THE ROLE OF HUMIC ACID, GIBBERELLINS AND SMOKED WATER IN IMPROVING THE FLORAL AND FRUIT TRAITS FOR THE TOMATO YIELD

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ABSTRACT

The experiment was conducted at the Protected Agriculture Research Station (B) at the college of Agriculture / University of Baghdad in Al-Jadriya Complex to study the effect of spraying different concentrations of humic acid (0, 75 ml, 100 L^{-1}), Gibberellins (0, 100, 200 ppm) and Smoked water (0, 1: 250, 1: 500, 1: 1000 v/v) In the growth and yield of tomato under protected agriculture conditions for the autumn season 2017-2016. The results showed that the treatment of Spraying with Gibberellins (G1) and Smoked water (S2) was significantly excelled in most vegetative traits, either as individual or interaction factors, as well as in the interaction effect of the humic with the Gibberellins and its interaction with the Smoked water. Triple interaction of the factors in all the traits was excelled under study. While no significant effect was observed for individual humic spraying treatments in any of the traits.

Keywords: Humic acid, Gibberellin, Smoked Water, Growth and yield of tomato yield.

دور حامض الهيومك والجبرلين والماء المدخن في تحسين الصفات الزهرية والثمرية لحاصل الطماطة

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الخلاصة:

نفذت التجربة في محطة بحوث الزراعة المحمية (B) في كلية الزراعة / جامعة بغداد في مجمع الجادرية لدراسة تأثير رش تراكيز مختلفة من حامض الهيومك (0 , 75 مل. 100 لتر$^{-1}$) و الجبرلين (0,100 ,200 جزء بالمليون) والماء المدخن (0 , 1:250 , 1:500 , 1:1000) v/v في نمو وحاصل الطماطة تحت ظروف الزراعة المحمية للموسم الخريفي 2016-2017. ويمكن تلخيص أهم نتائج هذا البحث بما يأتي: تفوق معاملة رش الجبرلين (G1) والماء المدخن (S2) معنوياً في معظم صفات النمو الخضري سواءً كعوامل فردية او متداخلة مع بعضها فضلا عن التاثير المعنوي لتداخل الهيومك مع الجبرلين وتداخله مع الماء المدخن وتفوق التداخلات الثلاثية للعوامل في جميع الصفات قيد الدراسة , في حين لم يُلحظ وجود اي تاثير معنوي لمعاملات رش حامض الهيومك الفردية في اي صفة من الصفات .

الكلمات المفتاحية : حامض الهيومك, الجبرلين, ماء مدخن , نمو وانتاجية محصول الطماطة.

1. INTRODUCTION

Vegetables are important agricultural yields in achieving food security and stability to cope with the increase in the world's population. One of these vegetables is the tomato yield, which is scientifically known as *Lycopersicon esculentum Mill*, It is the cultivated type that follows the family of Solanaceae Which includes 90 species and about 2000 plant species [1]. Statistics indicate that the area cultivated with tomato yield for 2104 in Iraq amounted to 34820 hectares and productivity of 770.5 tons compared to the global total area of 5023810 hectares with a productivity of 170750767 tons according to statistics of the Organization of Agriculture and Food [2]. In recent years, organic fertilizers of environmentally safe plant origin, which are not harmful to humans and animals, have been used as a modern technology to stimulate plant growth, increase production and improve its quality according to the organic farming system, which is one of the facets of sustainable agriculture. It is a

comprehensive system of production based on the management and sustainability of the natural system. During the recycling of available natural resources, including animal residues of various types and the residues of plants resulting after harvest and natural extracts whether directly added to the soil or with irrigation water or as foliar fertilizer, Organic fertilizers have a role in providing the necessary nutrients in a balanced manner, It is also linked to the activity of internal plant hormones (Phytohormons) within the plant tissue, especially the activity of Gibberellin, which are hormones that stimulate growth and development from the early stages of the plant life to the stages of flowering and holding fruits and physiological and chemical changes of fruits, As the growth and yield of tomato is related to the Plant Growth Regulators [3], the addition of Gibberellin spray on tomato plants have a significant effect in most of the field traits and productive [4]. Plant environments are unstable mobile systems and consequently the quality and quantity of resources vary, Both natural long-range climate variability (Such as the rise in earth temperature) and short-term impacts such as fires affect the nature of these environments, In the event of such changes, it is necessary to find technical solutions to maintain the natural balance, On the other hand, there is a concept in the agricultural side called (Directed Fire), Which is carried out by human and is fully controlled. Fire has been used all over the world in the agricultural sector to resist pest and eliminate the harmful bush of various kinds, Organic substances accumulated over long stage can release elements nutrient into soil and can remain or volatilize with rising smoke and gases from the combustion process or may be washed off soil. The elements nutrient within that ecosystem are highly absorbable by developing plants. In the course of these observations, subsequent studies have been conducted, the [5] found that the effect of smoke from the burning of plant parts was a catalyst for seed germination. This is what the study of the effect of the activated water on the smoked water, which was conducted on more than 1200 plant species and about 80 strains, including the Solaneacea family [6], And this number has become increasing as research in this area. The emitted smoke consists of carbon oxides, water vapor, hydrocarbons, organic compounds and nitrogen oxides, as well as containing volatile compounds (Volatial Organic Compounds) include hydrocarbons [7]. Based on the mentioned and the absence of any study on the technology of water in Iraq and the Arab world, the research aims to know its effect as well as the spraying agents humic acid and Gibberellin in improving the floral and fruit traits and of the Tomato yield.

2. MATERIALS AND METHODS

The experiment was conducted at the greenhouse of the Agriculture collage - University of Baghdad for the autumn season 2016 - 2017, which included three factors:

The first factor in the study: spray the humic acid with using the concentrations of (0, 75 ml.100 L^{-1}) (manufacturer's recommendations) produced by German company Humiutech GMbh, The second factor is the spray of Gibberellin with concentrations of (0, 100, 200 ppm). The third factor is the spraying of various solutions of smoked water (0, 1: 250, 1: 500, v / v 1: 1000) which was prepared according to method [8] using a special device for smoking water was prepared for the objectives of the research, 200 g of dry plant material (wheat straw) was burned for the purpose of obtaining the smoke, which was soaked in a container of distilled water (500 ml) for 45 minutes, The resulting solution was nominated with a filter paper to get rid of the impurities. Counting the solution produced (Stock Solution), which was taken from one volume (100 ml) and complete the rest with distilled water to prepare dilute solutions and ratios required, And the preparation of an unplanned plastic house and disinfected the soil of the house prior to agriculture. Tilling, flipping, settling and dividing agricultural lines were carried out for the distribution of experimental units. Random samples of soil were taken before planting at a depth of 0-30 cm for the purpose of knowing the properties of chemical and physical soil, The seedlings were moved and planted in the protected house for the autumn season on 29/10/2016

with distance between plant and another 0.40 m, the pit locations mutual in two lines and with five plots with width of 0.80 m With plants left guard in front and behind each experimental unit, The concentrations of humic (4 sprays), Gibberellin (2 sprays) and smoked water (2 sprays) were sprayed two weeks after the cultivated. The first spraying was given on 12/11/2016, and the period between the factors used was 48 hours and between sprays are10 days. Spraying was conducted in the early morning and Tween 20 was added with solutions to reduce surface tension until complete wetness. The fertilizer recommendation (soil fertilization) as recommended for the tomato yield was given equally to all experimental units, As well as to perform all the various service operations of the crop such as Irrigation, weeding, controlling and flatting, plants were flattened vertically, The experiment was designed according to Randomized Complete Design (R.C.D), which are fully distributed according to the Siplt- split plot design and with three replicates, The experimental units contained 10 plants and the total number of experimental units was 72 units, humic concentrations have been considered less important factor so have been distributed randomly to the main-plot, Gibberellin concentrations were randomly distributed to sub-plots. As for the solutions of the smoked water, the most important factor was returned and distributed randomly to sub-sub plots, The results were analyzed using the GenState Discovery Edition and comparing the averages for all the indicators by the least significant difference (L.S.D) at the 5% probability level.

Experimental Measurements:

1. flowering growth indicators:

a. Number of flowers in the flower (flower. inflorescence^{-1}):

The number of flowers in the second bulb on the main stem of the plant was calculated and multiply in the total number of bulbs of the plant and extracted the average [9].

b. the number of flowering inflorescence per plant (inflorescence.plant^{-1})

According to the number of total flowering inflorescence found on the main stem of the plant at the end of the growing season.

2. Indicators of the yield and its components:

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

According to the number of fruits of the experimental unit cumulatively from the beginning of the genie until the last year on the plants number of experimental unit.

b. Total production (kg.greenhouse^{-1})

According to the total production (kg.greenhouse^{-1}) with an area of 418.5 m^2 By accumulating the cumulative score of all fairies and each experimental unit as in the following equation:

Total production (kg.greenhouse^{-1}) = plant yield (kg) × total number of plants in the greenhouse

3. Measuring fruit quality indicators

A random sample of the tomato fruits (5 fruits) was taken in the red fruit stage and measured in it:

a. Total acidity in fruits: -

It was estimated that a random sample of five fruits was taken for each treatment. The juice was then filtered and the color was shortened using Charcoal and 10 mL of juicy juice was obtained. It was corrected with sodium hydroxide (N 0.1) after adding 1 mL of phenofthalene The dominant acid is citric [10].

b. Lycopene pigment estimation (mg / 100 mg fresh weight^{-1}):

The fruit was taken and added 4 ml of acetone with a concentration of 80% with 6 mL of hexane. The components were then crushed and recombined so as to be homogenous and a clear solution was obtained. The solution was then taken and measured by the optical spectrometer and on three wavelengths of (663, 505 and 553 nm) as in the following equations:

Lycopen (mg/100 mg)= 0.0458A663+0.372A505-0.0806A453

3. RESULTS AND DISCUSSION

The number of flowers in the inflorescence (flower number.inflorescence^{-1}):

Table (1) showed that the spraying of humic acid did not significantly affect the number of flowers in the bulb for the tomato crop, while the significant effect of the spray agent was observed in gibberellin. The treatment (G2) gave the highest rate of this trait with (12.69 flower number.inflorescence^{-1}) compared to the non-spray treatment, which gave the lowest rate of (11.23 flower number.inflorescence^{-1}), This may be due to the effects of GA3 on plant growth, its role in the process of photosynthesis and its activation of other vital activities that occurs in the parts of the plant tissues such the increase in cell division in the peaks and the increase in elongation, as well as the activity of the root system. Thus, the total of these effects was reflected in the increase the flowers number in the plant, Table (1) shows that there is a significant effect of the spraying treatments with the smoked water, the treatment of spraying S2 has given a significant effect of the number of flowers (12.85 flower number.inflorescence^{-1}) compared to the lowest value of S1 treatment (11.31 flower number.inflorescence^{-1}), As well as Its superiority on other treatments. The increase may be attributed to the role of the factor in improving food content, which increased the carbonate representation and thus improved vegetative growth, resulting in the distribution of processed food in a balanced manner to the apical meristems responsible for the formation of flower initiator, which may have responded to the increased concentration of dissolved carbonates in the extract and accelerated the growth of apicals and formation the flowers, In addition, the carbon structures of the organic compounds present in the extract of smoked water increase the total carbohydrates in the plant and affect the percentage of C: N responsible for the shift towards flowering and thus increase the number of flowers. It is clear from the results of the table that there is a significant effect of the bi-interaction of the factors under study, The interaction of spraying of humic acid and Gibberellin was given a significant effect in this traits, The spraying treatment H1G2 gave the highest average number of flowers of (12.96 flower number.inflorescence^{-1}) Compared to other treatments and control treatment (10.77 flower number.inflorescence^{-1}) Perhaps the positive effect is due to the improvement of the nutritional and hormonal condition of the plant by the act of both two factors and their reflection on the vegetative indicators, which leads to the activation of the trend towards flowering. The bi-interaction of the spraying with the humic acid and smoked water had a positive effect in the trait. The treatment H1S2 gave the highest average number of flowers of (13.10 flower number.inflorescence^{-1}) Compared to the lowest average of the two treatments (H1S1 and H1S3) Which gave the same no significant value of (10.97 flower number.inflorescence^{-1}), The triple interaction of the combined study factors did not have a significant effect.

Table 1: Effect of spraying with humic acid, gibberellin, and smoked water and their interactions on the flowers number in the inflorescence (flower number.inflorescence^{-1}) for the tomato plant

Studied Factors						
Humic acid	**Gibberellin**	**Smoked water**				**Interactions of humic acid with gibberellin**
		S0	**S1**	**S2**	**S3**	
H0	**G0**	10.73	10.40	11.68	10.25	10.77
	G1	12.45	10.98	13.03	11.32	11.95
	G2	13.72	11.53	13.09	11.33	12.42
H1	**G0**	12.22	11.87	12.39	10.29	11.69
	G1	12.65	11.03	13.62	12.20	12.38
	G2	12.86	12.03	13.29	13.66	12.96
LSD 5%		**N.S**				**1.003**
Interactions of humic acid with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Humic acid**

H0	12.30	10.97	12.60	10.97	11.71
H1	12.58	11.64	13.10	12.05	12.34
LSD 5%	**1.101**				**N.S**
Interactions of Gibberellin with Smoked water	**S0**	**S1**	**S2**	**S3**	**Average of Gibberellin**
G0	11.48	11.13	12.03	10.27	11.23
G1	12.55	11.01	13.33	11.76	12.16
G2	13.29	11.78	13.19	12.50	12.69
LSD 5%	**1.104**				**0.476**
Average of smoked water	12.44	11.31	12.85	11.51	
LSD 5%	**0.686**				

Number of inflorescence in the plant (inflorescence.plant^{-1}):

Table (2) indicates that there is no significant effect for the spraying treatments with humic in the number of inflorescence of the tomato yield, While the significant effect of the spraying treatments with the Gibberellin was observed in the trait, The G2 spraying treatment gave the highest rating of (14.05 inflorescence.plant^{-1}) Compared to the lowest average of without spraying treatment (G0) of (13.10 inflorescence.plant^{-1}), This result gives a clear explanation that vegetative growth regulators (represent in this study with Gibberellin) act as a way to make the plant use nutrients more efficiently and make it exploits its physiological and genetic ability to the highest level, which leads to increased indicators of vegetative growth and then the growth of flowering and its components, In the same direction, it is noted from the results that there is a significant effect of the foliar spraying treatments by the smoked water in this trait, The treatment of smoked water S2 gave the highest number of inflorescence in the plant of (14.44 inflorescence.plant^{-1}) compared to the low-value for the S3 spraying treatment of (13 inflorescence.plant^{-1}), The results of the table showed a significant effect for the bi-interaction of the spraying agents (humic and Gibberellin). The treatment of spraying H1G2 gave the highest average of (14.23 inflorescence.plant^{-1}) compared to the treatment of foliar spraying H1G01 which gave (2.93 inflorescence.plant^{-1}), This result can be explained by the increase in the number of inflorescences being within the appropriate concentration of both humic and Gibberellin acid, which led to the increase of active bio-activities within the plant during the stage of vegetative growth (modernity), Which was subsequently reflected on the traits of flowering growth by increasing the number of floral buds in the flowering cluster, The bi-interaction of the spraying agents with the humic acid and the smoked water had a significant effect on this trait, The spraying treatment H1S2 gave the highest average for the number of inflorescences reached of (14.51 inflorescence.plant^{-1}) compared to spraying treatment H1S3, which gave the lowest average of (12.86 inflorescence.plant^{-1}), In the same context, the bi-interaction of spraying with Gibberellin and smoked water resulted in a significant increase in the number of inflorescences in the plant represented by treatment G2S2, which gave the highest average of (15.05 inflorescence.plant^{-1}) compared to the control treatment (12.42 inflorescence.plant^{-1}), The triple interaction effect of the study factors in the trait can be observed from the results of the table and significantly, that represented by the superiority of the treatment H0G2S2 significantly on the control treatment by giving it the highest value of (15.22 inflorescence.plant^{-1}) if compared to the average of treatment H0G0S0 with a minimum average of (12.30 inflorescence.plant^{-1}).

Table 2: Effect of spraying with humic acid, gibberellin, and smoked water and their interactions on the number of inflorescence in the plant (inflorescence.plant^{-1}) for the tomato plant

Studied Factors						
Humic acid	**Gibberellin**	**Smoked water**				**Interactions of humic acid with gibberellin**
		S0	**S1**	**S2**	**S3**	
H0	**G0**	12.30	13.24	14.57	12.98	13.27
	G1	14.70	12.97	13.34	13.39	13.60
	G2	13.73	13.55	15.22	13.02	13.88
H1	**G0**	12.53	13.37	13.77	12.07	12.93
	G1	14.48	13.83	14.80	12.73	13.96
	G2	13.46	14.70	14.97	13.78	14.23
LSD 5%		**1.343**				**0.516**
Interactions of humic acid with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Humic acid**
H0		13.58	13.25	14.38	13.13	13.58
H1		13.49	13.97	14.51	12.86	13.71
LSD 5%		**0.735**				**N.S**
Interactions of Gibberellin with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Gibberellin**
G0		12.42	13.30	14.17	12.52	13.10
G1		14.59	13.40	14.07	13.06	13.78
G2		13.59	14.13	15.09	13.40	14.05
LSD 5%		**0.973**				**0.447**
Average of smoked water		13.53	13.61	14.44	13.00	
LSD 5%		**0.600**				

Fruits Number per plant (fruit. plant $^{-1}$):

Table (3) shows that the spraying treatment of humic acid and gibberellin did not behave positively in achieving a significant increase in the fruits number of per plant, Perhaps due to the fact that they did not positively affect the percentage of the fruits set, As for the effect of the smoked water factor, the results of the same table showed a significant effect of treatment S2 by giving it the highest average of fruits number per plant (50.27 fruit.plant^{-1}) compared with the lowest average of treatment S3 (42.76 fruit.plant^{-1}), The reason may be attributed to the effect of the treatment in increasing the flowers number in the inflorescences, the inflorescences number incense and reflected on the increase of the proportion of the fruits set, In the context of bi-interactions for factors of the study, It is noted from the table that there is a significant effect of the spraying treatments with humic acid and gibberellin. The spraying treatment H1G2 gave the highest fruits number (48.62 fruit.plant^{-1}) which was significantly excelled than the control treatment (38.74 fruit.plant^{-1}). But did not differ significantly from the treatments H1G1 and H1G0, The results of the table also showed a significant effect of the interaction of the workers of humic acid and smoked water. The interaction gave a positive effect of the trait represented by the treatment of H1S2, The average fruits number per plant was (52.79 fruit.plant^{-1}) compared with the lowest value represented by the spraying treatment of H0S3, which is (39.33 fruit.plant^{-1}), The bi-interaction of the spraying treatment and the smoked water gave a positive effect in the trait and recorded the treatment G1S2 the highest rate was (53.10 fruit.plant^{-1}) compared by the lowest value of spraying treatment G0S1 which gave (41.38 fruit.plant^{-1}), The results of the table showed a significant effect of the triple interaction of the study factors. The spraying treatment H1G2S2 gave the highest average of (53.33 fruit.plant^{-1}) compared with the lowest average giving by the H0G0S0 treatment of (35.97 fruit.plant^{-1}).

Table 3: Effect of spraying with humic acid, gibberellin, and smoked water and their interactions on the Fruits Number per plant (fruit. plant^{-1}) for the tomato plant

Studied Factors						
Humic acid	**Gibberellin**	**Smoked water**				**Interactions of humic acid with gibberellin**
		S0	**S1**	**S2**	**S3**	
H0	**G0**	35.97	37.77	44.97	36.27	38.74
	G1	41.83	43.17	45.40	40.53	42.73
	G2	45.70	41.00	52.87	41.20	45.19
H1	**G0**	49.37	41.90	52.00	46.50	47.44
	G1	47.27	45.63	53.03	45.47	47.85
	G2	49.90	44.70	53.33	46.57	48.62
LSD 5%		**6.906**				**4.557**
Interactions of humic acid with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Humic acid**
H0		41.17	40.64	47.74	39.33	42.22
H1		48.84	44.08	52.79	46.18	47.97
LSD 5%		**4.179**				**N.S**
Interactions of Gibberellin with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Gibberellin**
G0		42.67	39.83	48.48	41.38	43.09
G1		44.55	44.40	49.22	43.00	45.29
G2		47.80	42.85	53.10	43.88	46.91
LSD 5%		**4.923**				**N.S**
Average of smoked water		45.01	42.36	50.27	42.76	
LSD 5%		**2.633**				

Total yield (kg.greenhouse^{-1}):

Table (4) shows that there is no significant effect of the spraying treatment with humic acid in increasing the productivity of the cultivated tomato yield according to the Protected agriculture, While the positive effect of the spraying treatments with gibberellin on the total yield represented by the spraying treatment G2, which gave the highest productivity of the greenhouse amounted to (3026 kg.greenhouse^{-1}) compared to the non-spraying treatment, which gave the lowest yield of (2588 kg.greenhouse^{-1}), The results of the same table showed a significant effect of spraying treatments with smoked water on the tomato yield cultivated inside the greenhouse positively. The spraying treatment S2 gave the highest yield of (3238 kg.greenhouse^{-1}), While the spraying treatment S3 gave the lowest in the greenhouse amounted to (2620 kg.greenhouse^{-1}), The reason may be attributed to the positive effect of the two factor in improving the overall traits of flowering growth and yield components represented by the fruits number, which was the final outcome that positive effect in the trait, In the context of the bi-interactions between the studied factors, it was observed that there was a significant effect of the spraying interaction between humic acid and Gibberellin in the Total productivity of the yield represented in the treatment H1G1, which excelled by giving it the highest productivity of (3197 kg.greenhouse^{-1}) compared to the control treatment that gave the lowest productivity of (2260 kg.greenhouse^{-1}) But not significantly different from H1G2 (3141 kg.greenhouse^{-1}), As shown by the results of the table there is a significant effect of the bi-interaction of the spraying with humic acid and smoked water, The spraying treatment H1S2 gave the highest productivity of the greenhouse of (3578 kg.greenhouse^{-1}) compared with the treatment of spraying treatment H0S3, which gave the lowest productivity of (2430 kg.greenhouse^{-1}), It is also noted from the results of Table (4), the presence of a significant effect of the

spraying interaction with Gibberellin and smoked water in the productivity increase positively for the tomato yield, The G1S2 treatment gave the highest yield of (3,311 kg.greenhouse^{-1}) compared to the lowest average of treatment G0S0 (2346 kg.greenhouse^{-1}). The positive effect of bi-interactions on the studying factors may be attributed to the increase in the role of these factors in their effect on the overall biological and physiological activities within the plant or to stimulate them to do that, which was reflected in the traits of flowering growth and the yield components With a later effect and led to a significant increase in productivity. The results of the table showed a significant effect of the triple interaction of the studied factors. The spraying treatment H1G1S2 gave the highest average of greenhouse productivity of (3748 kg.greenhouse^{-1}) compared to the treatment of H0G0S0 (control) with a lowest productivity of (1836 kg.greenhouse^{-1}) .

Table 4: Effect of spraying with humic acid, gibberellin, and smoked water and their interactions on the Total yield (kg.greenhouse^{-1}) for the tomato plant

Studied Factors						
Humic acid	**Gibberellin**	**Smoked water**				**Interactions of humic acid with gibberellin**
		S0	**S1**	**S2**	**S3**	
H0	**G0**	1836	2179	2796	2230	2260
	G1	2418	2584	2874	2611	2622
	G2	3156	2796	3024	2449	2856
H1	**G0**	2856	2591	3446	2773	2917
	G1	3043	3080	3748	2691	3141
	G2	3309	2973	3541	2964	3197
LSD 5%		**830.5**				**810.7**
Interactions of humic acid with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Humic acid**
H0		2470	2520	2898	2430	2579
H1		3069	2882	3578	2810	3085
LSD 5%		**854.1**				**N.S**
Interactions of Gibberellin with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Gibberellin**
G0		2346	2385	3121	2502	2588
G1		2730	2832	3311	2651	2881
G2		2707	3282	2885	3232	3026
LSD 5%		447.3				365.3
Average of smoked water		2770	2701	3238	2620	
LSD 5%		**199.9**				

Fruit content of lycopene (mg 100 g fresh weight^{-1})

Table (5) shows there is a significant effect of spraying with Humic acid in increasing the content of tomato fruits from lycopene pigment. Treatment H1 gave the highest average of (2.836 mg 100 g fresh weight^{-1}) compared to the control treatment, which gave (2.531 mg 100 g fresh weight^{-1}), Perhaps the reason for the superiority of these traits when sprayed with humic acid is to contain a number of micro and macro-elements, cytokinines, Auxins, Gibberellins and other growth hormones, which in turn increase photosynthesis in the leaf And increase their transmitted products to fruits in a direction that improves the content of the fruits from this pigment, The results showed that there was a significant effect of spraying with Gibberellin in improving the dye content in the fruits of the tomato. The treatment G1 gave the highest average of (2.696 mg 100 g fresh weight^{-1}) compared to the lowest average of treatment G2 (2.667 mg 100 g fresh weight^{-}

^{1}), Also did not differ significantly from the control treatment (2.688 mg 100 g fresh weight^{-1}) in the content of the pigment, The results in the table also indicate that there is no significant effect of the spraying treatments on the smoked water in increasing the fruit content of the lycopene pigment in the tomato fruits, The results of the table showed a significant effect of the bi-interactions between the studied factors in the trait. The interaction of the spraying with the humic acid and the Gibberellin gave a positive effect in raising the fruit content of the lycopene pigment represented by the treatment H1G0 which gave the highest average of (2.933 mg 100 g fresh weight^{-1}) compared to the lowest average of treatment H0G0 of (92.442 mg 100 g fresh weight^{-1}), But did not differ significantly from the treatment H1G1 (2.842 mg 100 g fresh weight^{-1}), Perhaps the reason for the increased fruits content from the pigment to improve the efficiency of photosynthesis and plant metabolism by organic fertilizer through improved vegetative growth, Which increases the production of pigment within the fruit, The results of the table showed that the bi-interaction of the spraying treatments with humic acid and smoked water, and Gibberellin and smoked water did not positively affect the increase in the content of the tomato fruits from this pigment, However, the triple interaction of the studying factors was significant as the results showed that the spraying treatment of H1G0S2 was excelled by giving it the highest lycopene fruit content of (3.033 mg 100 g fresh weight^{-1}) compared with the lowest average for control treatment (2.100 mg 100 g fresh weight^{-1}).

Table 5: Effect of spraying with humic acid, gibberellin, and smoked water and their interactions on the Fruit content of lycopene (mg 100 g fresh weight^{-1})for the tomato plant

Studied Factors						
Humic acid	**Gibberellin**	**Smoked water**				**Interactions of humic acid with gibberellin**
		S0	**S1**	**S2**	**S3**	
H0	**G0**	2.100	2.600	2.600	2.467	2.442
	G1	2.600	2.833	2.267	2.500	2.550
	G2	2.667	2.767	2.500	2.467	2.600
H1	**G0**	2.967	2.967	3.033	2.767	2.933
	G1	3.000	3.100	2.700	2.567	2.842
	G2	2.700	2.733	2.600	2.900	2.733
LSD 5%		**0.304**				**0.164**
Interactions of humic acid with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Humic acid**
H0		2.456	2.733	2.456	2.478	2.531
H1		2.889	2.933	2.778	2.744	2.836
LSD 5%		**N.S**				**0.121**
Interactions of Gibberellin with Smoked water		**S0**	**S1**	**S2**	**S3**	**Average of Gibberellin**
G0		2.533	2.783	2.817	2.617	2.688
G1		2.800	2.967	2.483	2.533	2.696
G2		2.683	2.750	2.550	2.683	2.667
LSD 5%		**N.S**				**0.399**
Average of smoked water		2.672	2.833	2.617	2.611	
LSD 5%		**N.S**				

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