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EFFECT OF DIFFERENT LEVELS OF HUMIC ACID, FULVIC ACID AND N P K IN SOME GROWTH PROPERTIES AND TOTAL SEED YIELD OF SUNFLOWER PLANT (*HELIANTHUS ANNUUS* L.)

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Abstract

A field experiment was carried out to study the effect of three levels of the humic and fulvic acid (0, 15, 30) kg h^{-1} and three levels of NPK (33.3, 66.6, 100%) of the fertilizer recommendations in some growth characteristics and total seed yield of the sun flower plant. The experiment was applied in a factorial experiment according to the Randomized Complete Block Design (RCBD) and three replicates. The obtained results showed that the adding 30 kg $h^{-1}$of the humic was superior by giving the highest rate of plant height (178.03 cm), stem diameter (2.38 cm), number of the plant leafs (33.03 leaf $^{-1}$), leaf area (8265 cm^2) and the total seed yield (5.53 tons h^{-1}) while fertilizer level F3 showed the highest rates for all the studied traits. The interaction between the fertilizer and the mixture of acids (humic and fulvic) had a significant effect on the increase of the total seed yield and the highest recorded value was 5.74 tons h^{-1} at the combination level F2H2.

Keywords : Humic Acid, Fulvic Acid, Total Seed yield, *Helianthus annuus* L.

Introduction

Sun flower (*Helianthus annuus* L.) is one of the most important oil crops, ranking third in the world after soybean and rapeseed crops. The sun flower seeds consist of more than 49% oil with high taste qualities (Nasrallah *et al*., 2014). It has many uses in cooking, butter and soap, and it is used as a feed for farm animals while the stem can be used as fuel (Baldawi, 2014). The Iraqi environment is suitable for the growth and production of the sun flower plant and despite the availability of factors of production of soil, water and climate, the production of the cultivated area is still low compared to the global average due to several reasons, the most important not to use the modern means to increase production, including the maximum use of fertilizers added and quantities and dates recommended causing a decline in the yield due to the emergence, growth, development and differentiation of plant organs under unsuitable conditions for the high production. According to the central statistical organization (2016), the cultivated area in central and southern Iraq was very limited and did not exceed 450 hectares and an average yield of 1.765 tons h^{-1}. Thus, the lack of cultivated land and the low yield of unit area compared to the developed countries can be noted. The main nutrients N, P and K of the elements needed by the plant in relatively large quantities to reach the best yield, which increases the cost of crop production in addition to the exposing these elements to problems of loss and fixation. To reduce these problems, using non-harmful organic fertilizers for humans, animals and plants (humic and fulvic), which have spread in recent years in local markets was a good contributor to increasing the readiness of the elements and improving soil physical and chemical properties. Most recent studies confirm that the major elements N, P and K increase most of the growth and yield characteristics of the sun flower plant (Mahmoud, 2016). Addition of 12.5 kg $h^{-1}$of humic acid was significantly increased growth and yield characteristics (Thakur, 2013). The present study was conducted to increase the productivity of the unit area due to the role of humic and fulvic acids in increasing the readiness of N, P and K, and reducing the environmental pollution by reducing the amount of chemical fertilizers added.

Materials and Methods

An experiment was carried out at the second research station (3 km from Muthanna Governorate) of the Faculty of Agriculture - Muthanna University for the spring season 2017 in a silty loam soil (Table 1) to study the effect of three levels (0, 15, 30) kg h^{-1} of humic and fulvic acid and three levels (33.3, 66.6, and 100%) of NPK of the fertilizer recommendation in some growth traits and total seed yield of the sun flower plant. The experiment was of a factorial experiment according to the Randomized Complete Block Design (RCBD) with three replicates. The soil of the experiment was prepared with a plow of two orthogonal plows using the plowshare plow and the smoothing process was performed using the disc harrows. The field was divided into 81 experimental units, the area of each experimental unit was 7.5 square meters (3 mx 2.5 m), which included four lines with length of 2.5 m per line and the distance between lines 75 cm. The hybrid seeds lilo was cultivated on 9/3/2017 and three seeds were planted in one place and 25 cm between place and another with deep of 3 cm (Sahuki, 1994). After the emergence and formation of the first pair of leaves, the number of plants was reduced to one plant in one place. Irrigation and weeding operations were carried out as needed, using urea fertilizer (N% 46) as a source of nitrogen while Superphosphate fertilizer (P_2O_5% 49) was used as a source of phosphorus and potassium sulphate (K_2O% 50) as a source of potassium and a fertilizer recommendation of 160 kg N^{-1} and 100 kg P_2O_5 E-1 and 160 kg K_2O E-1 (Abadi, 2011), based on this recommendation the amount of the second factor was calculated. After the completion of the fertilization process and before reaching the physiological maturation stage, the plants were covered with nets to avoid bird damage. When the signs of complete maturity were observed, the field was harvested on 7/7/2017 after sampling for each experimental unit. The data were statistically analyzed according to the design used by the statistical program Genstat and the least significant difference (LSD) was used to compare the mean of the treatments with a significant level of 5%.

Table 1 : Physical and chemical properties of soil before planting

Soil qualities		Details	
Soil separators	Sand %	21.5	Silty loam soil
	Clay %	40.8	
	Silt %	37.7	
Degree of soil reaction		7.8	
Electrical conductivity (ECe)(DS/M^{-1})		3.7	
Cation-exchange capacity cmolc/ Kg^{-1} soil		22.8	
Nitrogen		22.8 mg. Kg^{-1} soil	
Phosphorus		14.3 mg. Kg^{-1} soil	
Potassium		142 mg. Kg^{-1} soil	
Organic matter		**1.02** %	

* Soil models were analyzed in the Central Laboratory / Soil and Water Department Laboratory of the Faculty of Agriculture - University of Baghdad

Results and Discussion

Plant Height (cm)

Plant height is a high heterogeneity under the influence of growth inputs and the results of the statistical analysis in Appendix 3 and the results of Table (2) showed a significant increase in the addition of the humic and fulvic acid mixture. The treatment H2 gave the highest mean of 178.03 cm compared to H0 which showed the lowest mean of 165.56 cm with a 7.0% increase. The H1 treatment gave 171.65 cm with an increase of 3.54% compared to the H0 comparison. This may be due to the ability of the humic and fulvic acid to bring soil nutrients and increased its readiness and absorption which positively reflects plant growth (Katkat *et al*., 2009). This result was in line with findings of several researchers (Thakur, 2013; Baldotto and Baldotto, 2015; Attia and Kazim, 2017). Additionally, the results showed a significant increase between the fertilizer treatments (NPK) in plant height. The F3 fertilizer treatment gave the highest average of 183.15 cm compared with the F1 treatment which gave the lowest average of 156.85 cm with an increase of 14.3% while F2 gave an average of 175.25 cm with an increase of 10.49% compared to treatment F1. Furthermore, F3 represents the full fertilizer recommendation of the sun flower plant, which covers the plant's need for nutrients by providing it in the soil solution, absorbing it and moving it through the roots and creating a balance between them within the plant tissue and with proper concentration to stimulate the necessary physiological processes responsible for cellular division and elongation and cell expansion which positively reflected plant height increase (Nawaz *et al*., 2003). This finding was in agreement with the findings of Siddiqu (2010), Banjeree *et al*. (2014) and Khanwani *et al*. (2014). The results showed that there was a significant interaction between the addition of fertilizer (NPK) and the mixture of humic and fulvic acids. The combination F3H2 gave the highest plant height of 187.06 cm and an increase of 20.3% compared to F1H0 which gave the lowest height of 149.08 cm. (F3H1) and (F2H2) were significantly higher than the combination (F1HO) with an increase of 18.4 and 18.2% respectively, which may be due to the presence of these elements with the presence of humic and fulvic increases the readiness and absorption of these elements, contributes to the formation of energy-rich compounds, and improves the growth of the root mass which in turn increases the amount of nitrogen and potassium absorbed, which plays an active role in increasing cell division and elongation and expansion of cells and regulate the transmission of metabolic substances within the plant, which increases the characteristics of plant growth in general, including the status of plant height (Atiyeh *et al*., 2002).

Table 2: Effect of different levels of humic, fulvic, NPK and their interaction on the height (cm) of plant

F \ H	H0	H1	H2	Average H
F1	149.08	168.01	179.60	156.85
F2	156.84	175.31	182.80	175.25
F3	164.62	182.42	187.06	183.15
LSD 0.05	1.755			1.013
Average F	165.56	171.65	178.03	
LSD(0.05) F	1.013			

Stem Diameter (cm)

The results of Table (3) showed a significant increase in the stem diameter when the acidic mixture of humic and fulvic was added. The H2 treatment gave the highest mean of 2.38 cm compared with H0 which gave a mean average of 2.21 cm with an increase of 7.14% while H1 recorded means of 2.30 cm. The increase in the stem diameter may be due to the high ability of humic and fulvic acids in increasing the growth of roots and root whiskers as well increase nutrients in soil (Atiyeh *et al*., 2002) thereby increasing the possibility of plant utilization and ease of absorption of these nutrients by root cells and then accumulating within the plant tissue which appears to have been positively reflected in increased cell division, increased vascular bundles and vector vessels, and an increase in the size of the wood and bark tissues, which increases stem diameter (Malik *et al*., 2004). These results are consistent with the results of Atiyeh *et al*., 2002 and Baldotto and Baldotto. Also, the results showed a significant increase between fertilizer treatments (NPK) in stem diameter feature. The F3 gave the highest mean of 2.41 cm compared with the F1 which gave the mean average of 2.12 cm with an increase of 12.03% while F2 recorded an average of 2.36 cm. The increase in the stem diameter may due to increase the thickness of the bark and wood layers as well as the pulp tissue (Karam *et al*., 2007), resulted from increased absorption of elements of F3 and F2 and their accumulation within the plant, which increased cell activity and division. The results also showed no significant interaction between the addition of fertilizer (NPK) and the mixture of humic and fulvic acids.

Table 3 : Effect of different levels of humic, fulvic and N P K and their interaction on stem diameter (cm)

F \ H	H0	H1	H2	Average H
F1	1.97	2.10	2.30	2.12
F2	2.31	2.37	2.40	2.36
F3	2.36	2.43	2.45	2.41
LSD0.05	N.S			0.0757
Average F	2.21	2.30	2.38	178.03
LSD(0.05) F	0.0757			

Number of Leaves (leaf^{-1})

Table (4) showed significant differences in the effect of the levels of the humic and fulvic mixture on the leaves number. The treatment H2 detected the highest mean of 33.03 plant leaf $^{-1}$ compared to H0 which gave the lowest average of 32.21 plant leaf^{-1} with an increase of 2.48% while H1 has given 32.69 plant leaf^{-1}. The addition of humic and fulvic mixture increased the leaves number which can be attributed to the high ability of these acids to increase the readiness of elements and nutrients to the plant, which in turn affect the characteristics of vegetative growth through the positive effect in most of the biological processes, which is reflected in the processing of the new leaves in the plant to meet the requirements for growth and increase the number of leaves in the plant. This result was consistent with the results of Baldotto 2015, Thakur 2013 and Mazaheri *et al*., 2001 and are inconsistent with the results of Attia and Kazim (2017). The results of the same table showed a significant increase in fertilizer yield (NPK). The fertilizer treatment of F3 gave the highest average of 33.73 plant leaf^{-1} compared to F1 treatment which gave the lowest average of 31.23 plant leaf^{-1} with an increase of 7.41% while F2 treatment gave an average of 32.98 plant leaf^{-1}. This may be due to the role of the major elements (N, P, K) in increasing most of the plant's vital processes and thus processing new leaves with their growth requirements and increasing the number of leaves in the plant. This result is consistent with Nawaz *et al*., 2003 and inconsistent with the results of Al-Rawi *et al*. (2006) and Malamasuri *et al*. (2006). The results indicate insignificant interaction between fertilizer additive (NPK) and additive fractionation.

Table 4 : Effect of different levels of humic, fulvic and N P K and their interaction on the number of leaves (leaf^{-1})

F \ H	H0	H1	H2	Average H
F1	30.93	31.23	31.51	31.23
F2	32.29	33.13	33.51	32.98
F3	33.42	33.70	34.08	33.73
LSD0.05	N.S			0.651
Average F	32.21	32.69	33.03	
LSD(0.05) F	0.651			

Paper Area (cm^2)

The results of Table (5) showed a significant increase in the leaf area of the plant by changing the levels of adding the acids mixture of the humic and fulvic. The treatment H2 gave the highest mean of 8265 cm^2 compared to the treatment H0, which gave the lowest average of 8074 cm^{2}with an increase of 2.31% while H1 gave 8176 cm^2. The addition of humic and fulvic mixture increased paper area which was due to the high ability of these acids to increase the growth of roots and root whiskers, which contributes to the utilization of soil nitrogen, that effectively affects the breadth of leaves and increase their area (Atiyeh *et al*., 2002). Additionally, the acids addition appears to have been positively reflected in increased cell division and thus improved overall growth characteristics and increased number of leaves in plant (Table 4). These results are consistent with the results of Sadiq *et al.*, 2014 and Attia and Kazim (2017). It is also noted from the results of the same table that there was a significant increase between the fertilizer treatments (NPK) of this characteristic. The F3 gave the highest mean of 8386 cm^2 compared to the F1 which gave the lowest average of 7877 cm^2 with an increase rate of 6.06% while F2 gave an average of 8253 cm^2. This may be due to the fact that increased levels of fertilization have increased plant absorption of the elements and a positive effect on increasing the number of leaves in the plant (Table 4). This result was consistent with Al-Rawi *et al.* (2006) and Al-Doori and Shaker 2012. The results also showed no significant interaction between fertilizer additive (NPK) and humic and fulvic mixture.

Table 5 : Effect of different levels of humic, fulvic and N P K and their interaction on paper area (cm^2)

F \ H	H0	H1	H2	Average H
F1	7804	7863	7965	7877
F2	8101	8283	8374	8253
F3	8318	8383	8456	8386
LSD0.05	N.S			126.1
Average F	8074	8176	8265	
LSD(0.05) F	126.1			

Total seed yield (tons h^{-1})

Table (6) showed a significant increase in the total seed yield when the acid mixture of humic and fulvic was added. The treatment H2 gave the highest mean of 5.53 tons h^{-1} with an increase of 6.69% compared to H0 which gave the lowest average of 5.16 tonsh^{-1} while treatment H1 gave mean of 5.36 tons h^{-1} with a significant difference from H0. The obtained result can be attributed to the increase in the indicators of vegetative growth of this treatment, which was positively reflected in the yield increase. The present result consistent with finding of Parvan *et al.* (2013), Osman *et al.* (2014), and Hatami (2017). Significantly, increasing fertilizer ratio (NPK) have increased the total seed yield. The F3 gave the highest average of 5.59 tons h^{-1} with an increase of 10.01% compared to F1 which gave a mean average of 5.03 tons h^{-1}, meanwhile, F2 gave an average of 5.42 tons h^{-1} with a significant difference and an increase rate of 7.19% compared to F1. This may be due to increased vegetative growth indicators of the plant, which was positively reflected in the increase in total seed yield. The obtained result was consistent with the results of Iqbal et al (2008), Nawaz *et al.* (2013) and Khanwani et al (2014). The results showed that there was a significant interaction between the addition of fertilizer (NPK) and the mixture of humic and fulvic acids. The combination (F2H2) gave the highest mean of 5.74 ton h^{-1} with an increase of 17.24% compared to the combination (F1H0) which gave the lowest average rate of 4.75 tons h^{-1} while F3H2 was not significantly different from F3H1 and F3H2, which recorded means of 5.64 and 5.62 tons h^{-1} respectively. These two combinations were not significantly different from F3H0 that gave 5.52 tons h^{-1}. The results showed a high increase in the total seed yield due to the addition of humic and fulvic acids with the level of fertilizer addition F2, indicating the benefit of this combination in increasing the seed yield.

Table 6 : Effect of different levels of humic, fulvic and N P K and their interaction on the total seed yield (tons h^{-1})

F \ H	H0	H1	H2	Average H
F1	4.75	5.11	5.23	5.03
F2	5.21	5.32	5.74	5.42
F3	5.52	5.64	5.62	5.59
LSD0.05	0.159			126.1
Average F	5.16	5.36	5.53	
LSD(0.05) F	0.0918			

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