



*Original Paper*

**Effect of Foliar Application of Nano-fertilizer of Iron on Growth and Biological Yield of Varieties Wheat (*Triticum aestivum* L.)**

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**ABSTRACT**

A field experiment was conducted during 2018-2019 winter season at Al-Huwair, north of Basrah, Iraq. The aim was to evaluate the effect of different concentrations of foliar application of Nano-fertilizer of Iron (0, 0.5, 1.0 and 1.5 g L<sup>-1</sup>) on growth and yield of four varieties of wheat, *Triticum aestivum* L. The experimental design used was randomized complete block design. The results showed that, there is significant differences among varieties, the variety of Iraq produced highest average of plant height (110.08 cm), flag leaf area (43.87 cm<sup>2</sup>), spike length (13.61 cm), tellers number m<sup>-2</sup> (459.83) and biological yield (12.493 t ha<sup>-1</sup>). The foliar applications levels of Nano-fertilizer of Iron have significant effect on some growth properties and yield of wheat. The treatment of 1.5 g L<sup>-1</sup> gave the highest average of plant height (105.42 cm), flag leaf area (38.58 cm<sup>2</sup>), spike length (12.73 cm), tellers number m<sup>-2</sup> (467.03) and biological yield (12.765 t ha<sup>-1</sup>). Moreover, the interaction of single factors has significant effect, treat variety of Iraq with 1.5 g L<sup>-1</sup> of Nano-fertilizer of Iron gave the highest average of plant height (116.00 cm), flag leaf area (51.19 cm<sup>2</sup>), spike length (13.96 cm), tellers number m<sup>-2</sup> (518.66) and biological yield (14.220 t ha<sup>-1</sup>).

**Keywords:** Foliar application, Nano-fertilizer of Iron, varieties and wheat

**INTRODUCTION**

Grains crops from the most important and oldest crops known to human being, because they are considered the main source of food (5), wheat crop *Triticum aestivum* L. is one of the most important of these crops, which ranks the first in Iraq and the world because of its strategic role in achieving the food security. Its planting area attained 736.5 million hectares and its productivity is 739.9 million tons globally (19). In Iraq, the planting area attained 3697 thousand hectares and by productivity 2885 thousand tons (3). Although Iraq is one of the original habitats the of the wheat up growth and one of the countries in which the success factors of its planting are available on it, but its production mean still below the required level as compared with the world and neighboring countries. There are many reasons caused the low productivity of this crop, which is

summarized by not choosing the appropriate varieties with high productivity and don't depended the modern technologies in the its planting field and the service of this crop (18) .Genetic factors of the varieties controlling in the attributes of growth and production, and the interaction of these factors with the environment. The application of modern technologies in field operations and practices will affect in determining and forming phenotypic and productive attributes . (1) observed that there was a significant differences between six genotypes of wheat crop in terms of plant height, as well as (16) indicated there was a significant differences between wheat varieties in plant height, as the IPA-99 variety gave the highest mean attained 80.83 cm (17) achieved the highest mean of the flag leaf of wheat attained 34.38 cm<sup>2</sup> at the Latifia variety , which significantly exceeded from Abu Ghraib variety , which gave the lowest mean attained 24.74 cm<sup>2</sup>. While (24) did not notice significant differences between the varieties in the flag leaf area attribute . the varieties also differ between them by their ability to form tillers, as (14) that Al-Fateh variety significantly exceeded and giving the highest number of tillers attained 420.90 tiller-2 as compared with Sally variety, which gave the lowest number, attained 291.00 m-2 , (28) explained that the IPA-99 variety was exceeded and given the highest mean of tillers with increasing rate attained %5.11 as compared with the Abu Ghraib-3 variety and the length of spike attribute is differ with different of varieties due to the difference in the length of duration which in it is formed and growth, and it is one of the attributes that are positively related to the yield. (7) noticed a significant difference in the length of spike and the five varieties of wheat ,as IPA-99 gave the highest length attained 11.11 cm and the lowest length attained 10.45 cm of Abu Ghraib-3 variety. as a result of the negative effects of improper use of chemical fertilizers in the southern region, including soil pollution problem as well as it increases the salinity of the soil of the region's lands, it was necessary to think about using a modern fertilizers as a substitute of traditional fertilizers and use it to provide the necessary nutrients of plant growth and increase it productivity with keeping the soil in perfect condition and clean environment (32) and between these fertilizers are environmentally friendly and highly effective fertilizers that are called nano-fertilizers and as a result of the it efficiency that led to manufacture and development of it which can be more soluble, effective and faster in penetration and metabolizing in the plant tissues than ordinary fertilizers (33) , as nano-fertilizers play an important role in increasing the ability of crops to tolerance the different stress conditions, increasing disease resistance, maintaining the required genetic attributes of different crops and increasing the active substances in plants. nano-fertilizers also used to cover the traditional fertilizers to facilitate its absorption and increase its efficiency due to its easy entry into cells, in addition to the contributing to the transportation of compounds to desired sites, whether leaves, roots, or fruits or other parts of the plant and in other metabolic processes by increasing the activity of photosynthesis through increased the chlorophyll content in leaves (31). iron element plays an important and effective role in many biological processes of the plant, either through its direct contribution as a synthetic component of plant materials or its activation of enzymatic processes inside the plant as it enters as an auxiliary and stimulant of the reactions of the green pigments formation through a series of compounds that end up with of chlorophyll molecule formation (23) and It has a role in the RNA metabolize to the chloroplast in leaves, which are substances that contain chlorophyll (21). Also it entry in the Cytochromes

formation and it was found that about %70 of the total iron is found in the plastids as phyto-protein compound which is an iron phosphate protein and this explained its importance in the process of photosynthesis (2 , 8) . Reducing nitrates to ammonia and forming saturated and unsaturated fatty acids ,Iron is contribution in the Ferredoxin protein synthesis, which is an important in the photosynthesis, nitrates reducing to ammonia, and synthesis of saturated and unsaturated fatty acids. Nanotechnology is a modern technological scale that serves agriculture and increases the quantity and quality of agricultural production on a wide range and serve farmers who suffering from the lack to the elements of agricultural success in their countries, as the optimal use of the elements of agriculture will ensure a high yield (29).And due to the importance of what mentioned above, this study was conducted to determine the appropriate variety of the region and determine varieties response of the wheat crop by adding nano -fertilizer and knowing the best addition amount and the effect of this on the growth attributes and the biological yield.

### Materials and methods

A field experiment was conducted during winter season 2018-2019 in the Al-Huwair region which located in north of Al-Basrah city at silt loam soil and its physio-chemical attributes shown in the table (1) and the experiment including spray iron-nano fertilizer with four concentrations (0,0.5,1,1.5) gm L<sup>-1</sup> of four varieties of wheat (Iraq, Al-Noor, Al-Hashimiyah and Al-Ezz).the experiment was applied according to randomize complete block design (R.C.B.D) with three replicates after preparing the experiment land for plowing, smoothing and leveling operations, the field was divided into experimental units. the area of the experimental unit (4 x 3 = 12 m<sup>2</sup>), The seeds were planted in lines and the distance between its was 15 cm and The date of planting was 15/11/2018 and the amount of seedling 120 kg ha<sup>-1</sup> (26). Urea fertilizer (% 46 N) was added with an amount 120 kg N ha<sup>-1</sup> in two equal batches, the first after the emergence of seedlings and the second in the elongation stage, while phosphate fertilizer was added in one batch when planting with a quantity about 100 kg P ha<sup>-1</sup> as triple super phosphate fertilizer (20 % Phosphorus) and potassium fertilizer was added in one batch when planting at a level 120 kg K ha<sup>-1</sup> as potassium sulfate fertilizer (27) . The other agricultural operations as irrigation and weeding were carried out equally of all treatments and as needed. Nano fertilizer was sprayed early in the morning by two sprays the first during the vegetative growth stage and the second at the beginning of the flowering and Al-Zahi cleaning solution was used as a spreader substance to increase the absorption efficiency by reducing the surface tension of the water ,whereas control treatment was sprayed with distill water only the plants were harvested when they reached full maturity on 10/5/2019, and the growth attributes were studied, the height of the plant (cm), the length of the spike (cm), the flag leaf area (cm<sup>2</sup>), the number of tillers M-2 and the biological yield (tons ha<sup>-1</sup>) from plants which harvested of one square meter area of each experimental unit after leaving the guard lines, the data were analyzed statistically according to the experiment design and by using the least significant difference test at a probability level of 0.05 to compare within treatment means.

**Table (1) Some physical and chemical properties of field soils before planting**

Properties	الوحدة Unit	Value
Electrical conductivity (EC)	ds/m <sup>-1</sup>	4.82
pH	-	7.5
Organic matter (OM)	Mg Kg <sup>-1</sup>	0.25
Nitrogen	Mg Kg <sup>-1</sup>	0.714
Available nitrogen	Mg Kg <sup>-1</sup>	5.4
Available Iron	Mg Kg <sup>-1</sup>	2.4
Available Zinc	Mg Kg <sup>-1</sup>	0.43
Available potassium	Mg Kg <sup>-1</sup>	2.7
Sand	%	54.17
Silt	%	41.25
Clay	%	4.58
Soil texture	-	loam silt

## Results and Discussion

The height of the plant (cm)

The results in the Table (2) refers that the Iraq variety gave the highest mean of height of the plant attained (110.08) cm, while the Al-Ezz variety recorded the lowest mean of the height of the plant attained (86.66) cm, and that due to the difference of wheat varieties among its in height due to the additional genetic act as well as to genetic variation In terms of the number and lengths of the Internodes, especially the upper parts from it , in addition to the action of the hormone oxine and gibberelin between the varieties and this agreed with what finding by,(10,15,16), While the high concentration of nano-iron gave (1.5) gm liter-1 the highest mean of this attribute attained (105.42) cm with a significant difference from the control treatment (0) gm liter-1 which gave the lowest mean attained (90.21) cm and the reason for this may be due to the direct role of iron in increasing the leaf content from chlorophyll which is one of the important basics in the photosynthesis (2). Also nano fertilizers have a unique behavior that is the small size of their particles and its effective and high surface area, which leads to rapid penetration and metabolize and increased the enzymatic activity and the speed of biological reactions (30).As for the effect of the interaction between the varieties and the concentrations of nano-iron, Iraq variety at concentration (1.5) gm L-1 gave the highest mean of this attribute attained (116.00) cm while AL-Eezz variety at concentration (0) gm L-1 gave the lowest mean of this attribute (80.50) cm, the reason may be due to the variation of varieties in its ability to absorb iron and achieve the highest benefit from it in biological processes.

**Table (2)** Effect of the varieties and the levels of nano fertilizer and the interaction between its on the mean of the height of the plant attribute

Varieties	The concentration Nano – Iron fertilizer ( gm L <sup>-1</sup> )				Varieties Mean
	0	0.5	1	1.5	
Iraq	101.33	110.00	113.00	117.00	110.08
AL-Noor	92.00	97.00	104.00	110.00	102.00
Al-Hashimiyah	87.00	90.00	93.00	98.00	92.00
Al-Ezz	80.50	85.17	88.27	92.70	86.66
Nano concentration mean	90.21	95.54	99.57	105.42	
L.S.D.(0.05)	Varieties = 0.93		Nano concentration= 0.93		Interaction=1.87

### Flag leaf area (cm<sup>2</sup>)

The results of table (3) show that the Iraq variety was exceeded by giving the highest mean of the flag leaf area attained (43.87) cm<sup>2</sup>, whereas AL-Ezz variety recorded the lowest mean of the flag leaf area attained (25.20) cm<sup>2</sup> and this may be due to the variation in the genotype between the varieties which led to a difference in the vegetative growth rates (13, 15), the high concentration of nano-iron (1.5) gm<sup>-1</sup> gave the highest mean of this attribute attained (38.58) cm<sup>2</sup> with a significant difference from control treatment (0) gm<sup>-1</sup> which gave the lowest mean of this attribute attained 26.42 cm<sup>2</sup>, this is due to the role of iron in increasing the content of chlorophyll in the leaves and then increasing the efficiency of photosynthesis, which positively reflected in increasing the flag leaf area (34). As for the effect of interaction between the varieties and the concentrations of nano-iron, Iraq variety at concentration (1.5) g liters<sup>-1</sup> gave the highest mean of this attribute attained (51.19) cm<sup>2</sup>, while AL-Ezz variety at concentration (0) g liters<sup>-1</sup> gave the lowest mean for this attribute (20.13) cm<sup>2</sup>.

**Table (3)** Effect of the varieties and the levels of Iron-nano fertilizer and the interaction between its on the mean of the flag leaf area (cm<sup>2</sup>)

Varieties	The concentration Nano – Iron fertilizer ( gm L <sup>-1</sup> )				Varieties Mean
	0	0.5	1	1.5	
Iraq	32.37	44.69	47.25	51.19	43.87
AL-Noor	30.22	32.13	36.42	39.56	34.58
Al-Hashimiyah	22.97	25.93	30.30	33.10	28.08
Al-Ezz	20.13	23.11	27.12	30.46	25.20
Nano concentration mean	26.42	31.47	35.27	38.58	
L.S.D.(0.05)	Varieties = 1.03		Nano concentration= 1.03		Interaction=2.07

### The length of the spike (cm)

The results of table (4) show that Iraq variety gave the highest length of the spike attained (13.61) cm, while AL-Ezz variety recorded the lowest length of the spike attained (10.27) cm, and it may be due to the genetic differences between the varieties because this attribute is most closely related attributes to the genetic factor. and this agreed with (5, 6, 22, 15). The fertilizer also significantly affected on this attribute as nano-iron fertilizer at concentration (1.5) gm L<sup>-1</sup> gave the highest mean of this attribute attained (12.73) cm with a significant difference from control treatment (0) gm L<sup>-1</sup> which recorded the lowest mean attained of this attribute attained (11.36) cm, as for the effect of interaction between the varieties and the concentrations of nano-iron, Iraq variety Iraq at concentration (1.5) gm L<sup>-1</sup> gave the highest mean of this attribute attained (13.96) cm while AL-Ezz variety at concentration (0) gm L<sup>-1</sup> gave the lowest mean of this attribute attained (9.61) cm this may be due to the difference in the varieties' response to the high fertilization levels.

**Table (4) Effect of the varieties and the levels of nano-Iron fertilizer and the interaction between its on the mean of the length of the spike (cm<sup>2</sup>)**

Varieties	The concentration Nano – Iron fertilizer ( gm L <sup>-1</sup> )				Varieties Mean
	0	0.5	1	1.5	
Iraq	12.76	13.85	13.90	13.96	13.61
AL-Noor	12.13	12.30	13.10	13.70	12.80
Al-Hashimiyah	10.96	11.36	11.76	12.36	11.61
Al-Ezz	9.61	9.83	10.71	10.93	10.27
Nano concentration mean	11.36	11.83	12.36	12.73	
L.S.D.(0.05)	Varieties = 0.19		Nano concentration = 0.19		Interaction = 0.39

#### **The number of tillers (m<sup>-2</sup>)**

The results in the table (5) indicate there is a significant effect of the varieties, as Iraq variety gave the highest mean of the number of tillers attained (459.83) tiller M<sup>-2</sup>, while the AL-Ezz variety recorded the lowest mean of the number of tillers attained (372.43) tiller M<sup>-2</sup>. This difference is due to the genetic factor and its role in determining the variety ability to tiller formation and its ability to produce the largest possible amount of metabolic substances (11). While the high concentration of nano-iron (1.5) gm L<sup>-1</sup> gave the highest mean of this attribute attained (467.03) tiller M<sup>-2</sup>, with a significant difference from the control treatment (0) gm L<sup>-1</sup> which gave the lowest mean of this attribute attained (362.96) tiller M<sup>-2</sup>, And this is due to the role of iron in improving the attributes of growth, increasing chlorophyll content in the leaves and activating enzymes involved in biological processes, especially photosynthesis and hormones such as cytokines (2, 9). As for the effect of interaction between the varieties and the concentrations of nano-iron, Iraq variety at concentration (1.5) gm L<sup>-1</sup> gave the highest mean of this attribute attained (518.66) tiller M<sup>-2</sup>, while AL-Ezz variety at concentration (0) gm L<sup>-1</sup> gave the lowest mean of this attribute attained (345.14) tiller M<sup>-2</sup> and this may be due to the role of iron in increasing

photosynthesis and increasing growth and stimulation of the formation of tillers and this interaction with the genetic difference of varieties (20).

**Table (5) Effect of the varieties and the levels of Iron-nano fertilizer and the interaction between its on the mean of the number of the tillers (m<sup>2</sup>)**

Varieties	The concentration Nano – Iron fertilizer ( gm L <sup>-1</sup> )				varieties Mean
	0	0.5	1	1.5	
Iraq	391.33	454.00	475.33	518.66	459.83
AL-Noor	364.96	406.66	455.66	509.66	434.03
Al-Hashimiyah	351.17	365.00	389.00	434.33	384.87
Al-Ezz	345.14	354.56	384.48	405.54	372.43
Nano concentration mean	362.96	395.05	426.11	467.03	
L.S.D.(0.05)	Varieties = 0.50		Nano concentration= 0.50		Interaction=1.00

#### The biological yield (tan ha<sup>-1</sup>)

From the results of table (6) we noted a significant effect of the varieties, as the Iraq variety gave the highest biological yield attained (12.493) tons ha<sup>-1</sup>, while AL-Ezz variety recorded the lowest biological yield attained (9.420) tons ha<sup>-1</sup>, and the reason may be due to the increasing that achieved by the exceeding varieties in the grain yield in addition to its exceeding in the growth attributes, which provided a better chance to increase the efficiency of the photosynthesis process and an increasing in the rates of production and accumulation of dry matter, which was reflected in the increase in the means of biological yields, and this is agreed with (12 ,15). nano - iron at concentration (1.5) gm L<sup>-1</sup> gave the highest mean of this attribute attained (12.765) tons ha<sup>-1</sup>, with a significant difference from the control treatment (0) gm L<sup>-1</sup> which gave the lowest mean of this attribute attained (9.305) tons ha<sup>-1</sup>, The reason may be due to the role of iron in increasing the growth rates, such as height, number of tillers, leaf area and photosynthesis, and then increasing the production of dry matter and thus increasing the biological yield, and this agreed with (4 ,15) . As for the interaction between varieties and nano-iron , Iraq variety at concentration (1.5) gm L<sup>-1</sup> recorded the highest mean of this attribute, attained (14.220) tons ha<sup>-1</sup>, while AL-EZZ variety at concentration (0) gm L<sup>-1</sup> gave the lowest mean of this attribute attained (7.620) tons ha<sup>-1</sup> and the reason may be due to the varieties variation in plant canopy formation which resulting from the variation of the height of the plant, the leaf area and tillers formation to responded to the high concentrations of nano-iron fertilizer and thus increased biological yield (25 ,14).

**Table (6) Effect of the varieties and the levels of Iron-nano fertilizer and the interaction between its on the mean of the biological yield (tons ha<sup>-1</sup>)**

Varieties	The concentration Nano – Iron fertilizer ( gm L <sup>-1</sup> )				Varieties Mean
	0	0.5	1	1.5	
Iraq	10.432	11.336	13.986	14.220	12.493
AL-Noor	10.400	11.256	12.356	13.180	11.798
Al-Hashimiyah	8.770	9.373	11.393	12.403	10.485
Al-Ezz	7.620	8.453	10.350	11.260	9.420
Nano concentration mean	9.305	10.105	12.021	12.765	
L.S.D.(0.05)	Varieties = 0.031		Nano concentration= 0.031		Interaction=0.063

### Conclusion and recommendation

We conclude from the previous results, the exceeding of Iraq variety with the fertilization level (1.5) gm L<sup>-1</sup> by giving the highest mean of all studied attributes, therefore we recommend planting this variety with the using a high level of nano-iron fertilizer (1.5) gm L<sup>-1</sup> to obtaining the best growth indicators of Wheat crop and with a highest biological value.

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