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ORIGINAL ARTICLE

RESPONSE OF THREE CULTIVARS OF OATS (*AVENA SATIVA* L.) TO HUMIC ACID AND ITS EFFECT ON YIELD AND ITS COMPONENTS

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Abstract: A field experiment was conducted during the winter season (2019-2020) in Babylon province - Al-Badaa area in a farmer's field, which is 20 km west of the province center within 32.52 degrees north latitude and 44.55 degrees east longitude for the purpose of studying the effect of the cultivar and spraying with humic acid on the growth and productivity of oats. The experiment was conducted by following the of randomized complete blocks design (RCBD) within the global experiment with three replications to know the effect of two factors: The first factor: It includes three varieties of oats, *Avena sativa* L. (Shifa, Ganzania and Karlop), The second factor: It included two concentrations of humic acid (2 and 4 $g.L^{-1}$). As well as the control treatment that was sprayed with distilled water only and the averages were tested according to the least significant difference test at the probability level of 0.05. It was obtained in the experiment that the spraying at a concentration of 4.0 $g.L^{-1}$ of humic acid was significantly excelled by giving the highest averages in all the yield indicators. The Ganzania cultivar was significantly excelled by giving the highest averages in most of the yield indicators (Number of panicles, number of grains in panicles, grain yield and harvest index). The results also showed a significant effect of the values of the bi-interaction between the study factors in most of the studied traits. The combination of Ganzania cultivar with spraying concentration of 4.0 $g.L^{-1}$ gave the highest averages in most of the yield indicators.

Keywords: Oats, *Avena sativa* L., Humic acid,

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1. Introduction

Oats (*Avena sativa* L.) is one of the important grain crops and its importance is highlighted through its multiple uses, where it is suitable for human consumption and is used as feed for livestock. Oat flour, which contains an antioxidant, is also used in the preparation of some children's foods and some types of biscuits in Western countries for ease of use take advantage of components of grain with high nutritional value. In addition, oats are rich in β-glucan, protein, fat and starch [Ahmad *et al.* (2014)] and some studies have been conducted in Iraq on this crop, most of them related to studying the effect of some agricultural processes on the production of feed and grains [Al-Jubouri and Al-Jubouri (2014), Abd AL-Hseen, Z.E. and A.I. Manea (2020)], that there are some aspects that still did not receive the required attention and need more studies. Therefore, thinking of other means achieves the possibility of increasing the capacity of the different varieties of this crop to give the highest yield of grains in quantity and quality. One of these means is the use of humic acid, where it is one of the main products for the decomposition of organic matter (humus). This affects plant growth by affecting the process of photosynthesis and respiration, as it activates the work of some enzymes, including phosphatase, phosphorylase and oxidase [Dantas *et al.* (2007)]. This is reflected positively on the vegetative growth of the plant by increasing the height of the plant, the number of branches and the leaf area. The humic acid spray is very effective because the humic molecules can enter the cell stream and make the cell membrane more

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permeable, facilitating the movement of elements and cell division.

2. Materials and Methods

The field experiment was conducted during the winter season (2019-2020) in Babylon province- Al-Badaa area in the field of a farmer, which is 20 km west of the province center. The aim of the experiment was to study the effect of two concentrations of humic acid on some growth traits, yield and its components of three cultivars of Oats *Avena sativa* L. namely (Shifa, Ganzania and Karlop). Random samples were taken from field soil before cultivation from different locations to form a composite sample and analyzed in the laboratories of the College of Agriculture, Al-Qasim Green University to know some of the chemical and physical properties of the experiment soil as shown in Table 1.

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

Traits	Values
Soil Separators	$g.kg^{-1}$
sand	434
silt	405
Clay	152
soil texture	sandy loam
Electrical conduction (EC)	2.3 $DS.m^{-1}$
pH	7.8
N $mg.kg^{-1}$	70.40
P $mg.kg^{-1}$	8.8
k $mg.kg^{-1}$	276

Oats seeds of Shifa and Karlop were obtained from the Agricultural Research Department in Baghdad, belonged to the Ministry of Agriculture. As for the seeds of the other cultivars, Ginzania, they were obtained from the Department of Field Crops, College of Agriculture, University of Baghdad. The germination percentage of the cultivars was tested, which was (99, 98, 99 and 99%) sequentially for the above-mentioned cultivars. The factorial experiment was conducted by following the design of randomized complete blocks (RCBD)with three replications to know the effect of two factors, The first factor: It includes three cultivars of Oats (*Avena sativa* L.) (Shifa, Ganzania and Karlop) with a seed average of 100 $kg.ha^{-1}$ [Devi *et al.* (2014)]. This recommendation was used for all types, The second factor: It included two concentrations of humic acid with no spray (0, 2 and 4 $g.L^{-1}$). Soil service and crop service operations were conducted as well as fertilization and according to the recommendations, the harvest was done after the plants reached the stage of full maturity and for each of the cultivars.

The traits that have been studied

1. Number of panicles.m^2: It was randomly calculated from a square meter area of each experimental unit.
2. The number of panicles.$grains^{-1}$: It is the average number of grains for ten panicles selected from each secondary experimental unit at random and from the median lines.
3. The weight of a thousand grains (g): It is the weight of 1000 pills taken at random from the grain yield of each experimental unit.
4. Grain yield $ton.ha^{-1}$: It was calculated from the yield of the harvested area (square meters) from each secondary experimental unit and then converted to $ton.ha^{-1}$.
5. Biological yield: It was calculated from the weight of the entire dry plants harvested above and for an area of one square meter chosen randomly and then converted to ton ha^{-1}.
6 Harvest index: It was calculated from the following equation.

Harvest index = (grain yield/biological yield) × 100.

Statistical analysis

The data for the studied traits were collected, arranged, tabulated and analyzed statistically using the statistical program GenStat and the averages were compared with the least significant difference under the 0.05% probability level [Steel and Torrie (1980)].

3. Results and Discussion

Table 2 indicates that there is a significant effect of each of the concentrations of humic acid and the

Table 2: Shows the effect of cultivars and humic acid on the trait of the number of panicles ($panicle.m^{-1}$).

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	366.90	385.60	419.80	390.77
Ganzania	487.97	569.83	584.13	547.31
Karlop	295.47	526.33	556.90	459.57
Average	383.44	493.92	520.28	
L.S.D 0.05	a=3.51 b= 3.51 ab= 6.45			

cultivars and the interaction between them, where the concentration 4 ml/L significantly excelled and gave the highest average of 520.28 panicle/m^{-2} compared to the treatment without spraying, which gave the lowest average of 383.44 panicle.m^{-2}. Majid and Salim (2018) agreed with this finding. It is also noted that there are significant differences between the cultivars, Where Ganzania cultivar was significantly excelled and gave the highest average number of panicles reached 547.31, while the cultivar gave the lowest healing average of 390.77 panicles/m^{-2}. The reason for this disparity and differences between oats cultivars in the number of panicles per unit area may be due to the genetic variation between these cultivars. The results in Table 2 indicate that there is a significant interaction between cultivars and humic acid concentrations. The reason for this interaction is due to the different cultivars in their response to humic concentrations and these results are consistent with the findings of Al-Zarkani (2017).

Table 3 indicates that there is a significant effect for each of the concentrations of humic acid and the cultivars and the interaction between them, where the concentration 4 ml/L significantly excelled and gave the highest average of 43.84 tablets compared to the treatment without spraying which gave the lowest average of 38.64 tablets. This result agrees with Majid and Salim (2018). It is also noted that there are significant differences between the cultivars, where the cultivar Ganzania significantly excelled and gave the highest average number of grains in the panicles, which amounted to 48.47 grains, while the Karloop cultivar gave the lowest average of 37.37 grains. The reason for this may be due to the nature of the genetic structure of the cultivar that gave the highest average of the number of panicles and this was positively reflected on the number of grains in panicles. These results are consistent with the findings of Al-Zarkani (2017).

Table 4 indicates that there is a significant effect for each of the concentrations of humic acid and the cultivars and the interaction between them, where the concentration 4 ml/L significantly excelled and gave the highest average of 41.10 g compared to the treatment without spraying, which gave the lowest average of 38.71 g. This result agreed with Majid and Salim (2018). It is also noted that there are significant differences between the cultivars, where the Karlop cultivar was significantly excelled and gave the highest average weight of one thousand grains amounting to 43.08 g, while the Ganzania cultivar gave the lowest average of 36.89 g. The reason for this is due to the Karlop cultivar, which gave the lowest average for the number of panicles.m^{-2} (Table 2), which reduced the level of competition for nutrients and growth elements, which was positively reflected in the increase in grain weight.

Table 5 indicates that there is a significant effect of each of the concentrations of humic acid and the cultivars and the interaction between them, where the concentration 4 ml/L was significantly excelled to and gave the highest average of 3.87 tons/ha^{-1} compared to the treatment without spraying, which gave the lowest average of 2.69 tons/ha^{-1}. The reason for the increase in grain yield may be due to an increase in humic acid concentrations where a result of the increase in vegetative growth indicators and then an increase in the efficiency of photosynthesis and an increase in the accumulation of dry matter, which in the end increased

Table 3: Effect of cultivars and humic acid on the trait of the number of grains per panicles^{-1}.

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	36.300	38.700	40.56	38.52
Ganzania	44.33	49.53	51.53	48.47
Karlop	35.300	37.37	39.43	37.37
Average	38.64	41.86	43.84	
L.S.D0.05	a = 0.17 b = 0.17 ab = 0.30			

Table 4: Effect of cultivars and humic acid on the trait of Weight of a thousand grains (g).

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	38.30	40.37	41.60	40.08
Ganzania	36.43	36.87	37.37	36.89
Karlop	41.40	43.50	44.33	43.08
Average	38.71	40.24	41.10	
L.S.D0.05	a = 0.106 b = 106 ab = 0.18			

Table 5: Effect of cultivars and humic acid on the trait of grain yield ton.ha^{-1}.

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	2.40	3.89	3.89	3.39
Ganzania	2.95	3.95	3.92	3.61
Karlop	2.70	3.56	3.80	3.35
Average	2.69	3.80	3.87	
L.S.D0.05	a = 0.10 b = 0.10 ab = 0.189			

the efficiency of the source and the efficiency of transferring that dry matter to the Sink, which caused an increase in the components of the yield from the weight of grain, the number of panicles and the number of grains per panicles in the plant [Chen and Aviad (1990). The reason for the increase in yield components may be due to the role of humic acids in increasing the permeability of cell membranes [Andrade *et al.* (2000)]. This facilitates and increases the speed of conversion of glucose to starch and other carbohydrate compounds inside the cell due to the presence of active groups of hydroxyl OH and carboxyl COOH in its composition, as well as enhancing the concentrations of macro and micro nutrients in the cell as a result of spraying humic acids, which leads to an increase in the effectiveness of the cellular enzyme system with the participation of these nutrients in the form of cofactors or coenzymes [Harborne (1999)]. **T**hese results are in agreement with Majid and Salim (2018) and Alabdulla (2019). It is also noted that there are significant differences between the cultivars, where Ganzania cultivar significantly excelled and gave the highest average weight of one thousand grains, which amounted to 3.61 tons/ha^{-1}, while the Karlop cultivar gave the lowest average amounting to 3.35 tons/ha^{-1}. The genetic structures in their ability to produce the components of the crop (weight and number of grains) lead to a difference in number and weight according to the genetic nature and the available growth factors, and to the differences among them in the extent of their response to the effect of humic acid concentrations on some growth traits and yield components. Also, this difference in the average grain yield between cultivars can be due to the genetic variations of the cultivars, as the cultivars differ in giving them grain yield [Jose *et al.* (1997)].

Table 6 indicates that there is a significant effect for each of the concentrations of humic acid and the cultivars and the interaction between them, as the concentration 4 ml/liter significantly excelled and gave

Table 6: Effect of cultivars and humic acid on the trait of Biological yield ton.h^{-1}.

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	10.73	15.05	15.02	13.59
Ganzania	12.62	14.84	14.90	14.13
Karlop	11.99	14.28	14.48	13.59
Average	11.78	14.73	14.80	
L.S.D 0.05	a = 0.43 b = 0.43 ab = 0.75			

Table 7: Effect of cultivars and humic acid on the trait of harvest index %.

Cultivars	Humic acid (ml/L)			Average
	0	2	4	
Shifa	22.37	25.88	25.94	24.73
Ganzania	23.44	26.65	26.29	25.46
Karlop	22.50	24.89	26.28	24.56
Average	22.77	25.81	26.18	
L.S.D 0.05	a= 0.31 b=0.31 ab= ns			

the highest average of 14.80 tons/ha^{-1} compared to the treatment without spraying, which gave the lowest average of 11.78. There are also differences significantly among the cultivars, where the cultivar significantly improved healing and gave the highest mean of biological yield traits of 14.13 tons/ha^{-1}. While the cultivar Karlop gave the lowest average of 13.59 tons/ ha^{-1}. The reason for the difference in the trait of the biological yield among the cultivars may be due to the genetic differences between them, which have already been referred to Ahmad *et al.* (2014).

Table 7 indicates that there is a significant effect for each of the concentrations of humic acid and the cultivars, where the concentration 4 ml/L significantly excelled and gave the highest average of 26.18 compared to the treatment without spraying, which gave the lowest average of 22.77. The reason for the increase in the harvest index may be due to the increase in humic acid concentrations to the positive effect of this substance, which improved the yield traits and increased the number of panicles.m^{-2}, the number of panicles per grains and the weight of a thousand grains, meaning that the efficiency of the plant in building nutrients (carbohydrates) and converting them into the stored parts of the plant, which are the grains, increased with the increase in the concentrations of this substance and its positive effect and this was reflected in the increase in the harvest index. This result agrees with Majid and Salim (2018) and there are significant differences between the cultivars, as Janzania cultivar significantly excelled and gave the highest mean of harvest index weight of 25.46%, while Karlop cultivar gave the lowest average of 24.73%. The reason for this is due to the excelled of this cultivars in the trait of the number of panicles, the number of grains in panicles and the yield of grains, which was positively reflected on the percentage of harvest index.

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