجن تفوق من حيث المحصول الكلى (1 × 5، 2 × 6، 2 × 7، 4 × 5، 4 × 7، 5 × 6، 5 × 7، 6 × 7)، كما أنها مقاومة لفيروس اصفرار وتجعد أوراق الطماطم تحت ظروف شمال سيناء.

الكلمات الاسترشادية: طماطم، سلالات، قوة الهجين، متوسط الابوين.

المحكمـــــون:

1- د. محمــد حامـــد 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.