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Nutrients Effect on Tomato's (*Lycopersicon esculentum* Mill) Hybrids grown in Unheated Plastic House

ABSTRACT

This experiment was conducted during autumn growing season of 2016-2017 under unheated greenhouse environment at the field station of college of Agriculture-University of Tikrit to study the effect of seaweed, and organic extracts spraying on growth and yield of tomato's (*Lycopersicon esculentum* Mill**)** three hybrids. The following nutrients were used; Alga600, Seaweed, and Max in addition to control treatment. The three hybrids were; Rakan, Bushra, and Sadouf. The experiment was designed using split plot design with two factors. The experiment results showed that the organic nutrient Alga600 significantly dominated on fruit average weight (146.00 gm. each fruit^{-1}, individual plant yield as it was recorded for 2.33 kg. each plant^{-1}, number of fruits for each plant (16.59 fruits. each plant^{-1}, the yield of experimental unit (46.67 kg), total greenhouse yield (3981.33 kg. each greenhouse^{-1}), texture toughness of fruits, and the pH was 4.88 of nutrient at concentration of 6.14 kg. cm^2 respectively. While the Seaweed affected the peel thickness as it was 1.00 mm and the fruit diameter was 6.67 cm. each fruit^{-1}.

The effect of hybrids, it was noticed that hybrid Rakan was significantly dominated in fruit peel thickness, fruit texture fruit toughness (0.86 mm) and (6.19 kg. cm^2). The following characteristics of yield including fruit yield for each plant (2.05 kg. each plant^{-1}, experimental unit total yield (41.00 kg), total yield of the green house (3.526 tones. green house), number of fruits per each plant (14.69 fruits. plant^{-1}), and fruit average weight (137.67 gm). The hybrid Sadouf was dominated in the pH, which was 4.46.

INTRODUCTION

Tomato (*Lycopersicom esculentum* Mill), is a vegetable plant of the plant family Solanaceae. It is considered one of the vegetable that is widely distributed in the world and it is one of the major and important vegetable in Iraq. Tomato is consumed in many ways as cooked, canned, and fresh as it is of high nutritional value. The medium size of it is about 150.00 gm and can substitute human being with 57% of daily requirements of vitamin C, more than 25% vitamin A, and 8% of iron in addition to other vitamins, (Matloub et al., 1989). There was an increase in the productivity of cultivated area by 33.6 million tons. Hectare^{-1} and the cultivated area estimated to be 1.2 million hectares, (FAO, 2010). In Iraq, the productivity was 3.209544 million. Hectare-1. When Iraqi productivity compared to the world productivity; it is lower than the world productivity on the unit area. Tomato quality depends on nutrients that are added to it, as it mentioned in previous studied like NPK, magnesium and seaweed spraying; these nutrients effect on the fruit quality and quantity (Khan *et al*., 2006). The goal of this project was to study the effect of hybrids on quality and quantity of

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tomato yield and to study the effect of leafy nutritional, which contains organic compounds and matters application on growth and yield of tomato.

MATERIALS AND METHODS

This experiment was conducted at the greenhouse of the research station of the department of horticulture and garden landscaping/ College of Agriculture/ University of Tikrit on growing season of 2016-2017. The greenhouse was unheated with dimensions of 50.00 meters long, 9.00 m wide, and 3.5 m height with total area of 450 m^2. The land was ploughed with mouldboard plough and soil was finned. The soil was sterilized with Formaldehyde of 45% concentration (1.5 liter/100 liter of water), to the limit of wetting of the surface soil and turned down and the sterilization process was repeated again. Transparency polyethylene layer was used to cover the area for three days. After the three days, the cover was removed and the exposed area left for seven days for aeration. The irrigation dripping pipes were installed and the area mulched by black plastic cover for sunny sterilization of soil, and then the soil was irrigated to the saturation limit.

Yield constituents:

1. **Mean fruit weight (gm. fruit^{-1}):**

This variable was calculated on the division of the total yield of experimental unite on the number of cultivated plants.

2. **Number of fruits per plant (fruit. Plant^{-1}):**

The number of fruits by the beginning of harvesting and the mean was based on the following equation: Total number of fruits. Plant^{-1} = total number of fruits of experimental unit/plants number that the fruits were harvested from.

3. **Plant yield (kg. plant^{-1}):**

This characteristic was calculated according to the following method, (Al-Dahamy, 2013):
The average of each plant yield (kg. plant^{-1}) = the total accumulated yield of all harvests to the end of the season of each experimental unit divided by the number of plants.

4. **Experimental unit yield (kg.):**

This variable was calculated according to the following equation:
Experimental unit yield = weight of the unit yield* number of the plants in the unit.

5. **The greenhouse yield (tone. Greenhouse^{-1}):**

The total yield for the greenhouse = total yield of the unit * 450 m^2 / area of the unit.

6. **Thickness of the fruit peel (mm):**

This characteristic was measured using the electronic Vernier for five fruits. Experimental unit^{-1}, starting from the widest part of the fruit and for all the four directions and calculated the mean.

7. **Estimation of the pH of the fruit acidity:**

The pH of the fruits was determined from the juice filtrate using the pH meter at the lab of College of Agriculture/ Kirkuk University. 10 ml of the filtrate was adjusted with 0.1 molar of Sodium hydroxide and phenolphthalein reagent based on citric acid, (A.O.A.C., 1980).

8. **Fruit firmness test (Kg. cm^2):**

This one was done using the fruit firmness tester at the point of fruit connected to the plant at the maturation stage. It was done on ten fruits from the last three harvests, and then the mean was determined.

9. **Fruit diameter (cm):**

This characteristic was measured on the middle of the fruit using digital Vernier of five fruits from each experimental unit starting at the widest area and calculated the mean for each fruit.

RESULTS AND DISCUSSION

1. **Fruit average weight (gm.):**

The results in Table (1), there is no significant differences of the fruit weight between the three hybrids even if hybrid Rakan was dominated. The nutrition treatments showed a significant difference as Alga600 gave the highest fruit average weight, as it was (146.00 gm.) compared to the lowest weight of Seaweed (128.11 gm.) which was also lower than control treatment.

The combination of hybrids and nutrients, there was a significant difference between those nutritional treatments. The combination of Alga600 and hybrid Rakan resulted in the highest average of fruit weight (154.00 gm.), compared to 116.67 gm. of the control (0.00 gm. nutritional addition), and hybrid Bushra.

Table (1): Combination of hybrids and nutritional addition effect on fruit average weight (gm.)

hybrids / nutrients	RAKAN	BUSHRA	SADOUF	Average
control	140.00 a b	116.67 b	127.67 a b	128.11 b
Alga600	154.00 a	144.67 a b	139.33 a b	146.00 a
SEAWEED	125.00 a b	131.00 a b	127.67 a b	127.89 b
Max	131.67 a	144.33 a b	124.00 a b	133.33 a b
Average	137.67 a	134.17 a	129.67 a	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

2. Number of fruits per plant (fruit. Plant^{-1}):

Table (2) showed the results of fruits number for each plants. From Table 2, there are significant differences between hybrids and nutrients treatments. The hybrid Rakan gave the highest number of fruits (14.69 fruits. Plant^{-1}), compared to hybrids Bushra (13.25 fruits. Plant^{-1}), and Sadouf (13.48 fruits. Plant^{-1}).For the nutritional treatments, it can be seen that Alga600 gave the highest number (16.59 fruits. Plant^{-1}), compared with the control treatment (0.00 addition), which was the lowest (11.28 fruits, plant^{-1}).

The results of combination of nutritional treatments with hybrids, reflected significant differences. The combination of hybrid Rakan and Alga600 resulted in highest number of fruits (19.67 fruits. Plant^{-1}), compared to the combination of no nutritional addition with hybrid Rakan (10.50 fruits. Plant^{-1}).

Table (2): Hybrids, nutritional treatments, and their combination effect on fruit number (fruits.Plant^{-1}).

hybrids / nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	10.50 e	12.50 c d e	10.83 d e	11.28 c
Alga600	19.67 a	14.73 b c	15.37 b	16.59 a
SEAWEED	13.73 b c	12.77 c d e	13.10 b c d	13.20 b
Max	14.87 b c	13.00 b c d	14. 60 b c	14. 16 a
average	14. 69 a	13.25 b	13.48 b	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

3. Yield of individual plant (Kg. plant^{-1}):

Table (3) shows the results of hybrids and nutrients and their combinations effect on the yield of individual plant. From the table, there is clear significant differences between hybrids; as hybrid Rakan was dominated over other two hybrids (Boushra and Sadouf), it got the highest value of the yield (2.05 Kg. plant^{-1}), compared with hybrids Boushra of 1.74 Kg. plant^{-1} and Sadouf of 1.72 Kg. plant-1. The nutritional treatments; the Alga600 dominated resulting in the highest yield of 2.33 Kg. plant^{-1} compared to the control treatment (0.00 addition), that gave 1.43 Kg. plant^{-1}.

The results of combinations between hybrids and nutrients showed a significant differences. The combination of Hybrid Rakan and nutrient Alga600 gave the highest value of the yield as it was recorded 3.03 Kg. plant^{-1}, compared with the same nutrient with Boushra hybrid.

Table (3): Hybrids and nutrients, and their combinations effect on the yield of individual plant (Kg. plant^{-1})

Hybrids / nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	1.47 c d	1.40 d	1.43 d	1.43 c
Alga600	3.03 a	2.03 b	1.93 b c	2.33 a
SEAWEED	1.73 b c d	1.67 a b c	1.72 b c d	1.71 b
Max	1.97 b	1.87 b c d	1.80 b c d	1.88 b
Average	2.05 a	1.74 b	1.72 b	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

4. Experimental unit yield (Kg.):

Table (4) shows the results of hybrids and nutrients and their combination effect on experimental unit yield. The data in table (4), reflected significant differences of the yield due to hybrids, as hybrid Rakan got the highest value of the yield (41.00 Kg. compared to hybrids Bushra (34.83 Kg.) and Sadouf (34.42 Kg.). While the nutritional treatments; Alga600 was significantly gave the highest yield as it reached 46.67 Kg. compared to the control treatment (0.00 addition) in which it got only 28.67 Kg.

The combinations between hybrids and nutrients resulted in significant differences as the combination of hybrid Rakan with nutrient Alga600 achieved the highest yield (60.67 Kg.) compared to the combination of Boshra hybrid and no added nutrient treatment, which gave 28.00 Kg.

Table (4): The effect of hybrids, nutrients, and their combinations on experimental unit yield (Kg.).

Hybrids / nutrients	RAKAN	BUSHRA	SADOUF	Average
control	29.33 c d	28.00 d	28.67 d	28.67 c
Alga600	60.67 a	40.67 b	38.67 b c	46.67 a
SEAWEED	34.67 b c d	33.33 b c d	34.33 b c d	34.11 b
Max	39.33 b	37.33 b c d	36.00 b c d	37.55 b
Average	41.00 a	34. 83 b	34.42 b	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

5. Greenhouse yield (tone. greenhouse-1):

Table (5) gives the data of hybrids, nutrients, and their combinations effect on the greenhouse yield. It can be seen that there is a significant differences between hybrids and nutritional treatments along with their combinations. The hybrid Rakan gave the highest result of the greenhouse yield of 3.526 tonnes. greenhouse^{-1} compared with Bushra and Sadouf hybrids as they gave (3.180 and 3.234 tonnes. greenhouse^{-1}). The nutritional treatments also showed that Alga600 was the highest in the yield as it resulted in 3.981 tonnes. greenhouse^{-1}, over other two hybrids and compared to the control treatment which it gave a yield of 2.707 tonnes. greenhouse^{1}.

The combinations of hybrids and the nutritional treatment were significantly different as the hybrid Rakan and Alga600 nutrient combination was the highest of the yield as the combination got the highest yield of 4.720 tonnes. greenhouse^{-1} compared to hybrid Bushra with no addition combination which gave the lowest of the yield (2.520 tonnes. greenhouse^{-1}.

Table (5): The hybrids, nutrients, and their combinations effect on the greenhouse yield (tone. greenhouse^{-1}).

hybrids / nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	2,520 e	3,000 c d e	2,600 d e	2,707 c
Alga600	4,720 a	3,536 b c	3,688 b	3,981 a
SEAWEED	3,296 b c	3,064 c d e	3,144 b c d	3,168 b
Max	3,568 b c	3,120 b c d	3,504 b c	3,397 b
Average	3,526 a	3,180 b	3,234 b	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

6. Fruit peel thickness (mm):

Table (6), shows the results of the hybrids, nutrients, and their combinations effect on fruit peel thickness (mm). There is no significant difference of hybrids on the fruit peel thickness. While the nutrients and the combinations of the nutrients and the hybrids show significant differences of the fruit peel thickness. From the table, it is shown that the three nutrients were with high results of the peel thickness as for Alga600 it was 0.95 mm, Seaweed of 1.00 mm, and Max of 0.89 mm, compared to the lowest value of the control treatment, which gave 0.51 mm.

The combinations of hybrids and nutrients, table 6 shows the combination of Bushra hybrid and nutrient seaweed is of high value as they gave 1.20 mm, compared to other combinations of hybrids and control treatment (0.00 addition), which is 0.50 mm fruit peel thickness.

Table (6): The effect of hybrids, nutrients, and their combination on the fruit peel thickness (mm).

Hybrids / Nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	0.53 c	0.50 c	0.50 c	0.51 b
Alga600	0.94 a b	0.90 a b	1.03 a b	0.95 a
SEAWEED	1.01 a b	1.20 a	0.80 b c	1.00 a
Max	0.95 a b	0.80 b c	0.93 a b	0.89 a
Average	0.86 a	0.85 a	0.81 a	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

7. Estimation of fruit acidity (pH):

Table (7) shows the results of hybrids, nutrients, and their combinations effect on the fruit acidity (pH). The results show that there is no significant difference of hybrids on the fruit pH. The nutritional treatments and the combinations of hybrids and nutrients reflected a significant difference of the pH. Alga600 gave the highest value of the pH as it recorded of 4.88, compared to the lowest pH of control treatments.

The combination of Sadouf hybrid and Alga600 nutrient resulted in highly significant value of pH (5.00), compared with other combinations as pH 3.38 which was with no nutrional addition with Rakan hybrid (pH 3.38).

Table (7): Hybrids, nutrients, and their combination effect on fruit pH.

Hybrids / Nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	3.38 d	3.55 c d	3.57 c d	3.50 c
Alga600	4.78 a b	4.85 a b	5.00 a	4.88 a
SEAWEED	4.20 a b c d	4.59 a b	4.37 a b c	4.38 b
Max	4.76 a b	3.99 b c d	4.90 a	4.55 ab
Average	4.28 a	4.24 a	4.46 a	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

8. Fruit hardness degree (Kg. cm^2):

The effect of hybrids, nutrients, and their combinations effect on fruit hardness degree results are shown in Table (8). The results show a significant differences of hybrids, nutrients, and their combinations. The hybrids Sadouf and Rakan gave a fruit hardness of 5.65 Kg. cm^2 and 6.19 Kg. cm^2 respectively, compared with Bushra hybrid (4.66 Kg. cm^2). The nutrients got a clear differences as the three nutrients Alga600, Seaweed, and Max that, resulted in fruit hardness of 6.14, 5.85, and 5.74 Kg. cm^2.

The combinations of hybrids and nutrients also showed significant differences in the fruit hardness as the combination of hybrid Rakan and nutrient Alga600 gave the highest mean of fruit hardness (7.50 Kg. cm^2), compared to the control treatment (0.00 addition), 4.20 Kg. cm^2 with Rakan combination.

Table (8): The effect of hybrids, nutrients, and their combinations on the fruit hardness degree (Kg. cm^2).

Hybrids / Nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	4.33 d	4.20 d	4.26 d	4.26 b
Alga600	7.50 a	5.40 b c d	5.53 b c d	6.14 a
SEAWEED	6.73 a b	4.73 c d	6.10 a b c	5.85 a
Max	6.20 a b	4.33 d	6.70 a b	5.74 a
Average	6.19 a	4.66 b	5.65 a	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

9. The fruit diameter (cm. fruit^{-1}):

Table (9) shows that there are significant differences of hybrids, nutrients, and their combinations. The hybrids of Rakan and Sadouf gave the highest results of the fruitl hardness as (6.36, and 6.22 cm. fruit^{-1}respectively), compared to hybrid Bushra which got 5.81 cm. fruit^{-1}. The nutrients were significantly different. The nutrient of Seaweed gave 6.67 cm. fruit^{-1} compared to non-addition treatment (0.00 addition) as it got 5.50 cm. fruit^{-1}.

The combinations of hybrids and nutrients reflected a significant differences as the nutrient Seaweed and hybrids got the value of 7.33 cm. fruit^{-1}, compared to 5.32 cm. fruit^{-1}, of the non-addition (control) treatment and hybrid Bushra.

Table (9): Hybrids, nutrients, and their combinations effect on the fruit diameter (cm.fruit^{-1}).

Hybrids / Nutrients	RAKAN	BUSHRA	SADOUF	Average
Control	5.61 d e	5.32 e	5.58 d e	5.50 c
Alga600	6.80 a b	5.69 d e	5.82 c d e	6.10 b
SEAWEED	6.59 b	6.10 b c d	7.33 a	6.67 a
Max	6.47 b c	6.12 b c d	6.14 b c d	6.24 b
Average	6.36 a	5.81 b	6.22 a	

***The numbers with the same letter means no significance on Duncan Multiple Test at 5% probability.**

Qualitative yield features:

The interpretation of the results:

The dominance of hybrid Rakan in fruit number, fruit weight, plant yield and the variance could due to genetic variation of the plants. The results difference of those characteristics may be based on the photosynthesis activities and accumulation of carbohydrates in addition to an increase of transfer and storage of metabolites to the fruits. This could be why the mean of fruit weight was increased (Al-Zubaidy, 2012, Mohammed et al., 2014). There was another possibility of sharing of macronutrients and micronutrients that were available to increase the vegetative growth as shoots and leaf area in addition to the chlorophyll which resulted in an increase of flowers and finally in the

number and weight of fruits. These findings were in agreement with Majeed, 2010, Deore, 2010 and also with what others found Al-Rakaby and Minsour, 2001, Al-Tahafi, 2005, and Yousif, 2011 as they noticed that the spraying of nutrients on the eggplant.

The increase of the yield with the addition of nutrients (organic spraying), which increase the availability of Nitrogen, and Potassium for the plant and their role on the metabolism of the plant and improve its nutritional situation. This condition of nutritional improvement affected in the increase of dry weight, leaf area, and chlorophyll contents of the leaves. This could be the results of increase of metabolites and accumulation of more carbohydrates and proteins that moved to the fruits, (Neerja et al. 2005, and Fawzy et al. 2007). These findings were in agreement with what Al-Fitlawy 2005, and Deore et al., 2010.

The cause of the yield qualitative characteristics differences between the hybrids as a results of hybrids genetic differences and that also agreed with Shah and Sadoon, 2012. Perhaps also due to the genetic differences of hybrids and that affected the fruit dimensions (Alzaidy, 2012). All the results agreed with what Malawadi et al. (2004), Mijaid (2010), and Al-Mirjani (2011), Yanar et al. (2011), Al-Ibrahaemy, (2011), Abdul Rahaman, (2011), and Khalaf (2016).

The better results of the fruit qualitative characteristics for the spraying with Max could be due the richness of this organic compounds with Nitrogen, Potassium, Phosphorus, Calcium, Magnesium, and Sulphur in addition to many amino acids. The results showed that was an increase in the N.P.K. elements in the vegetative growth as it can be seen from tables 3, 4, 5, 10, 12, 13, 14, 15, 16, as the results of spraying with Max. Max also could contains some plant auxins that activate the division and elongation of cells, which might affect in increase of leaf area and increase of photosynthesis in addition to increase the fruit contents of nutrients, (Jenson, 2004). He reported that the plant auxins of Max increased N.P.K. of the vegetative growth and fruits and also participated in translocation of carbohydrates from their location of formation in leaves to the accumulation locations. There is another possibility that Max plant auxins could do some regulations of plant hormones as IAA, which improve the plant capacity in metabolism of CO_2, (Tahai and Al-Younis, 1988).

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تأثير بعض المغذيات في صفات حاصل ثلاثة هجن من الطماطة *Lycopersicon esculentum* Mill المزروعة في البيت البلاستيكي الغير مدفأ

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1 قسم البستنة وهندسة الحدائق– كلية الزراعة– جامعة تكريت– العراق

المستخلص

نفذت هذه التجربة خلال الموسم الزراعي الخريفي 2016-2017 تحت ظروف البيوت البلاستيكية غير المدفأة التابعة لمحطة ابحاث كلية الزراعة – جامعة تكريت بهدف دراسة تأثير الرش بمستخلصات الأعشاب البحرية و العضوية في نمو وحاصل ثلاثة هجن من نبات الطماطة (*Lycopersicon esculentum*, Mill.) ، واستعمل فيها المغذيات التالية : (Alga600) و (Seaweed) و(Max) فضلاً عن معاملة المقارنة (Control) ، وثلاثة هجن (Rakan ، Bushra، Sadouf) ، صممت التجربة وفق نظام القطع المنشقة (Split plot design) بعاملين ، ويمكن تلخيص نتائج التجربة بما يلي : تفوق المغذي العضوي (Alga600) معنوياً في الصفات التالية : معدل وزن الثمرة بلغت قيمة تأثيره (146.00) غم . ثمرة $^{-1}$ وحاصل النبات الواحد بلغ التأثير (2.33) كغم. نبات$^{-1}$ وعدد الثمار للنبات الوحد بلغت بمعدل (16.59) ثمرة. نبات$^{-1}$ وحاصل الوحدة التجريبية بلغ (46.67) كغم وحاصل البيت البلاستيكي بلغ قيمة (398133) كغم. بيت بلاستيكي$^{-1}$ و درجة الصلابة الثمار و الحموضة بلغ تأثير المغذي فيها (6.14) كغم . سم^{2} و (4.88) pHعلى التوالي . وتفوق المغذي (Seaweed) في صفة سمك جدار الثمرة بلغت (1.00) ملم وقطر الثمرة بلغت (6.67) سم. ثمرة$^{-1}$.

أما بالنسبة لتأثير الهجين فقد تفوق الهجين (RAKAN) في صفة سمك جدار و درجة صلابة الثمرة بلغ (0.86) ملم و (6.19) كغم .سم^{2} تفوقت صفات الحاصل وهي حاصل النبات الواحد وحاصل الوحدة التجريبية وحاصل البيت البلاستيكي وعدد الثمار للنبات الواحد بلغت و(2.05) كغم . نبات$^{-1}$ و (41.00) كغم و (3.526) طن. بيت و (14.69) ثمرة. وحدة$^{-1}$ ومعدل وزن الثمرة بلغ (137.67) غم. وتفوق الهجين (SADOUF) في صفة تقدير نسبة الحموضة في الثمار بلغت (4.46) pH .

الكلمات المفتاحية: الطماطة، مستخلص الأعشاب البحرية، المغذيات العضوية، البيوت البلاستيكية.