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Impact of Irrigation Periods and Humic Acids on the Vegetative Growth Parameters of Sunflower Plants

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Annotation: A field experiment was conducted during the fall season (2024), at the Agricultural Research Station affiliated with the College of Agriculture, Al-Muthanna University. The aim was to study the effect of humic and fulvic acid levels and irrigation frequency on the growth parameters of sunflowers (Shamous variety). The experiment was conducted using a randomized complete block design (RCBD), according to a split-plot design and with three replicates. The experiment included (36) experimental units representing all combinations of the study factors and their replicates. The main plots represented the number of irrigations. The sub-plots (humic and fulvic) represented the effect of humic acids. Organic fertilizer (a mixture of humic and fulvic) was added in two batches: the first after thinning and the second after the flower disc appeared. The results indicated that 13 irrigations (W3) compared to 11 irrigations (W2) significantly improved plant height, while a concentration of 45 kg ha-1 significantly affected this trait compared to the control treatment. For stem diameter, it was observed that the H0W3 treatment yielded the highest average compared to the H0W1 treatment, while the remaining studied traits were not significantly affected by the study factors.

Keywords: irrigation periods, humic acids, vegetative growth, sunflower plants.

1. Introduction

Sunflowers are considered a low-to-medium-sensitive crop. The crop is characterized by a wide range of drought-tolerant conditions, which makes it adaptable to environmental changes. Sunflowers' rainfall requirements range between 600-1000 mm [1].

Drought is one of the most important factors limiting crop production in arid and semi-arid regions. The regions experience widespread changes in environmental and climatic conditions, as well as widespread variations in the forms of drought, whether in the soil or atmosphere, or in its duration, whether it extends throughout the entire season or occurs in the early or late stages. Under such conditions, productivity and water use efficiency decline, and they fluctuate from year to year. Sunflower plants are drought-tolerant, however, exposure to drought during the active vegetative growth stage and flowering negatively affects the oil content of the seeds [2].

Humic and fulvic acid play a key role in ensuring soil fertility and plant nutrition, adding them directly to the soil or by spraying them, with adding sufficient amounts of conventional fertilizers can improve their efficiency. They have a chelating effect that stimulates plant growth. They positively influence the growth of various groups of microorganisms [3, 4].

Researchers used humic and fulvic acids. They affect the physical, chemical, and biological properties of the soil mixture. They reduce the damage caused by salt stress and excessive alkalinity. Thus, they increase root diffusion capacity and absorption capacity. They also increase plant nutrient content and chlorophyll production [5].

Humic acids are characterized by their high capacity to hold various ions in the soil, affect the pH of the root zone, increases the availability of most added nutrients or elements already present in the soil. The activity of these acids is due to their content of active groups, the most important of which are carboxyl, phenol, alcohol, guanine, carbonyl, and amine [6].

This study aims to demonstrate the effect of irrigation periods and humic acids on the vegetative growth parameters of sunflower plants.

Materials and Methods

A field experiment was conducted during the fall season (2024), at the Agricultural Research Station affiliated with the College of Agriculture, Al-Muthanna University. The aim was to study the effect of humic and fulvic acid levels and irrigation frequency on the growth parameters of sunflowers (Shamous variety). The experiment was conducted using a randomized complete block design (RCBD), according to a split-plot design and with three replicates. The experiment included (36) experimental units representing all combinations of the study factors and their replicates. The main plots represented the number of irrigations. The sub-plots (humic and fulvic) represented the effect of humic acids. Organic fertilizer (a mixture of humic and fulvic) was added in two batches: the first after thinning and the second after the flower disc appeared.

Experimental Factors

First Factor:

Humic acids, symbolized by the symbol H, are added in two batches: the first after thinning and the second after the flower disc appears.

H0 0 Control

H1 15 kg h^{-1}

H2 30 kg h^{-1}

H3 45 kg h^{-1}

Second Factor:

Number of irrigations, symbolized by the symbol W

W1 9 irrigations

W2 11 irrigations

W3 13 irrigations

Agricultural Operations:

The experimental land was prepared by plowing it using a rotary-blade plow, then, a smoothing process was carried out using disc harrows. The leveling and hulling process was carried out to prepare a suitable seedbed.

The field was divided into (36) experimental units, Each experimental unit was 9 m^2 (3 ×3 m), it included four 3 m long rows, with a distance of 75 cm between each row.

A calibration irrigation was given and the planting period was allowed until the planting period was adequately dry. Shamous cultivar seeds were planted on July 7, 2024. Three seeds were placed in each hole, 25 cm apart, and 3 cm deep in the upper third of the row, after complete emergence and the formation of the first pair of true leaves, the plants were thinned to one plant per hole. Irrigation and weeding were carried out as needed.

Urea fertilizer (N 46%) was used as a nitrogen source, triple superphosphate (P2O5 46%) was used as a phosphorus source. Potassium sulfate (K2O 50%) was used as a potassium source. Fertilizer recommendations were 160 kg N ha-1, 100 kg P2O5 ha-1, and 160 kg K2O ha-1.

After the pollination process was complete and before reaching physiological maturity, the plants were covered with netting to prevent bird damage. When signs of full maturity appeared (the outer bracts turned brown and the back of the discs turned yellow. The field was harvested on November 10, 2024. Sampling for each experimental unit.

Table 1. Some physical and chemical properties of field soil before planting.

Items	Value	Units
ECe	7.60	ds. m^{-1}
pH	4.47	-
Available Nitrogen	10.27	mg. kg^{-1}
Available Phosphorus	11.37	
Available Potassium	121.50	
Organic mater	1.57	%
Sand	48.00	
Clay	30.00	
Silt	23.00	
Soil texture	Loamy sand	

Traits studied:

Vegetative growth traits: Growth trait readings were taken for two intermediate plants from experimental units at the 50% flowering stage.

Plant height (cm): Measured from the soil surface to the base of the disc.

Number of leaves per plant: The total number of leaves per plant was counted from the first green leaf to the last.

Leaf area (m^2): Calculated by following the equation:

Sum of the squares of the width of the sixth roll of paper × 4.31

Stem diameter (cm): Calculated using a vernier from the center of the stem to the plant.

Leaf Area Index: Calculated using the equation [7]:

LAI = LA / A

Where:

LAI: Leaf Area Index.

LA: Leaf Area.

A: The area occupied by the plant.

Disc diameter (cm): Measured by the part that includes the disc flowers.

Results and Discussion

3.1 Plant Height (cm)

Table (2) shows that the W3 irrigation level had the highest average of 133.52 cm, compared to the W2 treatment, which recorded the lowest average of 124.77 cm. As for the effect of humic acid, it had a significant effect on this trait.

The H3 concentration recorded the highest average of 137.48 cm, compared to the control treatment, which recorded the lowest average of 120.06 cm.

Plant height is a highly variable trait under the influence of growth inputs, this may be due to the ability of humic and fulvic acids to chelate nutrients present in the soil, increasing their availability and absorption, which positively impacts plant growth [8]. Humic acid also contains essential nutrients, which are important for increasing plant growth processes, stimulate division and elongation in plant cells, increasing plant height [9].

Table 2. The effect of irrigation periods, humic acids, and the interaction on plant height (cm).

Irrigation periods	Humic acids				Mean
	H0	H1	H2	H3	
W1	30.93	29.60	31.80	28.47	30.20
W2	30.33	30.60	30.33	30.67	30.48
W3	28.93	30.00	31.27	30.60	30.20
Mean	30.07	30.07	31.13	29.91	
$L.S.D_{0.05}$	W		H		W*H
	N.S		N.S		N.S

3.2 Leaves number

Table (4) shows no significant effect of irrigation periods, humic and fulvic acid content, and their interaction on the number of leaves.

Table 4. The effect of irrigation periods and humic acids, and the interaction on the number of leaves (leaf $plant^{-1}$).

Irrigation periods	Humic acids				Mean
	H0	H1	H2	H3	
W1	30.93	29.60	31.80	28.47	30.20
W2	30.33	30.60	30.33	30.67	30.48

W3	28.93	30.00	31.27	30.60	30.20
Mean	30.07	30.07	31.13	29.91	
L.S.D0.05	W		H		W*H
	N.S		N.S		N.S

3.3 Disc diameter (cm)

Table (5) indicates that there was no significant effect of irrigation periods, humic and fulvic acid, and the interaction between them on the disc diameter trait.

Table 5. The effect of irrigation periods, humic acids, and the interaction on the disc diameter (cm).

Irrigation periods	**Humic acids**				**Mean**
	H0	**H1**	**H2**	**H3**	
W1	19.27	20.40	21.53	18.73	19.98
W2	21.47	19.87	22.00	21.53	21.22
W3	21.07	22.40	22.67	22.20	22.08
Mean	20.60	20.89	22.07	20.82	
L.S.D0.05	W		H		W*H
	N.S		N.S		N.S

3.4 Leaf area (cm2)

Table (6) shows no significant effect of irrigation intervals, humic and fulvic acid concentrations, and their interaction on leaf area.

Table 6. Effect of irrigation intervals, humic acids, and their interaction on leaf area (cm^2).

Irrigation periods	**Humic acids**				**Mean**
	H0	**H1**	**H2**	**H3**	
W1	3208	3475	4188	3198	3517
W2	4997	3993	3475	3671	4034
W3	3219	4016	4402	3496	3783
Mean	3808	3828	4022	3455	
L.S.D0.05	W		H		W*H
	N.S		N.S		N.S

3.5 Leaf Area Index

Table (7) indicate that there is no significant effect of irrigation intervals, humic and fulvic acid concentrations, and their interaction on the leaf area index.

Table 7. Effect of irrigation intervals, humic acids, and their interaction on the leaf area index.

Irrigation periods	**Humic acids**				**Mean**
	H0	**H1**	**H2**	**H3**	
W1	1.710	1.847	2.230	1.700	1.872
W2	2.660	2.120	1.850	1.957	2.147
W3	1.710	2.140	2.343	1.857	2.013
Mean	2.027	2.036	2.141	1.838	
L.S.D0.05	W		H		W*H
	N.S		N.S		N.S

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