academicJournals

Vol. 12(23), pp. 1993-2001, 8 June, 2017
DOI: 10.5897/AJAR2017.12396
Article Number: DBE3EDD64652
ISSN 1991-637X
Copyright ©2017
Author(s) retain the copyright of this article
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Mass selection for enhancement fruit yield in Edkawy cultivar of tomato under different irrigation intervals in southern of Egypt

Abdel-Haleem A. H. El-Shaieny

Department of Horticulture, Faculty of Agriculture, South Valley University, Qena 83523, Egypt.

Received 24 April, 2017; Accepted 18 May, 2017

Field experiments were carried out during the period from 2013 to 2017 in the winter season at the experimental farm, Faculty of Agriculture, South Valley University, Qena, Egypt. Improvement yield and its attributes in Edkawy local cultivar via mass selection were done for three cycles. The unselected base population (C_0) and selected populations (C_1, C_2, and C_3) evaluated under two different water availability, favorable normal condition, and drought. The combined analysis of variance showed that significant differences between unselected and selected populations as well as highly significant among three cycles populations were detected all studied traits. Average fruit weight, number of flowers per plant, fruit yield per plant, number of cluster per plant, number of fruit per plant, number of branches per plant, fruit set percentage, and plant height have significantly increased a response to mass selection under unfavorable conditions. These increasing values for average fruit weight were 3.24, 6.90, and 12.09% in C_1, C_2, and C_3, respectively. Furthermore, there was a significant increase in the number of fruits per plant in the first (2.45%), second (9.48%) and the third (13.72%) cycles under drought conditions. Fruits yield per plant was increased by 4.70, 12.44 and 21.40% for unselected and selected population, respectively. There was positive and highly significant correlation among all studied traits. In the respect to base populations under water stress treatments, results revealed that the use of mass selection for improvement yield and its components of tomato cv. Edkawy appeared to be increasing significantly for all studied traits.

Key words: Drought, yield attributes, Edkawy, mass selection, tomato.

INTRODUCTION

Nowadays, tomatoes are grown year around in Egypt, in addition to its daily needs as the main staple for rich and poor human. So, this requires the presence of many genotypes (cultivars, hybrids, and lines) that could be obtained on germplasm to give higher yields. This does not come only through one way of plant breeding

E-mail: a.elshaieny@agr.svu.edu.eg. Tel: +20965211835.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

(introduction, mass selection, pure-line selection, hybridization), and evaluated germplasm under different abiotic stress, viz., heat, drought, and salinity. Egypt is the fifth largest producer of tomato in the world after China, USA, India and Turkey. Tomato is also the second largest vegetable crop in the world after potatoes.

The information of genotypic and phenotypic coefficient of variety is being helpful in outlining choice criteria from variable populace. When all is said in done, it was noticed that the estimation of phenotypic coefficient of variety is higher than the genotypic coefficient of variation (Tiwari et al., 2013). Mass selection utilized for cultivar improvement in plants included tomato for quite a long while back and it was valuable in developing cultivars. The proficiency of mass selection relies on upon quality impacts of the chose attributes, their heritability, population size and G×E interaction. Mass selection is compelling for characters controlled by additive genes.

In Egypt, tomato is grown over an area of 214016 ha annually, which produces 8288043 tons/ha with 38.37 tons/ha (FAO, 2014). Qena is one of the leading tomato production governorate in Egypt, it is occupies the third rank in tomato production after Sharkia and Noubaria. On the other hand, Qena ranked third after Sohag and Ismailia in terms of productivity by 22.3 ton per acre. Lessening the measure of water which is subjected or decreasing the quantity of water irrigation times is assuming an incredible part through upgrading plant capacities for water utilizes effectiveness (Kirda, 2002).

Water is typically the most restricting component for plant development. If plants do not get satisfactory precipitation or water system, the subsequent drought stress can lessen development more than all other environmental stresses. A plant reacts to absence of water by ending development and diminishing photosynthesis and other plant forms with a specific end goal to decrease water utilize (Khan et al., 2015). Drought and salinity are now far reaching in numerous locales and are relied upon to bring about genuine salinization of more than 50% of every single arable land by the year 2050 (Ashraf, 1994).

Tomato (*Solanum lycopersicon* L.) is a standout amongst the most vital vegetable products and is a standout amongst the most requesting as far as water utilize (Peet, 2005). The extent of change in tomato is for the most part in view of the degree of genotypic and phenotypic variation display in the material more is the hereditary potential and there will be more prominent odds of delivering a coveted sort. Information in regard of the nature and size of relationship of yield with different segment characters is an essential to acquire change the coveted bearing. A harvest rearing project went for expanding the plant efficiency requires thought of yield as well as of its segments that have an immediate or circuitous bearing on yield.

Bodunde (2002), Metwally et al. (2003, 2004), Zakher (2005), Salib (2006), Bhnan (2008), Hidaytullah and Ghafoor (2008), Jitendra and Devendra (2011) and Rashwan (2015), the pervious researchers used different selection strategies for enhancing yield and its components of *S. lycopersicon* L, while Damarany (1994a) on cowpea and lettuce, Bakheit and Ali (2013) on Egyptian clover, and Gehan (2016) on sunflower. The review was done to improve the fruit weight and yield characters and to assess the performance of three cycles of mass selection in the drought stress of tomato cv. Edkawy.

MATERIALS AND METHODS

Experimental site

A field experiment was carried out at the Experimental Farm of Faculty of Agriculture, South Valley University, Qena, Egypt (26° 11 N and 32°44 E) during 2013 to 2017 winter season.

Seeds material

Seeds of Edkawy tomato local cultivar were obtained from Agricultural Research Centre, ARC, Giza, Egypt.

Mass selection procedure

In the first season, base population (C_0) seeds were sown in nursery at August, 1st 2013, without replication area, (50 rows 5.0 m long, 1 m apart and 30 cm between transplants). Agricultural practices were done and 50 plants with high yielding under drought stress (irrigation every 12 days) were selected according to 5% selection intensity. Seeds of selected plants were bulked together (C_1) and sown in nursery at August 4th, 5th 2014 and 2015, respectively. The same procedure of mass selection was done to produce C_2, and C_3. Mass selection populations (C_1, C_2, and C_3) and base population (C_0) were sown on August 1st 2016 and 2017 to evaluate selected plants to drought tolerance. All populations (C_0, C_1, C_2, and C_3) were assess under two irrigation intervals system which were: a. irrigation every 6 days (favorable), b. irrigation every 12 days (drought conditions). All agricultural practice was applied as recommend.

Data

Plant height cm (PH), number of branches per plant (NBP), number of cluster per plant (NCP), number of flowers per plant (NFP), number of fruits per plant (NFSP), average fruit weight (AFW), and fruit yield per plant g (FYP).

Statistical analysis

Data were statistically analyzed using analysis of variance for Randomized Complete Block Design (RCBD) for separate analysis. Combined analysis for the two years was analyzed using split plot analysis. Comparison among means was done using least significant differences (LSD) at 0.05% and simple correlation coefficient between traits were done according to Gomez and Gomez (1984). Realized gain% was estimated from combined means according to Gowda and Seetharam (2008) as follow:

Realized gain% for $C_1 = C_1 - C_0 / C_0 \times 100$, $C_2 = C_2 - C_0 / C_0 \times 100$,

Table 1. Mean square of separate and combined analysis of variance for all studied traits in selected and unselected populations after three cycle

SOV	d.f	PH	NBP	NCP	NFP	FS	NFSP	AFW	FYP
First season									
Replication	2	0.333	0.583	0.083	0.0001	0.799	0.250	1.750	158.333
Population	3	48.528**	2.972*	9.417*	10.528**	8.523 ^{NS}	13.000**	48.750**	18177.778**
Error	6	0.778	0.472	1.083	0.444	2.593	0.583	0.083	169.444
Second season									
Replication	2	0.250	0.333	0.083	0.333	1.006	0.083	0.333	558.333
Population	3	48.111**	3.194^{NS}	9.639*	10.889**	8.488^{NS}	12.972**	48.750**	19822.222**
Error	6	2.028	0.778	1.306	0.556	2.318	0.639	1.000	113.889
Combined									
Year	1	0.042	0.0001	0.167	1.042	2.024	2.042	0.667	1666.667
Error a	4	0.292	0.458	0.083	0.167	0.903	0.167	1.042	358.333
Population	3	96.486**	5.944**	19.000**	21.375**	16.767**	25.819**	97.500**	37977.778**
Y × P	3	0.153^{NS}	0.222^{NS}	0.056^{NS}	0.042^{NS}	0.244 ^{NS}	0.153^{NS}	0.0001^{NS}	22.222^{NS}
Error b	12	1.403	0.625	1.194	0.500	2.455	0.611	0.542	141.667

NS, *,**Not significant and significant at p = 0.05 and 0.01, respectively.

$C_3 = C_3 - C_0 / C_0 \times 100$.

RESULTS AND DISCUSSION

Population's performance

The separate and combined analysis for all studied traits in unselected (base population C_0) and selected population (C_1, C_2 and C_3 mass selection) are presented in Table 1. The mean square for all studied populations under investigation as well as the variance among populations were significant for all studied characters, except fruit set in both seasons, and number of branches per plant in the second season indicating the wide diversity among all population and selected populations and the presence of true differences among the populations. Interaction among populations and years were insignificant for all studied traits.

Means values of all studied traits in three cycles of selection increased gradually from C_1 to C_2 in both evaluations seasons as well as the combined analysis. The data are shown in Table 2. For plant height (cm), the means value ranged from 47.8 to 52.5 cm for C_1 and C_3, respectively, and 9.5 to 11.2 for number of branches per plant, 18.8 to 21.3, number of cluster per plant, 55.5 to 58.8 number of flower per plant, 33.5 to 37.2 fruit per plant, 60.4 to 63.2% fruit set, 79.7 to 86.5 g average weight of fruit and 856.7 to 993.3 g for fruit yield per plant. These findings indicating that fruit yield of tomato could be improved via mass selection cycles because, its efficiency by improving such trait through increasing the frequencies of desirable genes which result to specific irregular mating which could have helped in breaking closely linkage group, sequence complexes of genes or eliminates the recessive alleles (Gowda and Seetharam, 2008). These results are in agreement with the findings of Damarany (1994a, b), Ghosh et al. (2010), Bakheit et al. (2011), Bakheit and Ali (2013), Hassan and Abdel-Haleem (2014), Rashwan (2015) and Gehan (2016). In the present study, mass selection cycles had a significant role in enhancing the mean values of most studied traits; this may be due to the presence of genetics factors that have more effect on such traits (Gehan, 2016; Rashwan, 2015) indicating that the mass selection cycles could be more effective after three cycles in improving fruit yield of tomato cv. Super strain B, and observed a positive and highly significant correlation among the fruit yield per plant and the other studied traits, and this indicate that mass selection can be used as a tool to improve the fruit yield per plant.

Data are presented in Table 2 indicating that the realized gain % was gradually raised from the first cycle of mass selection to the third cycle in all the studied traits. For plant height, it was 10.65, 16.90 and 21.53 for C_1, C_2, and C_3, respectively; 7.95, 15.91 and 27.27 number of branches per plant; 8.67, 18.50 and 23.21 number of cluster per plant; 2.21, 4.97 and 8.29 number of flower per plant; 2.45, 9.48, 13.76 for fruit number per plant; 0.66, 4.33 and 5.33 for fruit set; 3.24, 6.87 and 12.05 for average weight of fruit, and 4.70, 12.44 and 21.90 for fruit yield per plant for C_1, C_2, and C_3, respectively, as compared to base population C_0. These results showed that significant increase was observed after application of mass selection cycles from the first cycle C_1 to the third C_3. Many researchers (Kansouh, 2002; Zanata, 2002; Bhnan, 2008; Ara et al., 2009; Zakher, 2010; Singh and Cheema, 2011; Meseret et al., 2012; Kashif et al., 2013;

Table 2. Mean performance of separate and combined for PH, NBP, NCP of the two seasons.

Traits	PH			Realized gain %	NBP			Realized gain %	NCP			Realized gain %
Season	2016	2017	Com.		2016	2017	Com.		2016	2017	Com.	
C_0	43.0	43.3	43.2	-	8.7	9.0	8.8	-	17.3	17.3	17.3	-
C_1	48.0	47.7	47.8	10.65	9.7	9.3	9.5	7.95	18.7	19.0	18.8	8.67
C_2	50.3	50.0	50.2	16.90	10.3	10.0	10.2	15.91	20.3	20.7	20.5	18.50
C_3	52.3	53.0	52.5	21.53	11.0	11.3	11.2	27.27	21.3	21.3	21.3	23.21
L.S.D 05	1.8	2.8	2.4	-	1.4	1.8	1.6	-	2.1	2.3	2.2	-
Average	48.4	48.5	48.4	-	9.9	9.9	9.9	-	19.4	19.6	19.5	-
CV %	-	-	-	-	-	-	-	-	-	-	-	-
Traits	NFP			Realized gain %	NFSP			Realized gain %	FS			Realized gain %
Season	2016	2017	Com.		2016	2017	Com.		2016	2017	Com.	
C_0	54.3	54.3	54.3	-	32.3	33.0	32.7	-	59.5	60.4	60.0	-
C_1	55.3	55.7	55.5	2.21	33.3	33.7	33.5	2.45	60.3	60.5	60.4	0.66
C_2	56.7	57.3	57.0	4.97	35.3	36.3	35.8	9.48	62.4	63.4	62.9	4.33
C_3	58.7	59.0	58.8	8.29	37.0	37.3	37.2	13.76	63.1	63.3	63.2	5.33
L.S.D 05	1.3	1.5	1.4	-	3.2	3.0	3.1	-	1.5	1.6	1.6	-
Average	56.3	56.6	56.4	-	34.5	35.1	34.8	-	61.3	61.9	61.6	-
CV %	-	-	-	-	-	-	-	-	-	-	-	-

Traits	AFW			Realized gain %	FYP			Realized gain %
Season	2016	2017	Com.		2016	2017	Com.	
C_0	77.0	77.3	77.2	-	803.0	833.0	818.16	-
C_1	79.3	80.0	79.7	3.24	850.0	863.3	856.7	4.70
C_2	82.3	82.7	82.5	6.87	910.0	930.0	920.0	12.44
C_3	86.3	86.7	86.5	12.05	983.3	1003.3	993.3	21.40
L.S.D 05	0.6	2.0	1.5	-	26.0	21.3	23.8	-
Average	81.2	81.7	81.5	-	886.6	907.4	897.0	-
CV %	-	-	-	-	-	-	-	-

Rashwan, 2015) haave studied the effect of selection on tomato yield and yield attributes traits as number of fruit, number of cluster, number of flowers per plant and fruit yield per plant. They observed that the selection improved tomato yield and yield components and suggested that the presences heritability and genetic advance for yield characters.

Correlation coefficient

Table 3 shows the correlation between fruit yield per plant and the other studied traits in the combined analysis for both evaluation seasons 2016 and 2017of the 3 cycles of mass selection (C_1, C_2, and C_3) and base population (C_0). Fruit yield per plant g showed highly significant and positive association with plant height ($r = 0.932^{**}$), number of branches per plant ($r = 0.970^{**}$), number of cluster per plant ($r = 0.939^{**}$), number

Table 3. Correlation coefficient among studied traits.

Traits	PH	NB	NC	NF	NFT	FW	FY
PH	1.000						
NB	0.957**	1.000					
NC	0.958**	0.958**	1.000				
NF	0.948**	0.974**	0.953**	1.000			
NFT	0.874**	0.912**	0.890**	0.936**	1.000		
FW	0.926**	0.965**	0.931**	0.991**	0.936**	1.000	
FY	0.932**	0.970**	0.939**	0.992**	0.937**	0.997**	1.000

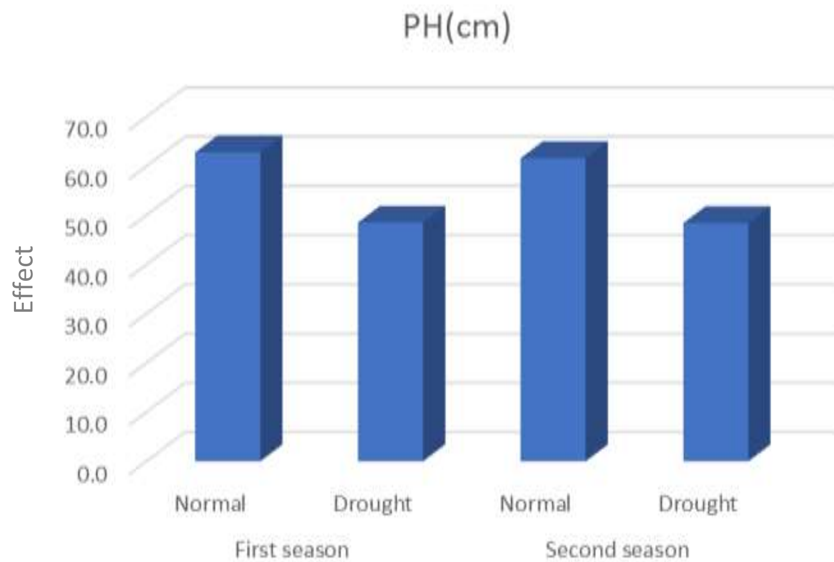

Figure 1. Effect of water stress on tomato cv. Edkawy on plant height (cm) in 2016 and 2017.

of flowers per plant (r = 0.992**), number of fruit per plant (0.937) and average fruit weight g (r = 0.997**).

Improvement of crops depends on multiple factors; one of these, is in understanding the magnitude of the correlations among different yield characters components and it is considered the primary interest for enhancing yield through yield components. These results are in line with findings by Bakheit and Ali (2013), Meseret et al. (2012), Kashif et al. (2013), Rashwan (2015) and Gehan (2016).

Performance of tomato cv. Edkawy under drought stress conditions:

Water stress could have the vital effect on vegetative growth, flowering, fruit set, and yield of plants. The main effect of drought on plants is wilt. As a result of water shortage and this led to reducing growth and yield of plants (Khan et al., 2015). It is observed from the mean values of Figures 1 to 8 that there is a decrease in plant height cm, number of branches, number of cluster per plant, number of flowers per plant, number of fruits per plant, fruit set %, average weight of fruit, and fruit yield per plant by 21.4 and 22.8% in both seasons, respectively for plant height, 38.1 and 39.6 for number of branches, 26.5 and 26.9% for number of cluster, as for number of flower the decrease was 19.1 and 18.8%, in both seasons, respectively. While, it was 14.1 and13.3% for number of fruit per plant, on the other hand, the reduction in average weight of fruit per plant after application of drought was 33.3 and 33.6% and the huge reduction was observed in fruit yield per plant for 69.3 and 49.0% in both seasons, respectively. These results indicate that water stress reduced the growth parameters due to their harmful effect on photosynthesis, which led to decrease in growth and development of plants, as a result of lake energy production in plant cell. Similar results were detected by Pervez et al. (2009), Celebi (2014), and Khan et al. (2015) on tomato; Abdel-Haleem

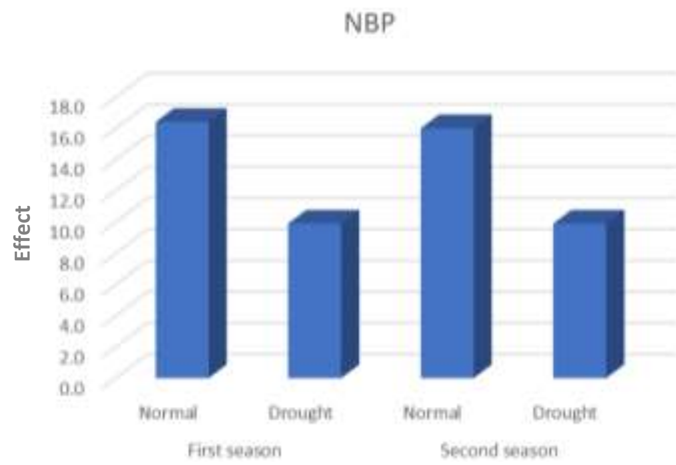

Figure 2. Effect of water stress on tomato cv. Edkawy on number of branches per plant in 2016 and 2017.

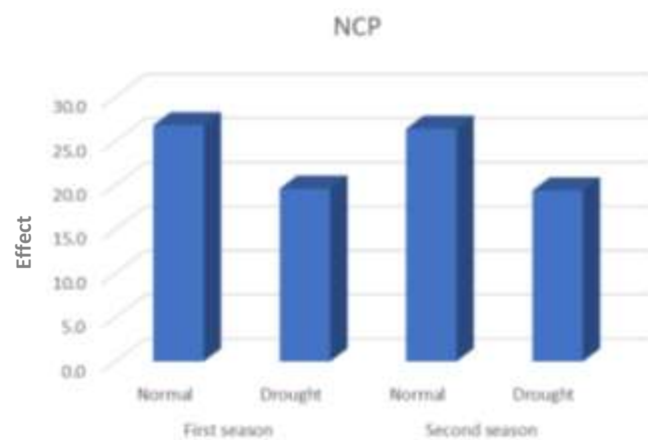

Figure 3. Effect of water stress on tomato cv. Edkawy on number of cluster per plant in 2016 and 2017.

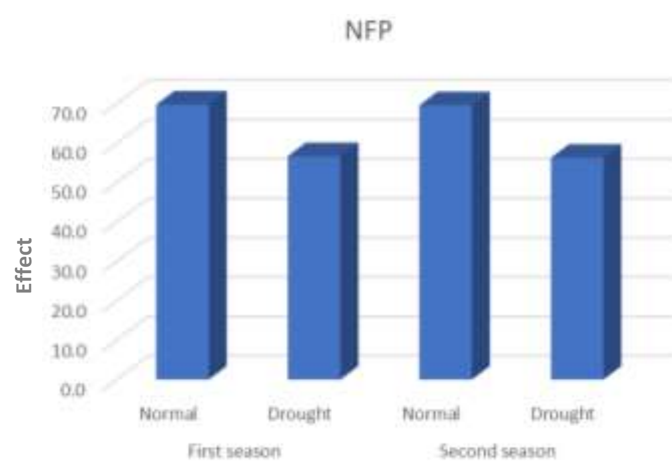

Figure 4. Effect of water stress on tomato cv. Edkawy on number of flower per plant in 2016 and 2017.

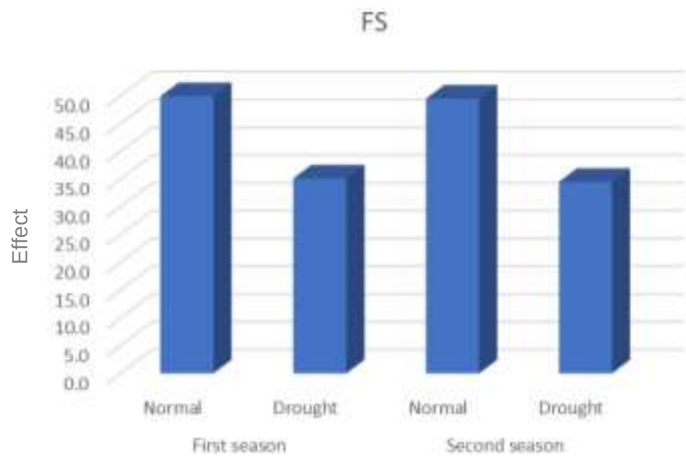

Figure 5. Effect of water stress on tomato cv. Edkawy on number of fruit set % in 2016 and 2017.

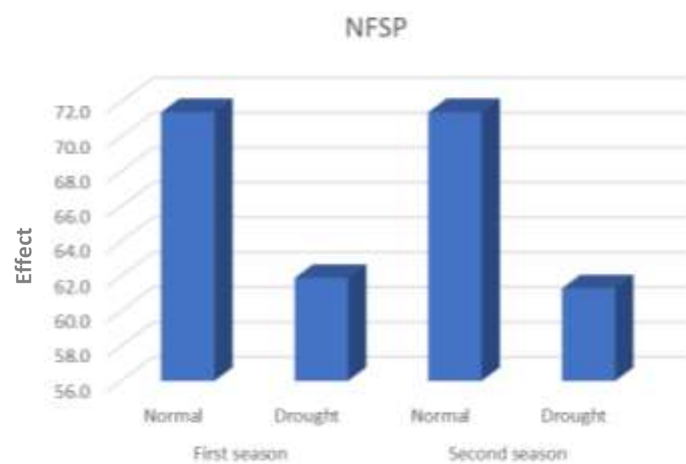

Figure 6. Effect of water stress on tomato cv. Edkawy on number of fruit per plant in 2016 and 2017.

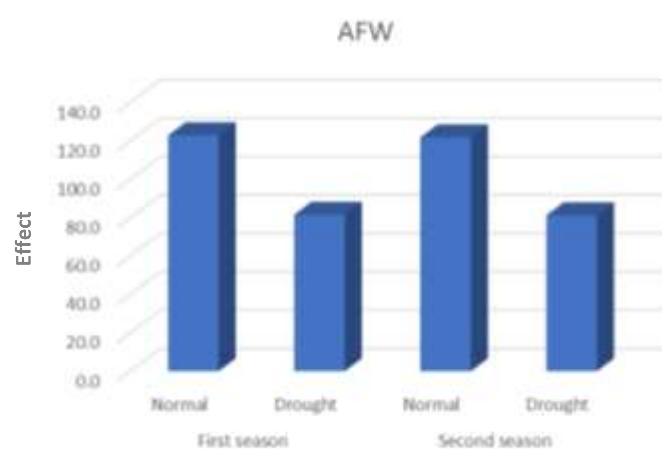

Figure 7. Effect of water stress on tomato cv. Edkawy on average weight of fruit per plant in 2016 and 2017.

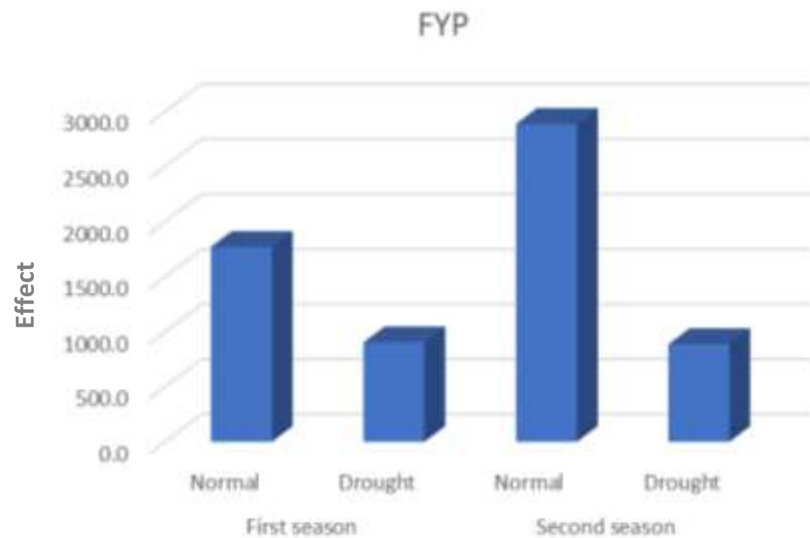

Figure 8. Effect of water stress on tomato cv. Edkawy on fruit yield per plant in 2016 and 2017.

(2017), Hussein and Abd El-Hady (2015), Hussein et al. (2014), and Farouk et al. (2011) on cowpea; Al Ameen (2012), Kheiralla et al. (1997) and Kheiralla and Ismail (1995) on wheat.

Conclusion

Data presented in this study indicated that mass selection for the three cycles has more effect for improving fruit yield per plant of tomato cv. Edkawy. In addition, the growth and yield parameters were reduced after exposure to water stress conditions.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

Abbreviations

PH, Plant height; **NBP,** Number of branches per plant; **NCP,** Number of cluster per plant; **NFP,** Number of flowers per plant; **FS,** Fruit set %; **NFSP,** number of fruit per plant; **AFW,** Average fruit weight; **FYP,** Fruit yield per plant.

REFERENCES

Abdel-Haleem AH El-Shaieny, (2017). Drought tolerance of some cowpea genotypes under Upper Egypt conditions. Nat. Sci. 15(5):22-29.

Al-Ameen T (2012). Stability analysis of selected wheat genotypes under different environment conditions in Upper Egypt. Afr. J. Agric. Res. 34:4838-4844.

Ara A, Narayan R, Nazeer A, Khan SH (2009). Genetic variability and selection parameters for yield and quality attributes in tomato. Indian J. Hortic. 66(1):73-78.

Ashraf M (1994). Breeding for salinity tolerance in plants. Crit. Rev. Plant Sci. 13:17-42.

Bakheit BR, Ali MA (2013). Improvement of single cut Egyptian clover (*Trifolium alexandrinum* L.) by mass and family selection methods. Asian J. Crop Sci. 5:304-311.

Bakheit BR, Ali MA, Helmy AA (2011). Effect of selection for crown diameter on forage yield and quality components in alfalfa (*Medicago sativa* L.). Asian J. Crop Sci. 3:68-76.

Bhnan EY (2008). Development of some new tomato lines for fresh market by selection. Egypt. J. Appl. Sci. 23 (4A):168-178.

Bodunde JG (2002). Path co-efficient and correlation studies in tomato (*Lycopersicon esculentum* Mill.). Moor J. Agric. Res. 61(4):327-330.

Celebi M (2014): the effect of water stress on tomato under different emitter discharges and semi-arid climate condition. Bulg. J. Agric. Sci. 20:1151-1157.

Damarany AM (1994a). Improvement of pod filling and yield in TVU 21 cultivar of cowpea (*Vigna unguiculata* (L.) Walp) by mass selection. Assiut J. Agric. Sci. 25(4):71-77.

Damarany AM (1994b). Mass selection for tip burn resistance in lettuce (*Lactuca sativa* L.) by. Assiut J. Agric. Sci. 25(4)79-87.

FAO (2014). Food and Agriculture Organization of the United Nations http://www.fao.org/faostat/en/#data/QC

Farouk S, Amany R, Abd EL Mohsen (2011). Improving growth and yield of cowpea plant by foliar application of chitosan under water stress. J. Plant Prod. Mansoura Univ. 2(10):1341-1358.

Gehan M (2016). Improvement in the branching mutant of *Helianthus annuus* by mass selection. Asian J. Crop Sci. 8:60-65.

Ghosh KP, Islam AKM, Mian MAK, Hossain MM (2010). Variability and character Association in F2 segregating population of different commercial hybrids of tomato (*Solanum lyzopersicon* L.). J. Appl. Sci. Environ. Manage. 14(2):41-95.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agriculture Research. 2nd Edn., John Wiley and Sons, Inc., New York, USA P. 680.

Gowda J, Seetharam A (2008). Response to mass and SI selection for autogamy, seed yield and oil content in sunflower populations (*Helianthus annuus* L.). Helia 31:101-110.

Hassan MS, Abd-El-Haleem SHM (2014). Effectivenss of gamma rays to induce genetic variability to improve some agronomic traits of canola (*Brassica napus* L.). Asian J. Crop Sci. 6:123-132.

Hidaytullah SA, Ghafoor M (2008). Path coefficient analysis of yield components in tomato (*Lycopersicon esculentum* Mill.). Pak. J. Bot. 40(2):627-635.
Hussein AH, Abd El-Hady MAH (2015). A comparing of some promising lines and commercial cultivars of cowpea. Egypt. J. Plant Breed. 19(1):101-139.
Hussein M, Al-Ashry M, Camilia SM, El-Dewiny Y (2014). Cowpea growth and yield components as affected by drought and PK soil fertilization. Int. J. Sci. Res. 3(12):2200-2207.
Jitendra T, Devendra U (2011). correlation and Path-coefficient studies in tomato (*Lycopersicon esculentum* Mill.). Res. J. Agric. Sci. 2(1):63-68.
Kansouh AM (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 28:152-164.
Kashif N, Muneeb M, Ahmed SC (2013). Genetic Architecture and Association of fruit yield and quality traits in tomato (*Solanum Lycopersicon* L.). Universal J. Agric. Res. 1(4):155-159.
Khan SH, Khan A, Litaf U, Shah ASS, Khan MA, Bilal M, Ali MU (2015). Effect of drought stress on tomato cv. Bombino., J. Food Process Technol. 6:465.
Kheiralla KA, Ismail AA (1995). Stability analysis for grain yield and some traits related to drought resistance in spring wheat. Assiut. J. Agric. Sci. 26(1):253-266.
Kheiralla KA, Ismail AA, El-Nagar GR (1997). Drought tolerance and stability of some spring wheat cultivars. Assiut J. Agric. Sci. 28(1):75-88.
Kirda C (2002). Deficit irrigation scheduling based on plant growth stages shoeing water stress tolerance in: Deficit irrigation practices, FAO, Rome pp. 3-10.
Meseret DR, Ali M, Kassahum B (2012). Evaluation of tomato (*Lycopersicon esculentum* Mill.). Genotypes for yield and yield components. Afr. J. Plant Sci. Biotechnol. 6:45-49.
Metwally EL, Ghobary HMM, Kassam MH (2004). Production of local tomato hybrids high yielding ability and heat tolerance. J. Agric. Sci. Mansoura univ. 29(12):7321-7338.
Metwally EI, El-kassas AI, Abd El-Moneim A, Bayomy KE (2003). Improving the quality of the Egyptian tomato cultivar “Edkawy”. Egypt. J. Plant Breed. 7(1):551-561.
Peet MM (2005). Irrigation and fertilization In: E.P. Heuvelink (ed.), Tomato. CABI Publishing, Wallingford, UK pp.171-198.
Pervez MA, Ayub CM, Khan HA, Shaihd MA, Ashraf I (2009). Effect of drought stress on growth, yield and seed quality of tomato (*Lycopersicon esculentum* L. Pak. J. Agric. Sci. 46(3):174-178.
Rashwan AMA (2015). Improvement of weight fruit and yieldin super strain-B cultivar of tomato (*Lycopersicon esculentum* Mill.) by mass selection. J. Am. Sci. 11:45-50.
Salib FS (2006). Introducing new frosh market line of tomato. Egypt J. Appl. Sci. 21(10B):631-642.
Singh H, Cheema DS (2005). Studies on genetic variability and heritability for quality traits of tomato (*Lycopersicon esculentum* Mill.). under heat stress conditions. J. Appl. Hortic. 7(1):55-57.
Tiwari G, Slaugter DC, Cantwell M (2013). Nondestructive maturity determination in green tomatoes using a handheld visible and near infrared instrument. Postharv. Biol. Technol. 86:221-229.
Zakher AG (2005). Comparative studies on advanced segregated generations of some tomato hybrids. Ph.D. Thesis, Fac. Agric., Ain Shams University, Egypt.
Zakher AG (2010). Developing fresh market tomato lines by selection. Egypt J. Plant Breed. 14(1):321-332.
Zanata OA (2002). Heterosis in tomato (*Lycopersicon esculentum* Mill.). and possibilities of producing F1 hybrids of commercial. Ph.D. thesis, Fac. Agric., Mansoura University, Egypt.