Effect of compositions in which different regions of humic acid appear on the yield of barley Hordeum vulgare L.

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Abstract:
A field experiment was executed in the winter season (2023-2024) in mid-November 2023 at the Agricultural Research Station associated with the College of Agriculture - Al-Muthanna University in the Al-Bandar region, aimed at investigating the response of barley genotypes to varying levels of humic acid, employing a split-plot arrangement within a randomized block design. Humic acid was administered at four concentrations (0, 30, 50, 70) L/ha in the mine plots. The sub-plots comprised four genotypesincluding the indigenous variety Ibaa 256. The results were as follows :
The statistical analysis results indicated that the third concentration of humic acid H3 (70 L/ha)exhibited superior chlorophyll content, measuring 41.89 SPAD, The H2 concentration also outperformed the highest number of grains per spike, reaching 42.64, and it did not differ significantly from the H3 concentration, with the highest number of grains per spike, reaching
The statistical analysis results indicated that the fourth genotype had greater chlorophyll content, measuring 41.46, whereas the first genotype shown superiority in grain count, achieving 43.83 grains spike-1 .
The H3×G4treatment exhibited greater chlorophyll content, attaining a value of 44.20, while the H3×G1 treatment demonstrated superiority in the number of grains per spike, achieving 48.22 grains spike-1 .

Introduction

Based on its broad cultivation area and output levels, barley (Hordeum vulgare L.) is the fourth most significant strategic grain after wheat, rice and corn. It is a member of the grass family and ranks as the fourth most important strategic grain. Because of its rapid development and maturation, barley is well-known for its ability to withstand difficult cultivation circumstances in arid and semi-arid locations. These factors include cold temperatures, dryness, alkalinity, salt, and vegetation. Barley is recognized by its tolerance to these environments. According to [1], the central and southern parts of Iraq are the best places to plant it because of its widespread cultivation. The most important genotypes is the economic significance of barley production, which is currently consumed by around 85 percent as chicken feed, either in grain form or as green fodder. According to [2], the quality of Canadian fodder is improved by combining the application of barley with the improvement of pasture quality. A total of 99 thousand tons of barley was reported to have been produced in Iraq, with an output of 1,756 thousand tons [3]. The barley growing area in Iraq spans 18112 thousand hectar. Numerous applications

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can be found for it, including those in the fields of medicine, industry, and the culinary arts. According to [4] the grains of barley contain a wealth of nutrients, including proteins, fibers, amino acids, and vitamins. These nutrients are known as the nutritional components of barley. Nearly all of Iraq's governorates are responsible for the cultivation of barley. As part of the introduction program, the initial measures include analyzing the performance of established compositions, evaluating novel compositions, and examining local varieties. It places an emphasis on their resistance to agricultural pests and the various environmental conditions, as well as their higher nutritional content and superior capacity for production. According to the findings of the research conducted by [2], the employment of originals and exotics in hybridization processes led to a fifty percent increase in yield, which was optimally attained. According to [5], humic acids are a class of complex compounds that are found in large quantities in organic materials that can be broken down. Nitrogen, carbon, hydrogen, and oxygen are just few of the vital nutrients that are included in these techniques, which are designed to promote the growth of plants. A wide range of resilient courses are produced as a consequence of this [6]. In addition to increasing the amount of oxygen that is available to plants, the addition of humic acids causes an increase in the amounts of cytokinin [7]. Through its ability to stimulate plant development and increase output, humic acid makes a substantial contribution to the ecosystem of agriculture. Because of its nutritional composition and the hormone-like effects that can be linked to the presence of various vitamins inside it, the good benefits are mostly a result of its composition. It was proven by [8] that humic acid has a considerable influence on the actions of the natural auxin IAA.

Materials and Methods:

Site of experimentation

In mid-November 2023, a field experiment was carried out at the Agricultural Research Station associated with the College of Agriculture - Al-Muthanna University in the Al-Bandar area at longitude (45.30) and latitude (31.32) during the winter season (2023-2024). The objective of the experiment was to investigate the impact of varying levels of humic acid on the modification of barley genotypes.

Analysis of soil

Samples were obtained from the field soil prior to planting and from nine distinct areas of the land at a depth ranging from 0 to 30cm. The soil was then air-dried after eliminating plant residues. It was vigorously ground and then sifted through a 2 mm diameter sieve. The mixture was thoroughly mixed to ensure uniformity. A composite sample was then obtained and its physical and chemical characteristics were examined in the Soil Physics Laboratory at the Department of Soil and Water Sciences - College of Agriculture - Al-Muthanna University. The results are presented in Table 1 .

Table 1 Some chemical and physical properties of the experimental soil before planting

Parameter		value	Unit
Chemical Properties	PH	8.2	—
	EC	12.4	ds m-1
	N	23.8	mg kg-1
	P	19.6	mg kg-1
	K	149.1	mg kg-1
Physical Properties	Sand	62.5	g kg-1 Soil
	Silt	12.5	g kg-1 Soil
	Clay	25	g kg-1 Soil
	Soil texture	Sandy clay	

Experimental factors

The experiment included two factors:

First factor: Genotypes

It included three genotypes (first genotype G1 - second genotype G2- third genotype G3) and the Local variety (control) Ibaa 256

Second factor: Humic acid

It was added at four concentrations:

1First concentration (control) concentration (0) L/ha-1

2Second concentration (30) L/ha-1

3Third concentration (50) L/ha-1

4Fourth concentration (70) L/ha-1

Design of the experiment:

In a Randomized Complete Block Design)R C B D) experiment, a split-plot arrangementwas used with two factors: spraying humic acid in the main plots and genotypes in the sub-plot. The experiment was structured with a split plot arrangement. Consisting of three replicates for each treatment, the total number of experimental units was 48. The data were subjected to statistical analysis using the Genstat software. An analysis was conducted to compare the arithmetic means of the results using the least significant difference test (LSD), with a significance level of 0.05 .

Crop production activities

The experimental land had two perpendicular ploughing treatments with a rotary plough. Following the tamping procedure, it was smoothed using disc harrows and then leveled using a leveling machine. The property was partitioned based on the design employed into panels with a total space of 2.25 square meters (1.5 m × 1.5 m). The panel comprised seven lines, each measuring 1.5 metres in length and spaced 20 centimetres apart. Each of the secondary panels was spaced apart by a distance of 0.5 metres.

Traits studied

Chlorophyll concentration of the flag leaf (SPAD (

The total chlorophyll content of the flag leaf was assessed at the complete blooming stage using the American CCM200-Plus Leaf Chlorophyll Content Meter. Five plants were randomly selected from the midlines of each experimental unit, with three measurements taken per leaf to get an mean.

Number of fertile spikes

The calculation was performed at the complete maturity of all plants harvested from the two central rows of each experimental unit and expressed on a per square meter basis.

Number of grains per spike

The calculation was derived from the mean grain count for ten spikes after manually thinning the ears and determining the grains per spike minus one.

Weight of 1000 grains

Five hundred grains are randomly selected from each experimental unit, thereafter weighed using a precise balance, and then corrected to the weight of one thousand grains.

Grains yield

The plants taken from the two central rows were assessed following hand threshing of the plants from each experimental unit. After separating the straw from the grains, the weights were recorded to determine the grain yield in tons per hectare.

Biological yield

The plants from the two central rows were weighed in total (including both grain and straw), and the weight was subsequently converted from grams per square meter to tons per hectare.

Statistical analysis

The data were analyzed statistically using the statistical analysis program 12GenStat and the arithmetic means were compared according to the L.S.D test under the probability level (0.05) [9.[

Results and Discussion

Chlorophyll content

The results in Table (2) indicate a considerable impact of humic acid, genetic components, and their interaction on the chlorophyll content attribute .

The third concentration of humic acid, H3, exhibited the greatest mean at 41.89 SPAD, which did not substantially differ from H1, but the second concentration, H2, recorded the lowest mean at 37.93 SPAD.

The potential cause may be the influence of humic acid on some metabolic processes in the plant, its enhancement of antioxidants, and the maintenance of chlorophyll levels in the leaves against degradation, as noted by [10]. This outcome agreed with [11] findings in his study on yellow corn, whereby he asserted that the enhancement in chlorophyll content in the leaves was attributable to elevated quantities of humic acid .

The fourth genetic composition exhibited the greatest mean at 41.46 SPAD, showing no significant difference from G2, whilst the third composition recorded the lowest mean of 38.64 SPAD. This variation may result from the genetic differences among the kinds. This outcome aligned with the findings of [12], who noted that the varieties exhibited differences in the chlorophyll characteristic. The H3×G4 treatment exhibited the highest mean at 44.20 SPAD, showing no significant difference from the treatments H0×G2, H0×G4, H1×G1, H1×G2, H1×G4, H3×G1, and H3×G3. Conversely, the lowest mean was observed in the H0×G1treatment, which recorded 36.70 SPAD .

Table (2) The effect of genotypes and humic acid on the chlorophyll content trait

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	36.70	41.37	37.76	41.70	39.38
H1	42.42	43.98	37.82	41.14	41.34
H2	37.38	38.22	37.32	38.81	37.93
H3	41.14	40.53	41.68	44.20	41.89
Mean	39.41	41.03	38.64	41.46	
L.S.D 5% H	2.563	L.S.D 5% G	1.553	L.S.D 5% H*G	3.448

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Number of spikes

From the results of Table (3), it is clear that the effect of humic acid and genotypes and interaction between them was not significant on the number of spikes trait.

Table (3) Effect of genotypes and humic acid on the number of spikes trait

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	360.2	325.9	323.9	357.6	341.9
H1	411.0	402.2	327.0	418.8	389.8
H2	378.9	369.5	362.8	328.5	359.9
H3	380.4	355.0	357.6	403.3	374.1
Mean	382.6	363.2	342.8	377.1	
L.S.D 5% H	N.S	L.S.D 5% G	N.S	L.S.D 5% H*G	N.S

Number of grains per spike

The data in Table (4) clearly demonstrate the major impact of humic acid, genetic components, and their interaction on the trait of grain number per spike.

The concentration of humic acid, H1, exhibited the greatest mean at 42.64 grains spike-1, which was not substantially different from H2. Conversely, the lowest mean was observed in the control concentration, H0, at 38.92 grains spike-1.

This outcome agreed with the findings of [13], [14], and [15], who reported an augmentation in the number of grains per spike in wheat harvests corresponding to elevated concentrations of humic acid. [16] also reported an augmentation in the number of grains per spike in barley crops corresponding to elevated concentrations of humic acid. The initial genotype exhibited the highest mean at 43.83 grains spike-1, whereas the fourth composition recorded the lowest mean at 39.64 grains spike-1.

The disparity may stem from variations in genotypes regarding their responsiveness to existing environmental conditions, which manifested in the heightened satisfaction of the demands of new origination sites for sustenance, thereby influencing the grain count in the spike. The superiority of the genotype regarding the trait of grain quantity in the spike may be attributed to its genetic basis, as it is a quantitatively determined trait. This outcome concurred with the findings of [17]. [18], [19], and [20] identified differences in genetic components regarding the grain count in the spike. The H3×G1treatment exhibited the highest mean, reaching 48.22 grains spike-1, which did not substantially differ from the H1×G1 and H1×G3 treatments. Conversely, the H3×G4 treatment recorded the lowest mean at 35.33 grains spike-1.

Table (4) The effect of genotypes and humic acid on the trait of the number of grains per spike

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	39.78	37.78	39.22	38.89	38.92
H1	44.44	37.89	45.78	42.44	42.64
H2	42.89	42.22	43.44	41.89	42.61
H3	48.22	42.89	36.89	35.33	40.83
Mean	43.83	40.19	41.33	39.64	
L.S.D 5% H	1.347	L.S.D 5% G	2.375	L.S.D 5% H*G	4.241

Weight of 1000 grains

From the results of the analysis in Table (5), it is clear that the effect of humic acid and genotypes and interaction between them was not significant in the weight of 1000 grains.

Table (5) The effect of genotypes and humic acid on the trait of weight of 1000 grains

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	32.31	41.32	38.35	46.87	39.71
H1	42.03	44.61	41.03	37.97	41.41
H2	54.87	47.67	41.61	42.49	46.66
H3	41.46	41.95	45.29	43.03	42.93
Mean	42.67	43.89	41.57	42.59	
L.S.D 5% H	N.S	L.S.D 5% G	N.S	L.S.D 5% H*G	N.S

Grain yield

From the results of Table (6), it is clear that the effect of humic acid and genotypes and interaction between them was not significant on grain yield.

Table (6) Effect of genotypes and humic acid on grain yield

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	2.279	3.276	3.427	3.019	3.000
H1	3.006	3.615	2.743	2.702	3.016
H2	3.355	3.628	3.047	2.943	3.243
H3	2.796	2.229	3.604	3.473	3.026
Mean	2.859	3.187	3.205	3.034	
L.S.D 5% H	N.S	L.S.D 5% G	N.S	L.S.D 5% H*G	N.S

Biology yield

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From the results of Table (7), it is clear that the effect of humic acid and genotypes and interaction between them was not significant on the Biology yield

Table (7) Effect of genotypes and humic acid on the Biology yield trait

humic acid	genotypes				Mean
	G1	G2	G3	G4	
H0	9.16	8.30	7.01	9.76	8.56
H1	7.21	6.85	6.18	7.14	6.84
H2	8.17	10.12	9.50	8.17	8.99
H3	9.13	9.00	7.86	8.19	8.55
Mean	8.42	8.57	7.64	8.31	
L.S.D 5% H	N.S	L.S.D 5% G	N.S	L.S.D 5% H*G	N.S

Conclusions

This emphasizes leads us to the following conclusions:

The third concentration of humic acid H3 exhibits higher chlorophyll content and an increased number of grains per spike.

The fourth a marked superiority in chlorophyll concentration.

The H3×G4 treatment exhibited improved chlorophyll content, while the H3×G1treatment had a greater number of grains per spike

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