Effect of addition of humic acid and water stress in some growth traits of wheat plant *Triticum aestivium* L.

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ABSTRACT

A field experiment was conducted for the cultivation of wheat crop *Triticum aestivum* L. in one of the fields belonging to the extension farm experiments in Al-Mahnawiya belonging to the Extension Center in Babylon province during the winter season (2017-2018) to study the effect of adding humic acid in wheat bearing to water stress during branching stage and grains filling stage, In the experiment, three levels of humic acid were used (0: The control treatment, 20 $kg.ha^{-1}$: Added to soil, 10 $ml.L^{-1}$: Sprayed on the plant) which are symbolized by (H_0, H_1, H_2), respectively. Three water stresses were also used: S_0 is the control treatment, (S_1) stopping irrigation in the branching stage, (S_2) stopping irrigation in the grain filling stage. The experiment was applied within the classification of the Randomized Complete Blocks Design (R.C.B.D), in the order of split plots, with three replicates. Wheat seeds (Aba 99 cultivar) were cultivated which obtained from Agricultural Research Station in Babylon. Concentrations of nutrient elements have estimated of nitrogen, phosphorus and potassium in post-harvest soil. Plant height, number of branches, weight of 1000 grains, Biologic yield, grain yield and harvest index, concentrations of nutrient elements (N, P, K) in grain, Protein and Leaves content of K were also estimated. The depth of irrigation water and its date were determined depending on the moisture of the soil and according to the depth of the plant root system and the results were as follows:

1. The spraying treatment with humic acid H_2 was excelled compared to the control treatment was significantly increased in most of the growth traits of wheat yield (100.05 cm plant height, 9.33 branches, 48.93 cm^2 flag leaf area, 49.96 spad unit, chlorophyll index).
2. The interaction treatment (H_2S_0) gave the highest values and for most of the study indicators of (104.39 cm plant height, 12 branches, 56.80 cm^2 flag leaf area, 55.20 spad unit chlorophyll index).

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تاثير اضافة حامض الهيوميك والاجهاد المائي في بعض صفات النمو لنبات الحنطة *Triticum aestivium* L.

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الخلاصة

اجريت تجربة حقلية لزراعة محصول الحنطة *Triticum aestivum* L. في احدى الحقول التابعة لتجارب المزرعة الارشادية في المهناوية التابع الى المركز الارشادي في بابل خلال الموسم الشتوي (2017-2018) لدراسة تاثير اضافة حامض الهيوميك في تحمل الحنطة للاجهاد المائي في مرحلتي التفرعات ومرحلة امتلاء الحبوب , حيث استعملت في التجربة ثلاث مستويات من حامض الهيوميك وهي (0 معاملة السيطرة , 20 كغم .$هـ^{-1}$ اضافة ارضية و10 مل / لتر رشا على النبات) وهي معاملة المقارنة واضافة حامض الهيوميك الى التربة والرش بحامض الهيوميك ورمز لها (H_0 وH_1 وH_2) بالتتابع , كما استعملت ثلاثة اجهادات مائية هي (S_0) وهي معاملة المقارنة , (S_1) قطع الري في مرحلة التفرعات , (S_2) قطع الري في مرحلة امتلاء الحبوب طبقت التجربة ضمن تصنيف القطاعات المعشاة بالكامل بترتيب الالواح المنشقة وبثلاث مكررات RCBD , زرعت بذور الحنطة صنف (اباء 99) , الذي تم الحصول عليه من محطة البحوث الزراعية في بابل قدرت تراكيز العناصر الغذائية لكل من النتروجين والفسفور والبوتاسيوم في التربة بعد الحصاد كما قدر ارتفاع النبات وعدد التفرعات ووزن الف حبة والحاصل البايلوجي وحاصل الحبوب ودليل الحصاد , كما قدرت تراكيز المغذيات N , P , K في الحبوب , البروتين ,K في الاوراق. وحدد عمق ماء الري موعد الريات اعتمادا على

الاستنفاد الرطوبي للتربة وبحسب عمق المجموع الجذري للنبات وكانت النتائج كالاتي :- تفوقت معاملة الرش بحامض الهيوميك H_2 قياسا بمعاملة المقارنة الى زيادة معنوية في اغلب صفات النمو لمحصول الحنطة وبلغت (100.05 سم ارتفاع النبات , 9.33 تفرع , 48.93 سم^2 مساحة ورقة العلم , 49.96 Spad unit دليل الكلوروفيل). اعطت معاملة التداخل H_2S_0 اعلى القيم ولاغلب مؤشرات الدراسة بلغت (104.39 سم ارتفاع النبات , 12 تفرع , 56.80 سم^2 مساحة ورقة العلم , 55.20 Spad unit دليل الكلوروفيل.

البحث مستل من رسالة ماجستير للباحث الثاني.

1. INTRODUCTION

Wheat *Triticum estivum* L. is the first seed crops in the world in terms of importance, cultivated area and global production. It is considered the main food for more than one-third of the world's population (Jamali, 2000). Iraq, as in most other countries of the world, suffers from the reduction of rain and the scarcity of water resources, which has led to the reduction of water levels in the Tigris and Euphrates rivers, As well as the misuse of the sources of this water in agriculture by following a random style in the number of irrigation during the growing season, which requires reconsideration of how to ration water and exploitation in an optimal manner and increase attention to the rationalization water use in agriculture, and not to waste them, the creation of new technologies enable the crop to withstand the lack of water to expand the agricultural area when water is the determining factor, Because decrease in the supply of water to Iraq from neighboring countries, the adoption of scientific and accurate irrigation practices is a crucial issue and is very important. Wheat plants are exposed at certain times of their growth stages to the effects of water stress caused by the lack of moisture of the soil availability for the plant as a result of the lack of adequate water supply at the time of request, or not follow the schedule of scientific irrigation controlled when practicing irrigation or there may be a desire to apply deficit irrigation method to increase the efficiency of water use, which is an essential target for irrigation in dry and semi-dry regions of the world (Ghany Abd-El, 2012, Khan and Naqvi, 2011). Jones and Jones (1989) were more accurate in defining water stress as they defined stress as any force or adverse effect that disrupts normal activity of any plant. Humic acid is one of the commercial products of economic and effective and quick and harmless to humans and animals and plants (Anonymous, 2005) and contains many nutrient elements that lead to increase the growth and yield of the plant and It contains in its composition a carbon, nitrogen, hydrogen and oxygen in varying proportions, led to the formation of compounds of varying molecular weights. Humic acid is used to reduce the harmful effect of mineral fertilizers in soils (Hartwigson and Evans, 2000). The main purpose of the use of humic acid is because it is a humic substance that is nutritious to the plant (Anonymous, 2005). Zhang and Ervin (2004) demonstrated that adding the humic acid to the plant increases the internal Cytokinin with increased oxygen. Therefore, the objective of this study is: the effect of adding of humic acid by spraying and added directly to the soil in increasing the tolerance of wheat for water stress in the branches stage and the grain filling stage considering as two critical stages and their effect on the wheat yield and its components and some traits of soil.

2. MATERIALS AND METHODS

A field experiment was conducted for the cultivation of wheat crop *Triticum aestivum* L. in the experiments field of the extension farm in Al-Mahnawiya belonging to the extension training center in Babylon province during the winter season (2018-2017), 8 km north of Babylon province, located at Latitude 32 ° 31 'north and longitude 44 °21' To the east in a silty clay loam soil that falls within the level of the Typic Torrifluvent aggregates according to modern classification (Soll survey staff, 2006). The leveling and adjustment processes were conducted; the field was divided into three main replicates according to the order of the split-split plots in the Randomized Complete Blocks Design (R.C.B.D), with experimental area 3 × 3. The samples were taken from the field soil represented by 10 samples for the depth 0-0.3 m, the soil samples were mixed and obtained from a compound sample. The soil samples were aerated, then grinded and sieved with a 2 mm diameter sieve. These samples were used to estimate the physical, chemical and fertility properties of field soil before cultivating. The experiment included the following treatments:

Irrigation treatments (water stress): S_0 without stress, S1 Stress in the branches stage, S_2 Stress in the grain filling stage.

Addition of humic to soil treatment (20 $kg.h^{-1}$), H_2 Spraying the humic to the plant (10 $ml.L^{-1}$).

Treatments have become 3 × 3 × 3 = 27 experimental units

Table 1: Physical properties of soil before cultivating.

Properties	Unit	Value
Sand	$g.kg^{-1}$	155
Silt		370
Clay		475
Texture		Silty clay loam
Bulk density	$\mu g.m^{-3}$	1.31
Real density	=	2.65

Table 2: Chemical properties of soil before cultivating.

Properties	Unit	Value
Electrical conductivity	$ds.m^{-1}$	3.55
pH		7.69
Soil Organic matter	$g.kg^{-1}$	6.44
Carbonate minerals		247.41
interchangeable capacity of positive ions	$Cmol.cal.kg^{-1}$ soil	27.22
Gypsum	$g.kg^{-1}$	7.30
Calcium	Dissolved ions $mmol.L^{-1}$	8.20
Magnesium		7.00
Sodium		8.14
Potassium		0.66
Chloride		14.45
Sulfates		9.33
Carbonates		Nill
Bicarbonates		6.21
Nitrogen availability	$mg.kg^{-1}$ soil	41.41
Phosphorus availability		14.55
Potassium availability		220

Wheat seeds were cultivated (99 aba cultivar) (which was obtained from the Agricultural Research Station in Babylon) on 25 November 2017, with amount of seed 120 $kg.ha^{-1}$ on the lines, It utilized 25 cm between the lines. Each experimental unit contained 8 lines. The tri-superphosphate fertilizer was added, with 100 kg $P.ha^{-1}$ at in one batch with the soil during cultivation.

Nitrogen fertilizers were added by 200 kg.N g^{-1} in the form of urea fertilizer (46%

N) and potassium by 120 kg.Kg^{-1} in the form of potassium sulphate (52% K_2O) in the two stages, first at the branches stage and the second at the elongation stage.
The thickets were manually treated and the crop was harvested on April 5, 2018.

Studied traits

Plant height

10 plants were taken as average from each experimental unit below the subsoil from the level of the soil surface to the end of the rachis for spike of the main stem (Donaldson, 1996).

Number of branches

The number of branches bearing spikes per plant was calculated by counting the number of branches bearing spikes per 10 plant for each experimental unit and then extracting the average.

The flag leaf area

It was calculated from the average of ten flag leaves of the main stem of each experimental unit according to the following equation.
The flag leaf area = the length of the flag leaf × width at the center × 0.95.

Chlorophyll index in plants (Spad unit)

It was estimated as average of 10 readings from each experimental unit by placing the group of flag leaf between the jaw of the instrument using (Chlorophyll Meter device, Spur-502) (Reyolds et al., 1998).

3. RESULT AND DISCUSSION

Plant height

The results of the statistical analysis showed a significant effect on both the addition of humic acid and water stress and their interactions on the height of wheat plant as shown in Table (3). The addition of the humic acid has a significant effect in this trait by giving it the highest value of 100.05 cm when spraying with humic acid (H_2 treatment) compared to the ground additive of the humic acid and control treatment, which amounted to (99.18, 97.95 cm), respectively, The effect of water stress was also significant in the increase of plant height (cm). The highest value of plant height was in the S_0 treatment of 102.96 cm, while the value of this trait has reduced at both water stresses in the branches stage and the grain filling stage (S_1, S_2) to become (99.29, 94.92 cm). The increase ratio in water stress (S_0) on stresses (S_1, S_2) was (3.70, 8.47%), respectively. The results of the statistical analysis showed that the interaction between the water stress and humic acid was significant in increasing the height of the wheat plant (cm). The highest value of the plant height at the treatment of H_2S_0 was 104.39 cm while the lowest value of plant height for H_0S_2 treatment was 94.82 cm, with an increase of 10.09%.

Table 3: Effect of the addition of humic acid and water stress and their interactions in the height of wheat plant (cm).

Stage / Humic acid	Control treatment S_0	Branches stage S_1	The grain filling stage S_2	Average
H_0	102.20	97.82	94.82	98.28
H_1	103.30	99.30	94.95	99.18
H_2	104.39	100.75	95.00	100.05
Average	103.30	99.29	94.92	
L.S.D 0.05	H	S	H× S	
	0.53	0.53	1.33	

The number of branches

Table (4) indicates that the effect of addition of humic acid and water stress and their interactions were a significant in the number of branches of wheat plant. It is noted from the table that the effect of the addition of humic acid was significant in the number of branches of wheat plant by giving it the highest value of (9.33 branches) for the treatment of spraying with humic acid (H_2) and the lowest values at H_1 and H_0 treatments of (8, 6.66 branches), respectively. The increased ratio in the number of branches of wheat plant for H_2 treatment on H_1 and H_0 treatments was 16.63% and 40% respectively. It is also noted from the same table that the water stress treatments had a significant effect on the number of branches of wheat plant and the highest value in the control treatment (S_0) was 10 branches, while the value of this trait has reduced at both water stresses in the branches stage and the grain filling stage (S_1, S_2) to become (8, 6 branches), respectively. The increase ratio in water stress for (S_0) on stresses (S_1, S_2) was (25, 66.66%), respectively. The effect of the interaction between water stress and the humic acid was significant in this trait. The H_2S_0 treatment gave the highest value of (12 branches) while the interaction treatment H_0S_2 recorded the lowest value of the number of branches was 5 branches and with an increase of 140%.

Table 4: Effect of the addition of humic acid and water stress and their interactions in the number of branches.

Stage / Humic acid	Control treatment S_0	Branches stage S_1	The grain filling stage S_2	Average
H_0	8	7	5	6.66
H_1	10	8	6	8
H_2	12	9	7	9.33
Average	10	8	6	
L.S.D 0.05	**H**	**S**	**H× S**	
	0.21	**0.21**	**0.58**	

The flag leaf area (cm^2)

Table (5) shows that the effect of the addition of humic acid and water stress and their interaction had a significant effect on the flag leaf area. The effect of adding the humic acid was significant in this trait, the spraying treatment with humic acid (H_2) gave the highest value of 48.93 cm^2 while the lowest value was recorded for the treatment of addition humic acid directly to soil and the control treatment of (47.38, 44.45 cm^2), with an increased ratio of (3.27, 10.08%) respectively. The effect of water stress has a significant effect on the flag leaf area of the wheat plant. The control treatment (S_0) recorded the highest value of (53.76 cm^2) compared to the stress treatments (S_1, S_2) at the branches stage and the grain filling stage which gave (45.83, 41.16 cm^2), with an increase ratio of (17.30, 30.61%), respectively. The interaction between the addition of humic acid and water stress has significantly affected in the trait of the flag leaf area. The treatment H_2S_0 gave the highest value of the flag leaf area of (56.80 cm^2) while the lowest value was at the interaction treatment of H_0S_2 which amounted to 40.00 cm^2, with an increase ratio of 42%.

Table 5: Effect of the addition of humic acid and water stress and their interactions in the flag leaf area (cm^2).

Stage / Humic acid	Control treatment S_0	Branches stage S_1	The grain filling stage S_2	Average
H_0	50.18	43.18	40.00	44.45
H_1	54.31	46.33	41.50	47.38
H_2	56.80	48.00	41.99	48.93
Average	53.76	45.83	41.16	
L.S.D 0.05	H	S	H× S	
	0.36	0.36	2.20	

The chlorophyll index (spad unit)

Table (6) shows that the effect of humic acid and water stress and their interactions had a significant effect on the chlorophyll index (spad unit). It is noted that the addition of humic acid has a significant effect on the chlorophyll index, the highest value was obtained in the treatment of spraying H_2 of (49.96 Spad Unit) which did not differ significantly from the treatment of the addition of humic acid, which amounted to (49.95 Spad Unit), while the lowest value of the chlorophyll index in the control treatment (H_0) which amounted to (49.08 Spad Unit), The increase ratio of H_2 treatment on the H_0 treatment wad 1.79%,As for the effect of water stress treatments in the chlorophyll index, the control treatment (S_0) recorded the highest value of chlorophyll index which amounted of (53.39 Spad Unit) while the lowest value was in the treatment of water stress during the grain filling stage, which amounted to (47.30 Spad Unit), with an increase ratio of 12.88%. The effect of the interaction between the addition of humic acid and water stress was significant in increasing the chlorophyll index. The treatment H_2S_0 gave the highest value of (55.20 Spad Unit) and the lowest value at H_0S_2 treatment was (46.00 Spad Unit), with an increase of 20%.

Table 5: Effect of the addition of humic acid and water stress and their interactions in the chlorophyll index (spad unit).

Stage / Humic acid	Control treatment S_0	Branches stage S_1	The grain filling stage S_2	Average
H_0	51.25	50.00	46.00	49.08
H_1	53.73	48.33	47.80	49.95
H_2	55.20	46.60	48.10	49.96
Average	53.39	48.31	47.30	
L.S.D 0.05	H	S	H× S	
	0.44	0.44	1.55	

Tables (6,5,4,3) show that both the addition of humic acid and water stress and their interaction led to improved vegetative growth traits of the wheat crop, where the addition of the humic acid had a significant effect on all the study indicators, which confirms the importance of this acid, especially when the treatment of spraying with the humic acid (H_2) because of the content of nutrients availability for absorption by the plant, which led to the release of nutrient elements from the soil and then increase their concentrations, which led to the increase in the construction of amino acids, which is the nucleus of the first growth and the consequent significant increase in plant height (Othman 2000, Ahmad and others 2009), The increase in the number of branches as a result of the addition of humic acid may be due to the fact that this acid produces nitrogenous and phosphatic compounds and others, which have a significant role in increasing the growth, development, cells division, and increase the growth of roots, which is reflected in the increase the number of branches as well as increase the biological processes (Hassan et al.,1990; Fageria, 2009). The effect on the flag leaf area may be due to the positive role of this added acid and then increase the amount of macro and micro-nutrients availability for absorption, which led to the development of vegetative growth and increase the effectiveness of the compost and then increase the flag leaf area of the plant, which gave the opportunity for the plant to optimize investment of these nutrients leading to Increased photosynthesis rates, which were also reflected in the increase in the chlorophyll index (2010). The effect of the addition of humic acid, especially the treatment of spraying (H2) in the content of the guide chlorophyll, the increase may be due to increased availability of nutrients available in this acid and its content of N, P, K and micronutrients, led to increased absorption by the plant, which involved the groups of Porphyrins introducing in the synthesis of chlorophyllates and cytokromates important in the process of photosynthesis (Pandy and Sinha, 1981). The decrease in the values of the above mentioned indicators, with the decrease in the amount of water added in the branches stage and the of grain filling stage, respectively, It may be attributed to the fact that water stress led to a decrease in the division and cellular expansion due to water stress, which affected cell expansion, cell wall expansion and reduction concentration of enzymes (Alam, 1999), and negatively affected on the expansion of leaves and stems and tubers due to low Turgor pressure, which is necessary for elongation and then decrease the process of photosynthesis, In addition, water stress led to the possibility of inhibition of the work of hormones, especially the Oxytocin hormone and therefore decreased the plant height, the number of branches, the flag leaf area and the chlorophyll index (Al-dukhula, 2011; Abdel-Latif etal., 2011). The effect of the interaction between the addition of humic acid and stress treatments at the branches stage and grain filling stage showed no significant differences between the two stages compared to the control treatment (without water stress). This may be due to the role of humic acid, which increases the soil's ability to retain water, creating a favorable environment for the reproduction and efficiency of organisms in the processing of micro and macro-nutrients (Hussein et al., 2011). The effective role of humic acids in reducing the sedimentation and adsorption processes of nutrients on the surface of colloids is due to competition on adsorption sites. Water stress negatively affects mineral organic matter, which in turn affects the amount of mineral nutrients availability to be absorbed by the plant, especially the wheat stages (branches and grain filling) by considered as a critical stages which can weaken the plant's mineral nutrition (Rennenberg, 2009). Sauchez-Rodriguez et al., (2010) showed that the effect of water stress on nutrient uptake has a negative effect on all the indicators of the study. The grain filling stage leads to a decrease in the availability of these nutrients, in particular the potassium availability with low soil content of water due to the low mobility of potassium under water stress conditions (Marschner, 2012), which negatively affected the plant height, the number of branches, the flag leaf area and the chlorophyll index, Especially in the two stages, of branching and the grain filling compared to the control treatment (without stopping water).

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