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The role of fractionation of humic acids and spraying with Azolla extract on vegetative growth indicators growth of sunflower crop (*Helianthus annuus* L).

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Abstract

A field experiment was carried out during the spring season of 2022 at a farm in the Al-Khader district 30 km south of Samawah. The experiment was conducted to study the role of fractionation (30 kg H-1) of humic acids for three batches (First batch, Second batch and Third batch) and spraying with Azolla extract using four concentrations (0%, 20%, 40%, 60%), on the vegetative growth indicators of sunflower. The treatments were arranged as a split-plot design with two plots, the fractionation (30 kg H-1) (Al-Mughayer**,** 2019) of humic acids in the main plot and Azolla spray concentrations in the second plot, using three replications .The results showed a superiority in the second batch for the percentage of nitrogen in the leaves with an average of (1.27%) and did not show significant differences in the plant height, number of leaves per plant, leaf area and stem diameter. Foliage and stem diameter were (34.06 leaves -1, 9514 cm2 one plant and 28.14 mm) for the characteristics, respectively, while the spraying concentration of 60% was superior in the percentage of nitrogen in the leaves with an average of (1.25%). The interaction between the study factors was high significantly, as was (40% Azolla extract at the second batch) the highest average of nitrogen content in the leaves, which was up to (1.30%).

Introduction

sunflower crop *Helianthus annuus* L. is one of the crops of the compound family and is characterized by its multiple uses, including the extraction of vegetable oils, and its oil is used in the manufacture of soap, inks and washing powders (Al-Badri, 2013). In addition to vitamins for being palatable and having a distinct flavor (Al-Rawi et al., 2013). Recently, the demand for the product of the crop has increased due to the existence of factories specialized in roasting and packing their seeds, in addition to their high financial returns, which prompted specialists to pay attention to the crop in order to increase specific weight of its product and reduce empty seeds to fill the shortfall in their production per unit area, as the production of the sunflower crop in Iraq is low with average reached to 1.98 t ha^{-1} (Central Statistical Organization, 2021).

The fractionation of the added fertilizers plays an important role in the life of the plant by providing the important elements for the different stages of plant growth and does not depend on a specific stage through the adding on one time, as the

adding for one batch in the percentage of utilization by the plant (Al-abar and Al-jobouri, 2021).

The humic acids (humic and fulvic) are also important organic fertilizers due to their role in improving the physical, chemical and biological properties of the soil in addition to being a nutrient medium to provide the necessary elements for the plant in its various stages of growth due to its existence in an easy and permanent way in the root spreading area (Fagundes et al., 2007). The most important characteristic of plant extracts is their natural availability as they are considered a common foliar fertilizer because of their high content of nutrients, plant hormones and growth regulators. When foliar spraying increases the ability of roots to grow and absorb nutrients, it is positively reflected on the increase of vegetative growth of the plant (Anisimov, 2014 , Chaikina). The aim of this study was to know the role of humic acid fractionation and spraying with Azolla extract on the vegetative growth indicators of sunflower crop.

Materials and methods

Experiment site

A field experiment was applied in the spring season of 2022 in Al-Khader district, 30 km south of Samawah, to study the role of humic acid fractionation and spraying the Azolla extract on the vegetative growth indicators of sunflower crop. Random samples from the field soil (0-30) cm depth were taken before planting and mixed well to take a sample representing the experimental field and dried and then sieved in a special sieve 2 mm. Physical and chemical analyses of the field soil were performed, which are shown in (Table 1).

Table (1) Physical and chemical properties of the field soil before planting*

Soil properties		Value	unit of measure
Ph		**7.60**	———
E.C		**3**	Desi Siemens M-1
Organic matter		**4.48**	gm kg-1 soil
ready-made nitrogen		**21.50**	mg-1 kg soil
ready-made phosphorous		**16.33**	mg-1 kg soil
ready-made potassium		**142**	mg-1 kg soil
separators the soil	the sand	**521**	gm kg-1 soil
	mud	**114**	gm kg-1 soil
	Silt	**365**	gm kg-1 soil
Tissue		Alluvial sand mixture	gm kg-1 soil

Field operations

Plowing, smoothing, leveling and dividing were done for the field soil in order to provide a suitable cradle for seeds. The field experiment had three replicates. Each replicate included 12 blocks (3 x 3 m per each) (Abd El-Satar and Hassan, 2017). Seeds of Shamoos variety were planted in 4/3/2022 on the upper of the meer by placing three seeds in Al-Joura (Al-Sahoki et al., 1996). plants in the hollow were reduced to one plant. The field experiment was fertilized in one batch before planting by triple superphosphate (21%P) as a source of phosphorous, and potassium sulfate (50%K) was used as a source of potassium, and urea (46%N) as a source of nitrogen according to fertilizer recommendation (160 kg N H -1 and 100 kg P2O5 H-1 and 160 kg K2O H-1) (Al-Abedy, 2011). The experiment has included the fractionation of (30 kg H-1)

of humic acids and symbolized as following:

The fractionated humus was added in three batches (First batch, Second batch, Third batch) and symbolized as (H1, H2 and H3) respectively. The first batch was added a month after emergence, the second batch was added a15 days after the first batch, and the third batch was added a15 days after the second batch, according to the design used.

Spraying with Azolla extract has included four concentrations (0, 20%, 40%, 60%), and symbolized as A0, A1, A2 and A3 respectively.

Plants were sprayed with Azolla concentrations after two months of planting, according to the design used in the experiment.

Results and discussion

plant height (cm)

The results of the statistical analysis indicate that there was no significant effect of humic acid fractionation spraying Azolla extract and the interaction between them on plant height.

Table (2) The role of humic acid fractionation spraying Azolla extract and the interaction between them in plant height (cm).

) Azolla (A Acids humic (H)	**A_0**	**A_1**	**A_2**	**A_3**	**humic acid averages**
H_1	211.73	211.46	215.35	217.84	214.09
H_2	215.79	211.52	211.98	219.05	214.58
H_3	214.05	216.72	216.13	215.37	215.56
Azolla averages	213.85	213.23	214.48	217.42	
L.S.D 0.05)(	**H**	**A**		**A×H**	
	N.S	N.S		N.S	

(%) Leaves nitrogen content

The results of the statistical analysis indicated that there were significant differences between the fractionation of humic acids and spraying spraying Azolla extract and the interaction between them in the nitrogen content in the leaves.

The study has shown that there was a significant difference between treatments of fractionation of humic acids, as the batch H2 was the highest average for the nitrogen content (%), which was 1.27%, while the batch H1 was the lowest average, which was 1.11% (Table 3).

It may be due to the fact that the fractionation of humus and its addition to the soil has increased the content of the soil of nitrogen and reduced its loss process due to washing or volatilization, which increases the efficiency of its

absorption and ease of its transmission via roots and thus its accumulation in the plant. It was also observed that there is a significant increase in the percentage of nitrogen in the leaves with increasing the concentration of spraying Azolla extract, as the concentration A3 was the highest average of 1.25%, compared to the concentration A0 which was the lowest average of 1.14% (Table 3).

The reason may be due to the content of the nitrogen and other nutrients, hormones and amino acids that synthetic the extract plus the effect of these components on the vital processes, which was positively reflected on the root growth system and contributed to the absorption of a large amount of nitrogen, therefore increasing its concentration in the leaves. This result was agreed with Osman and salem (2011) that stated the increase in the nitrogen content in leaves when spraying with plant extracts on sunflower crop.

It was also found that there is a significant interaction between the fractionation of humic acids and spraying Azolla extract in the content of nitrogen, as the combination (H2×A2) was the highest average of 1.30%, while the combination (H1×A0) was the lowest average of 1.02% (Table 3).

This result can be explained on what was discussed in the effect of factors individually, and this could reflect on the interaction between the factors.

Table (3) The effect of fractionation of humic acids, spraying Azolla extract and the interaction between them on the percentage of nitrogen in leaves (%).

) Azolla (A Acids humic (H)	**A_0**	**A_1**	**A_2**	**A_3**	**humic acid averages**
H_1	1.02	1.07	1.17	1.19	1.11
H_2	1.23	1.27	1.30	1.29	1.27
H_3	1.19	1.29	1.27	1.29	1.26
Azolla averages	1.14	1.21	1.24	1.25	
L.S.D 0.05)(	**H**	**A**		**A×H**	
	0.08	0.03		0.08	

Number of leaves per plant (Leaves-1)

The results of the statistical analysis showed that there is a significant effect of spraying Azolla on the number of leaves per plant, while the fractionation of humic acids and the interaction between them did not show any significant differences.

In (Table 4), concentration A2 had the higher average of the number of leaves per plant (34.06 leaves-1), while the control

treatment A0 was the lowest average (32.58 leaves-1).
This may be due to the high content of amino acids and other compounds in Azolla, such as nitrogen that plays an important role in the photosynthesis process and contributes to increasing the growth biomass in the plant, which has a positive impact on the plant growth and therefore increasing the number of leaves in the plant when spraying plant extracts.

Table (4) The effect of humic acid fractionation, spraying Azolla extract and the interaction between them on the number of leaves per plant (Leaves-1).

) Azolla (A / Acids humic (H)	**A_0**	**A_1**	**A_2**	**A_3**	**humic acid averages**
H_1	32.79	33.83	33.67	33.61	33.47
H_2	32.70	33.23	33.81	34.03	33.44
H_3	32.24	34.17	34.70	33.50	33.65
Azolla averages	32.57	33.74	34.06	33.71	
L.S.D 0.05)(	**H**	**A**		**A×H**	
	N.S	0.70		N.S	

area (cm2) Leaf

The results showed that there is a significant effect of spraying Azolla on the plant, while the fractionation of humic acids and the interaction between them did not show any significant effects on the leaf area.

The results have shown also a difference in the leaf area at the concentration A2, which was the highest average of 9514 cm2, while the control treatment A0 was the lowest average of 8617 cm2 (Table 5).
The reason may be due to the increase in the concentration of nitrogen in the leaves (Table 3), which led to an increase in cell division that contribute to an increase in biomass growth and led to an increase in the number of leaves per plant (Table 4), therefore, led to an increase in the leaf area of the plant. This result agreed with the result of Ibrahim (2022) that stated the increase in the leaf area was a result of spraying plant extracts.

Table (5) The effect of humic acid fractionation, spraying Azolla extract and the interaction between them on the leaf area (cm2).

) Azolla (A Acids humic (H)	**A_0**	**A_1**	**A_2**	**A_3**	**humic acid averages**
H_1	8268	8404	9221	9550	8860
H_2	8935	9826	9355	9809	9481
H_3	8650	8754	9967	8812	9045
Azolla averages	8617	8994	9514	9390	
L.S.D 0.05)(	**H**	**A**		**A×H**	
	N.S	577.30		N.S	

Stem Diameter (mm)

The results of the statistical analysis have shown also that there was a significant effect of spraying Azolla on the stem diameter, while there were no significant differences in the fractionation of humic acids and the interaction between them (Table 6).

The table showed a significant effect of the concentration A2, which was the highest average of 28.14 mm compared to the control treatment A0, which was the lowest average of 26.12 mm for the stem diameter. This is reflected positively on the number of vascular bundles and the increase in the stem diameter (Nasrallah et al., 2014). This result agreed with the results of Ramadhan et al. (2020) that noted an increase in stem diameter as a result of spraying plant extracts.

Table (6) The effect of humic acid fractionation, spraying Azolla extract and the interaction between them on stem diameter (mm).

) Azolla (A Acids humic (H)	A_0	A_1	A_2	A_3	humic acid averages
H_1	25.13	28.36	28.34	27.39	27.30
H_2	26.49	26.33	28.91	27.01	27.18
H_3	26.74	26.75	27.18	27.52	27.04
Azolla averages	26.12	27.14	28.14	27.30	
L.S.D 0.05)(	H	A		A×H	
	N.S	1.03		N.S	

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