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Impact of increasing humic and fulvic acid levels on wheat crop production and growth (*Treaticum eastivum* L.)

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Abstract

To investigate the effect of fulvic and humic acid levels on the growth and yield of wheat crops, a field experiment was conducted during the winter season of 2022–2023 in Al-Muthanna Governorate. Humic and fulvic acids were applied at growth stages: plant height and booting. The experiment included three fertilizer concentrations: 0, 20, and 30 mg/L. A Randomized Complete Block Design (R.C.B.D.) with three replications was used.

The effects of fertilizer treatments were evaluated based on several growth and yield parameters, including plant height, leaf area, spike length, number of tillers, number of spikes per meter square, number of grains per spike, 1000-grain weight, and grain yield.

The analysis of variance results indicated that the control treatment produced the tallest plants, with an average height of 65.73 cm. In contrast, the 30 mg/L fertilizer treatment recorded the highest mean values for leaf area and grain yield, reaching 25.63 cm² and 5.00 tons/ha, respectively. Meanwhile, the 20 mg/L fertilizer treatment achieved the highest average number of spikes, reaching 865 spikes/m².

Keywords: Humic and fulvic levels in plants, 1000 grain weight, leaf area, and grain yield

1. Introduction

Wheat (*Triticum aestivum* L.) one of the cereal crops that belongs to the grass family Poaceae and considered one of the most important strategic crops cultivated by humans, , as it provides approximately 20% of the food requirements of the world's population [13]. Its products are a rich source of energy and protein essential for human nutrition. It is considered an important source of carbohydrates and starch, and therefore it is consumed in various forms in human nutrition. Its importance is attributed to its content of gluten, which is responsible for the baking quality [12].

In Iraq, wheat is the most important cereal crop in terms of cultivated area, production, and consumption. In 2020, the cultivated area reached approximately 8,574 thousand dunums, with a total production of 6,238 thousand tons [8].

Under favorable environmental conditions and with the application of integrated fertilization systems, wheat crops can achieve high productivity and contribute to agricultural self-sufficiency. Researchers continuously seek innovative methods to enhance wheat production, among which foliar nutrition has gained considerable attention. This method involves spraying organic compounds, such as humic substances, that are environmentally friendly and do not negatively affect the ecosystem [16].

Humic acid contains various organic compounds that promote plant growth, improve yield, and stimulate root system development. Foliar application of humic substances also enhances the plant's ability to retain water and improves photosynthetic efficiency [9]. Furthermore, organic acids improve soil properties and reduce the adverse effects of alkalinity and salinity stress. They enhance root proliferation and nutrient absorption while increasing carbohydrate accumulation in plants. In addition, these substances stimulate the number and activity of soil microorganisms, thereby increasing enzymatic decomposition processes and improving nutrient uptake by plants. They also contribute to the synthesis of hormones and proteins within plant tissues [17].

Humates are among the most common forms of humic substances and are commercially produced mainly from leonardite, which contains approximately 60% humic and fulvic acids. Fulvic acid consists of carbohydrates, amino acids, and certain plant metabolic compounds, whereas humic acids are formed through the interaction of lignin with quinones, amino acids, and other plant metabolic products [6].

The present study aims to determine the optimal concentration of humic and fulvic acid nutrient solutions for improving the growth and productivity of wheat crops.

2. Materials and Method

a field experiment was conducted during the 2022–2023 winter agricultural season. Random soil samples were collected from a depth of 0 to 30 cm, and a composite sample was prepared. Table 1 presents the specifications of the estimated physical and chemical properties. Humic and fulvic acids were incorporated into the spray solution at three distinct doses (0, 20, and 30 mg/L) as part of the experiment. To prevent interference between treatments, plowing, smoothing, and leveling were performed after the land was divided into 1 m² panels (1 × 1 m). The panels were separated by a one-meter buffer. Planting occurred on November 15, 2022. The Aba 99 variety was sown at a rate of 120 kg/ha at a depth of 5 cm. The application of fulvic and humic acids was conducted in phases: plant height and booting. Nitrogen, at a rate of 200 kg/ha, was applied in two batches of 46% urea fertilizer: one at planting and the other at 50% blooming. Irrigation and weeding were carried out as needed. The plants were harvested on April 13, 2023, upon reaching full maturity.

Table 1: physical and chemical properties of the soil in the experimental field prior to planting.

Adjective		Value	Unit of measurement
Soil articulations	Sand	236	gram Kg^{-1} of soil
	Silt	560	gram Kg^{-1} of soil
	Clay	204	gram Kg^{-1} of soil
(PH) Soil reaction		7.22	--
(EC) (1:1) Conductivity of electricity		11.5	$dS.m^{-1}$
CEC		5.98	Cmol $^{+}Kg^{-1}$ Soil
Natural materials		5.4	gram Kg^{-1} of soil
Nitrogen		25.8	gram Kg^{-1} of soil
Phosphorous		12	gram Kg^{-1} of soil
Potassium		181	gram Kg^{-1} of soil
Texture of the soil		muddy alluvial mixture	

The data was examined using the analysis of variance approach and all the qualities that were examined using the statistical tool Genstat. The least significant difference (L.S.D.) at the 0.05 level was used to compare the arithmetic means [5].

2.1

Examined characteristics:

2.1.1 Plant height (cm):

The average height of ten randomly selected plants from each experimental unit was measured from the base of the plant, in contact with the soil surface, to the tip of the spike, excluding the peduncle.

2.1.2 Spike length (cm):

This was calculated as the average length of ten randomly selected spikes from each experimental unit during the harvest stage. It was determined by measuring the distance between the terminal spike's end and the spike holder's contact area with the stem.

2.1.3 Leaf area (cm^2):

Determined using the following formula [17] and averaged for ten randomly chosen plants and all leaves:

Leaf area (cm^2) = leaf length × leaf width at the middle × correction factor (0.95).

2.1.4 Number of spikes (m^2):

Calculated from plants harvested from a 1 m^2 area within the guarded center lines of each experimental unit after crop establishment.

2.1.5 Number of grains per spike:

Expressed as the mean quantity of grains from ten randomly selected spikes from each experimental unit.

2.1.6 Weight of 1000 grains (g):

Determined randomly from the grain yield of each experimental unit.

2.1.7 Grain yield (ton ha^{-1}):

Converted using the ton-per-hectare approach and based on the grain yield from the area of the experimental unit.

3. Findings and Discussion

3.1 Effect of humic and fulvic Acids on growth characteristics:

According to Table 2, the fertilization treatments (20 and 30 mg/L) resulted in average plant heights of 62.43 and 61.93 cm, respectively, with no discernible difference between them. In contrast, the control treatment (0 mg/L) was superior, yielding the greatest average plant height of 65.73 cm. This may be due to that fact that wheat plants had reached its maximum genetic height under the available environmental conditions, and humic and fulvic acids could not surpass this limit. Some studies suggest that the effect of humic acids on plant height can vary depending on concentration, plant type, and environmental conditions.

The results showed no significant differences in spike length among the different treatments (Table 2). The average spike lengths ranged between 7.70 cm (30 mg/L) and 8.10 cm (control treatment). This suggests that the application of humic and fulvic acids at the concentrations used did not have a significant effect on this trait, which may mean that spike length could be a more stable genetic trait or that it is influenced by other environmental factors not affected by the treatments.

The findings in Table 2 also indicated that the leaf area trait (cm^2) was significantly impacted by the fulvic acid and humic fertilization treatments. The lowest average leaf area, 22.00 cm^2, was observed with the 20 mg/L fertilization treatment, while the highest average, 25.63 cm^2, was produced by the superior 30 mg/L fertilization treatment. The control treatment, which showed no significant difference, ranked second with an average of 24.23 cm^2. The superiority of the 30 mg/L fertilization treatment is attributed to the action of humic acid, which facilitated the supply of a considerable amount of important nutrients that are translocated to leaves and had a favorable impact on the growth and expansion of leaf cells, as well as increased leaf area. This conclusion is consistent with the findings of [2, 3, & 11], who reported that spraying with varying humic acid concentrations increased leaf area.

Table 2: Impact of humic and fulvic Acids on wheat plant development traits.

Levels of spray ($mg.L^{-1}$)	Height of Plants (cm)	Length of spike (cm)	Area of leaves (cm2)
0	65.73	8.10	22.00
20	61.93	7.83	24.23
30	62.43	7.70	25.63
L.S.D 0.05	2.343	n.s	2.333

3.2

Effect of humic and fulvic Acids on yield characteristics:

The number of spikes attribute showed significant variation between fertilization levels. The control treatment (0 mg/L) produced the lowest average number of spikes (420 spikes m^{-2}), whereas the highest average for this feature was 865 spikes m^{-2} for the superior 20 mg/L fertilization treatment, followed by the 30 mg/L fertilization treatment with no discernible difference, averaging 793 spikes m^{-2} (Table 3). The frequency of spikes increases as the acid content rises, which is consistent with the findings of [2 & 11]'s study on the impact of humic acid on wheat harvests.

Table 3 further shows that the 30 mg/L fertilization treatment provided the highest average grain yield of 5.00 tons ha^{-1}, while the control treatment produced the lowest average for this attribute, 3.47 tons ha^{-1}. The 20 mg/L fertilization treatment ranked second, with no discernible difference, at 4.62 tons ha^{-1}. Humic acid plays a significant role in interacting with phospholipid molecules found in cell membrane composition, which explains the preference for the 30 mg/L fertilization treatment. These substances act as carriers for transferring nutrients from outside the cell to its interior, increasing cell membrane permeability and boosting the absorption of water and nutrients, including nitrogen and iron. Given that 80% of iron is located in chloroplasts and 70% of nitrogen from leaves enters the chlorophyll pigment with magnesium, the increase in yield is a result of improved photosynthesis and chloroplast formation [10]. This result aligns with the conclusions of [1 & 3] in their research on barley crops and [2] in their study on wheat crops, which demonstrated that grain production rose as humic acid concentrations increased.

Table 3: Impact of humic and fulvic leve on yield wheat plant.

Levels of spray ($mg.L^{-1}$)	quantity of spikes (m^2)	quantity of grains	1000 grams (gm) in weight	Yield of grain (tons h^{-1})
0	420	36.23	45.73	3.47
20	865	34.57	49.07	4.62
30	793	36.87	50.67	5.00
L.S.D 0.05	116.9	ns	n.s	0.971

4. Conclusions

Based on the study's findings, we propose raising fertilizer levels when fertilizing and planting other strategic crops because raising the acid levels to 30 mg/L significantly increased the leaf area (cm) and grain production when compared to the control treatment.

Following excellent horticulture practices can increase efficiency, and the middle's ongoing harvest research enhances its presentation as a multipurpose produce [4].

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