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Response of Some Tomato Varieties to The Spraying of Organic Fertilizer

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ABSTRACT

To study the response of some tomato varieties to foliar application of Alga 600 fertilizer, three varieties of tomato (Madanapalli, Kumkum Kesari, and Kashi) and three concentrations of Alga 600 (0, 2, and 3 mgL $^{-1}$) were used, as completely randomized block design with factorial arrangements with three replications. Data were recorded for the number of flowers in the cluster, plant height, branches per plant, fruits per plant, fruit weight, length and diameter of fruit, number of locules per fruit, total soluble solids (TSS), yield per plant and yield per hectare. The result showed that the variety Kumkum Kesari have the highest of plant length, the number of branches per plant and the number of fruits per plant, while the variety Kashi gave the highest number of locules per fruit, fruit diameter, fruit weight, TSS, and total yield per hectare. Alga 600 at a concentration of 3mgL^{-1} gave the best results for all the traits during the study. The interaction between the variety Kashi and concentration of humic acid (3mg L^{-1}) gave the highest values in most traits. The magnitude of phenotypic variance ($б^2p$) was slightly higher in the plant height, number of branches per plant, fruit weight, number of fruits per plant, while the phenotypic coefficient of variation (PCV) was higher than genotypic coefficient variation (GCV) for all the studied traits. High estimates of heritability were recorded for all characters under the study and it was more than 60%.

Keywords: Alga 600, Genetic parameters, Heritability, Variety, Yield components.

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INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family Solanaceae and the native land of tomato is Andean region of South America (Dorais et al., 2008). Tomato is an important crop in many countries. According to FAO, it has a main role in human nutrition because of its rich source of lycopene, minerals (especially iron and phosphorus) (Bagal et al ., 1989) and vitamins (especially B and C, such as ascorbic acid and β-carotene), which are antioxidants and promote good health (Wilcox et al. 2003). The tomato crop is economically attractive due to its good yielding capacity in a short duration, but, its yield potential is affected by many biotic and abiotic factors. Hence, the area under tomato cultivation is increasing with time. Tomato is one of the major crops grown all over the world according to FAO (2016) and it occupies the rank position among the cultivated area of all vegetable crops in Iraq. Matlob et al. (1994) evaluated some local and imported tomato cultivars in northern Iraq and found that the local tomato cultivars gave a significantly equal yield, weight, and diameter of fruits, to that of imported cultivars. Esho (2002) showed that the W.C. 156 cultivars gave a high stem length, the largest number of branches per plant, the highest number of flowers per inflorescence, the highest number of fruits per plant, the weight of fruit and total yield when the performance of 6 genotypes of tomato was evaluated. Organic fertilizer application, like humic acid, is essential for better yield of tomato. Humic acid is a heterogeneous mixture of many compounds with general similar chemical properties. It is a commercial product of organic fertilizers, containing most elements that improve soil fertility and increase nutrients availability. Thus it enhances plant growth and yield, as well as decreases the harmful effect of stresses (Doran

et al., 2003). The objective about the effect of humic acid on plant growth (Vaughan and McDonald, 1976) showed that humic acid affects the ion exchange of plant nutrients which is useful in microbial activity by increasing conversions directly, as well as indirectly, as a result of the stimulating plant growth hormones. Humic acid is believed to help increase nitrogen use efficiency and therefore stimulates the shoot and root growth (Adani et al., 1998). In cucumber plant, Sarhan et al. (2011) found that when 0.33 g/L of Alga 600 is applied three times after flower initiation at ten days intervals, there is an increase in plant height, chlorophyll content, early yield and total yield, so Alga 600 gave an excess in fruit weight, number of fruits /plant and TSS.

Several studies as shown that when humic acid was applied on tomato plants there is a significant increase in plant height, fruit weight, number of flowers per plant, TSS and yield per area (Abdel-Monaim et al., 2012; Kazemi, 2013 2014; Aman and Rab, 2013; Farnia and Moradi, 2015). Abdellatif et al. (2017) showed that in their studies the humic acid at 14.4 kg per hectare increased the plant height and fresh weight, and number of lower clusters and flowers per plant, as well as increased the fruit number per plant, fruit weight, total soluble solids and total yield in tomato plants. Kumar et al. (2013) indicated that the magnitude of genotypic and phenotypic coefficient of variation was higher for number of fruits per cluster, high values of heritability for plant height and fruit per cluster and TSS, and high genetic advance were observed for plant height and average fruit weight , and positive and significance association of yield per plant with all the traits both at genotypic and phenotypic levels. Shankar et al. (2013) showed that high heritability assisted with high genetic advance was observed for plant height, number of primary branches per plant, number of fruit per cluster, fruit length, and fruit weight . Marasini and Ppaudel (2017) found significant differences in the number of fruits per cluster, weight of fruits, fruits yield per plant and TSS in eight tomato genotypes.

The aim of this study is to evaluate the response of some tomato varieties to the spraying of organic fertilizer (humic acid) and the genetic parameters.

MATERIALS AND METHODS

The experiment was conducted at the vegetable research field, Department of Horticulture and Landscape Design, College of Agriculture and Forestry, Mosul University Iraq during spring growing season of 2018, to study the response of some tomato varieties to the foliar spraying of organic fertilizer. Three varieties of tomato were studied (Madanapalli, Kumkum Kesari and Kashi) obtained from Desi Seed Producer Company Limited (India) and three concentrations of Alga 600 fertilizer were used (0, 2, and 3 mg L^{-1}).

The seeds of the three cultivars were sowed at the greenhouse on 25 February 2018 to obtain seedlings and after 40 days, the seedlings were transplanted into the field. The distance between the seedlings was 30 cm and between the rows was 80 cm. The experiment was carried out using a randomized block design, with three replication, under drip irrigation system. The foliar treatment with humic acid concentrations was carried out twice: the first at the beginning of and the second after two weeks from the first application. All other necessary cultural practices, such as weeding and cultivation were applied to all plots, uniformly. The data were recorded for each trait (using five plants for each plot): plant height (cm), number of branches per plant, number of fruits per plant, number of flowers in the inflorescence, fruit weight (g), length and diameter of fruit (cm), number of locules per fruit, TSS (10 fruits were used), yield per plant (kg) and total yield (tons per hectare). The data were subjected to statistical and biometrical analysis by using the SAS Package (SAS, 2000). Genotypic and phenotypic coefficients of variation were estimated by the procedure given by Burton (1952), Heritability in a broad sense ($H^2_{b.s.}$) by Burton and Devane (1953) and the genetic advance was studied. If ($H^2_{b.s.}$) = or > to 40% was low. ($H^2_{b.s.}$) =40-60% was medium and more than 60% was higher. The correlation coefficients were estimated by the method of Al- Jibouri et al. (1958).

RESULTS AND DISCUSSION

Effect of genotypes

Table 1 showed a significant effect on tomato genotypes in all the studied traits. The Madanapalli genotype showed a significant effect in yield per plant and total yield (2.35 kg/plant, 15.25 tons/donum), when compared with the two other genotypes, while Kumkum Kesari genotype gave a positive significance and high value in the plant height (128.53 cm), number of flowers per cluster (5.16), fruit length (5.51cm) and in the number of fruits per plant (110.33). Table 1 also shows that Kashi genotype gave a high value in the number of branches per plant (8.38), the diameter of fruit (6.18 cm), fruit weight (42.73 g) and in TSS (5.70 %). These results indicate the differences in all traits among the tomato genotypes, which depend on the genetic factors for each studied genotype. These results are in line with those obtained in previous studies regarding the variation among tomato genotypes, during the vegetative growth, flowering phase and also the yield parameters (Matlob et al ., 1994; Esho, 2000, 2002; Marasini and Paudel, 2017).

Effect of Alga 600 foliar application

Table 2 showed that the foliar application of the Alga 600 caused a positive significant difference in all studied traits. The study result showed that foliar application of Alga 600 at a concentration of 2 mg/L. caused a significant influence on plant height (116.39 cm), number

Table 1 : Effect of the tomato genotypes on the traits in growing season.

Genotypes	Plant height (cm)	No. of branches/ plant	No. of flowers/ cluster	Diameter of fruit (cm)	Length of fruit (cm)	Fruit weight (gm)	Number of fruit / plant	Yield / plant (kg)	No.of locules./ fruit	T.S.S	Total yield (ton / donum)
Madanapalli	81.51^{c}	6.76^{b}	4.8^{b}	4.91^{b}	4.21^{c}	42.00^{a}	56.06^{b}	2.35^{a}	7.10^{b}	4.85^{b}	15.25^{a}
Kumkuma kesari	128.53^{a}	8.12^{a}	5.16^{a}	4.07^{b}	5.51^{a}	13.66^{b}	110.33^{a}	1.52^{a}	2.38^{c}	5.47^{a}	9.90^{c}
Kashi	101.3^{b}	8.38^{a}	4.97^{b}	6.18^{a}	5.14^{b}	42.73^{a}	53.47^{c}	2.28^{b}	8.10^{a}	5.70^{a}	14.82^{b}

*Means with the same letters had no significant differences according to Duncan multiple range test at probability 0.05**.**

Table (2) : Effect of alga 600 on the traits of tomato genotypes in the growing season.

Alga 600 concentration (mlg/l.	Plant height (cm)	No. of branches /plant	No. of flowers/ cluster	Diameter of fruit (cm)	Length of fruit (cm)	Fruit weight (gm)	Number of fruit / plant	Yield/plant (kg)	No.of locules./ fruit	T.S.S	Total yield (ton / donum)
0	89.61^{c}	6.13^{b}	4.64^{b}	4.72^{b}	5.28^{a}	32.93^{b}	63.89^{c}	1.79^{b}	4.58^{a}	5.25^{a}	11.66^{b}
2	116.39^{a}	8.83^{a}	5.81^{a}	4.74^{b}	4.54^{c}	33.03^{a}	73.91^{b}	2.07^{a}	6.22^{a}	4.89^{b}	13.48^{a}
3	105.34^{b}	8.29^{a}	4.48^{b}	5.68^{a}	5.04^{b}	32.43^{b}	82.07^{a}	2.28^{a}	6.78^{a}	5.87^{a}	14.67^{a}

*Means with the same letters had no significant differences according to Duncan multiple range test at probability 0.05**.**

of branches /plant (8.83), number of flowers per cluster (5.81) and in fruit weight (33.0g), while foliar application of Alga 600 at a concentration of 3mg/L also caused a positive significant difference on the fruit diameter (5.68 cm), the number of fruit per plant (82.07), yield per plant (2.28 kg/plant) number of locules per fruit (6.78), TSS (5.87 %) and in total yield (14.67 tons /donum) when compared with 0 and 2 mg/L of Alga 600. Lack of prior research on Alga 600 application on tomato, humic acid application on tomato was used to discuss the study result. The increase in plant height, number of branches per plant, number of flowers per cluster, (diameter, length, weight) of fruit, number of fruits per plant, yield per plant TSS and total yield per unit area caused by Alga 600 foliar application may be due to the role of Alga 600 (an organic fertilizer) as biostimulant for plant growth and development of yield components, due to the presence of trace elements (amino acid) which improved the growth of the plant. Results of the study conform with the result of previous studies that Alga 600 can increase nutrient uptake of certain elements and stimulate total dry matter production of shoot and roots (El-Moniem and Abd-Allah, 2008). Previous studies showed that organic fertilizers like humic acid, significantly increase the plant height of tomato and in yield parameters of potato (Doran et al., 2003; Sarhan, 2011). It was found that during crop growth, supplementary foliar fertilization increased plants mineral status and improved crop yields (Rahman et al. 2014a). El-Ramady and Shalaby (2014) found that the Alga 600 gave a significant effect on the number of pods /plant and higher in total yield in faba plants. Kazemi, (2013, 2014), Sahin et al. (2014), Abeer et al. (2015) and Abdellatif et al. (2017) reported Alga 600 at 0.5 ml/L caused a significant increase in the number of days of the first flower and also in the number of pods /plant, pod weight, protein content in pea plants, pepper, tomato. Marasini and Paudel (2017) found a significant difference in the number of fruit per cluster, weight of fruit, fruit yield per plant and TSS in eight tomato genotypes.

Effect of interaction between genotypes and Alga 600 foliar

The study results showed that growth parameters were significantly increased from the interaction between the tomato genotypes and Alga 600 application (Table 3). The interaction effect between Kumkum Kesari genotype and Alga 600 foliar application at 2 mg/L gave the highest values on the growth parameters; plant height (134.87cm), number of branches per plant (9.36) and number of flowers per cluster (5.93), respectively, as

Table 4: The genetic parameters in tomato genotypes in the growing season.

Genetic parameters	Plant height (cm)	No. of branches/plant	No. of flowers/ cluster	Diameter of fruit (cm)	Length of fruit (cm)	Fruit weight (gm)	Number of fruit / plant	Yield/ plant (kg)	No.of locules./ fruit	T.S.S	Total yield (ton / donum)
$Б^2P$	102.539	0.985	0.059	0.167	0.238	2.810	347.292	0.328	0.349	0.235	1.709
$Б^2G$	94.542	0.658	0.050	0.144	0.205	1.868	283.521	0.322	0.292	0.205	1.604
GCV	10.435	10.283	4.602	7.171	9.410	4.003	9.563	12.490	8.541	8.280	12.561
PCV	10.868	12.586	4.986	7.716	10.147	4.910	10.583	12.597	9.344	8.862	12.964
h2	92.201	66.757	85.165	86.384	85.998	66.468	81.638	98.306	83.562	87.28 9	93.891
Ga	19.233	1.365	0.425	0.726	0.864	2.295	31.340	1.159	1.017	0.872	2.528

Table 5. The genotypic and phenotypic correlation between the traits of tomato genotypes at growing season.

		Total yield (ton/donum)	T.S.S	No. of locules./ fruit	Yield /plant (kg)	No. of fruits/plant	Fruit weight (gm)	Length of fruit (cm)	Diameter of fruit	No. of flowers/ cluster	No. of branches /plant
Plant height (cm)	Rp	0.928 **	0.893 **	0.930 **	0.839 **	0.919 **	0.938 **	0.598 *	0.916 **	0.922 **	0.822 **
	Rg	0.917 **	0.901 **	0.823 **	0.817 **	0.904 **	0.975 **	0.617 *	0.825 **	0.734 **	0.966 **
No. of branches /plant	Rp	- 0.798 **	0.863 **	- 0.942 **	0.791 **	0.830 **	- 0.836 **	0.680 *	0.770 **	0.937 **	
	Rg	0.926 **	0.976 **	0.937 **	0.897 **	0.896 **	- 0.976 **	- 0.658 *	0.848 **	0.844 **	
No. of flowers/ cluster	Rp	0.728 **	0.525 *	0.822 **	0.664 *	0.616 *	0.699 *	0.250	0.665 **		
	Rg	0.895 **	- 0.712 **	- 0.863**	0.795 **	0.901**	0.809 **	0.224	0.932 **		
Diameter of fruit (cm)	Rp	0.900 **	- 0.830 **	0.979**	0.921 **	0.858 **	0.909 **	- 0.620 *			
	Rg	0.753 **	0.80 **	0.911 **	0.915 **	0.873 **	1.030 **	- 0.743 **			
Length of fruit (cm)	Rp	0.990 **	0.881**	- 0.859 **	0.930 **	0.975 **	0.964 **				
	Rg	0.805**	0.705 **	0.980 **	1.025**	0.811 **	0.911 **				
Fruit weight (gm)	Rp	0.552*	0.817 **	0.642 *	0.569 *	0.585 *					
	Rg	0.845 **	0.949 **	- 0.762 **	0.994 **	0.909 **					
No. of fruits /plant	Rp	0.981 **	0.931 **	0.914 **	0.928 **						
	Rg	0.90 **	0.913 **	1.032 **	0.940 **						
Yield/plant (kg)	Rp	0.956 **	0.936 **	0.888 **							
	Rg	0.821 **	0.890 **	0.758 **							
No.of locules./fruit	Rp	0.948 **	0.840 **								
	Rg	0.912 **	0.978 **								
T.S.S	Rp	0.897 **									
	Rg	- 0.756 **									

*,** significantly at 0.01 and 0.05 .

compared with other interactions. On the other hand, the treatment interaction between tomato genotype Kashi with Alga 600 at 3mg/L gave the highest value in fruit diameter (6.83 cm), yield per plant (2.57 kg), number of locules per fruit (9.73), TSS (6.27 %) and in total yield per unit (16.71 tons /donum). While the interaction between tomato genotype Madanapolli with Alga 600 foliar application at 2mg/L gave a high value only in fruit weight (44.87g) compared with the other interaction between genotypes and Alga 600 foliar application.

The genetic parameters and correlations

Analysis of variance showed a significant difference among the genotypes for all the traits under study (Table 4). Phenotypic variance ($б^2p$), Genotypic variance ($б^2g$) was higher for the plant height (102.539, 94.542 cm), the number of fruits per plant (347.292, 283.521). The phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV**)** indicating that the genotypic influence is lessened under the effect of a given environment. The coefficient of variation, phenotypic or genotypic, are both useful in the study of the extent of variability of different traits, as it measures the range of variability. A perusal of the results on heritability and genetic advance revealed that heritability estimates were higher for all the traits studied, which were over 60%. These results showed greater effectiveness for selection due to less effect of environment and improvement to be expected for these traits in future breeding programs. High values of GCV and heritability estimates also showed additive gene effects regulation and the inheritance of such traits. The high PCV is an indication of the existence of wide scape of selection for the improvement of these traits, from a considerable amount of variability present. According to Johnson et al. (1955) and Panse (1957), estimates of the genotypic coefficient of variation alone are not sufficient to assess the heritable variation. The result of the estimated genetic parameters were similar to results of Prema et al. (2011), Al-Aysh et al.(2012), (2011) Kumar et al.(2013) , Shankar et al. (2013), Rai et al. (2016) , Ambresh et al. (2017) and Marasini and Paudel (2017).
The estimated genotypic and phenotypic correlation coefficients done for ten characters during spring season are shown in Table 5. The phenotypic correlation and genotypic correlation were positively significant and higher among the plant height and number of branches per plant, number of flowers per cluster, the diameter of fruit, length of fruit, number of fruits per plant, yield per plant, number of locules per fruit, TSS, and total yield. The number of branches per plant was positively and significantly associated with all traits at the phenotypic and genotypic level. The fruit diameter has a positive significant correlation with the fruit weight number, fruits per plant, yield per plant and with total yield per unit area. Also, Table 5 indicates that total yield had a high positive significant correlation among all traits studied. In general, the magnitude of genotypic correlation coefficients was higher, than some traits phenotypic correlation, indicating thereby a strong inherent association between various characters under this study, while negative association was indicated with only the number of locules per fruit, among the number of branches per plant, number of flowers per cluster, length of fruit and fruit weight. These results are in accordance with the finding of Asati et al. (2008), Al-Aysh et al. (2012), Kumar et al. (2013) and Ambresh et al. (2017). These studies showed the yield had a positive and significant correlation with the plant height, diameters, length and weight of fruit and with yield per plant in the case of tomato genotype.

CONCLUSIONS

The tomato varieties showed an increase in plant height, number of branches per plant, number of flowers per cluster, (diameter, length, weight) of fruit, number of fruits per plant, yield per plant TSS and total yield per unit area as a result of foliar application of Alga 600. Such effect from foliar application of Alga 600 (an organic fertilizer) might be due to their critical role in crop growth, involving in photosynthesis processes, respiration and other biochemical and physiological activities and thus their importance in achieving higher yields. Heritability estimates was higher (over 60%) for all the traits studied.

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