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ORIGINAL ARTICLE

EFFECT OF SPRAYING WITH DIFFERENT CONCENTRATIONS OF NANO IRON FERTILIZER ON THE YIELD AND ITS COMPONENTS OF VARIETIES OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract: A field experiment was conducted during winter season 2018-2019 in a field located in the Al-Huwair region, which is located in north of Al-Basrah city to know the effect of spraying Nano-iron fertilizer with four concentrations (0, 0.5, 1, 1.5) gm L^{-1} on the yield and its components of four varieties of wheat (Iraq, Al-Noor, Al-Hashimiyah and Al-Ezz). The experiment was applied according to Randomized complete block design (RCBD) with three replicates. The results showed that Iraq variety exceeded and recorded the highest means of the number of spikes per m^2. The number of the grains in the spike and the yield of the grains attained (445.32 spike m^{-2} , 50.37) grain $spike^{-1}$, 5.580 tons ha^{-1}) respectively, whereas AL-Ezz variety exceeded and gave the highest mean of weight of 1000 grain attained (35.80) gm. As for effect of Nano-iron fertilizer spraying (1.5 gm L^{-1}) treatment it gave the highest means of the number of spikes per m^2, the number of the grains in the spike, weight of 1000 grain, the grain yield attained (441.60 spike m^{-2}, 46.35) grain $spike^{-1}$, 35.15 gm, 4.944 tons ha^{-1}), respectively. There was a significant effect of the interaction between varieties and the concentrations of nano-iron fertilizer as the Iraq variety exceeded at the (1.5) gm L^{-1} and recorded the highest means of the number of spikes per m^2, the number of the grains in the spike, the grain yield attained (499.65 spike m^{-2}, 54.60 grain $spike^{-1}$, 6.193 tons ha^{-1}) respectively, whilst AL-Ezz variety recorded the (1.5) gm L^{-1} the highest mean of the weight of the 1000 grain attained (40.23) gm.

***Key words*:** Spraying, Nano-iron fertilizer, Varieties, Wheat, Randomized complete block design (RCBD).

Cite this article

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1. Introduction

Wheat crop, *Triticum aestivum* L. is one of the most important crops, which ranks the first in Iraq and the world because of its strategic role in achieving food security. Its planting area attained 736.5 million hectares and its productivity is 739.9 million tons globally [FAO (2017)]. In Iraq, the planting area attained 3697 thousand hectares and by productivity 2885 thousand tons [Agricultural Statistics Directorate (2016)]. Although, Iraq is one of the original habitats of the wheat up growth and one of the countries where successful planting factors are available on it, but its production means still below the required level as compared with the world and neighbouring countries. There are many reasons caused the low productivity as the soil fertility, increase the salinity of irrigation water, genetic factors as not choosing the appropriate varieties with high productivity and do not depend on the modern technologies in its planting field and the service of this crop. Genetic factors of the varieties is an important factor that controls the crop productivity. AL-Kubaysi (2010) noticed a significant difference between wheat varieties as Ebba variety gave the highest mean of the number of spikes attained (414.77) spike m^{-2}, the number of the grains attained (44.84) grain $spike^{-1}$. AL-Abdullah (2015) achieved the highest means of the number of the spike attained 369.17 spike m^{-2}, the weight of 1000 grain attained 26.69 gm, a grain yield 3.59 tons ha^{-1} when he planting Ebba-99 variety, which significantly exceeded on the other varieties. AL-Abody

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(2019) pointed there was a significant difference between the varieties, as AL-Rashid variety gave the highest means of the number of grains, number of spikes per m^2 and the grain yield attained (47.77 grain $spike^{-1}$, 542.5 $spike^{-2}$, 5,585 ton ha^{-1}), respectively. The negative use of chemical fertilizers in the southern region caused 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 its productivity with keeping the soil in perfect condition and clean environment and these fertilizers are environmentally friendly and highly effective fertilizers that are called nano-fertilizers, as a result of its efficiency which can be more soluble, effective and faster in penetration and metabolizing in the plant tissues than ordinary fertilizers [Rameshaiah and Jpallavi (2015)], nano-fertilizers play an important role in increasing the ability of crops to tolerate the different stress conditions, increasing disease resistance, maintaining the required genetic attributes of different crops and increasing the active substances in plants. Nano-fertilizers are 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 [Lin *et al*. (2014)]. Iron element is one of the nutrients that the plant needs in small quantities, as it has a significant role and influence in many vital 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 [Hopkins (1999)]. Also its 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 [Al-Naimi (1999)]. AL-Alousi (2002) noticed increase in wheat yield and its components when increasing the iron level, as (100 mg L^{-1}) gave the highest mean of the yield as compared with the non-addition treatment and the level (50 gm L^{-1}) and due to the importance of varieties and fertilization 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 of wheat crop.

2. Materials and Methods

A field experiment was conducted during winter season 2018-2019 in 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 nano-iron fertilizer with four concentrations (0, 0.5, 1, 1.5) gm L^{-1} of four varieties of wheat (Iraq, Al-Noor, Al-Hashimiyah and Al-Ezz). The experiment was applied according to randomized complete block design (RCBD) with three replicates after preparing the experiment land for plowing, smoothing and levelling operations, the field was divided into experimental units. The area of the experimental unit was 4m × 3m = 12 m^2. The seeds were planted in lines and the distance between it was 15 cm and the date of planting was 15/11/2018 and the amount of seedling 120 kg ha^{-1}. Urea fertilizer (% 46 N) was added with an amount 120 kg N ha^{-1} 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^{-1} as triple superphosphate fertilizer (20% Phosphorus) and potassium fertilizer was added in one batch when planting at a level 120 kg K ha^{-1} as potassium sulfate fertilizer. 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 distilled water only. The plants were harvested when they reached full maturity on 10/5/2019. The yield attributes and components were measured at full maturity, as an area of one meter square of mean lines was harvested of each experimental unit to study the following attributes: calculate the number of the spikes m^{-2} in the same area of the meter square. The number of grains per spike was evaluated as the mean of the

number of grains of 25 spikes was taken randomly from each experimental unit, and the weight of 1000 grains (gm) also evaluated, as a random sample of 1000 grains of harvested spikes grains from the total yield of each experimental unit was measured at 14% moisture and their weights were measured. The grain yield (ton Ha^{-1}) was evaluated depending on the grain weight of the grains of the harvested sample in an area of meter square and it is converted into ton ha^{-1}. The data were statistically analyzed 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).

Table 1: Some physical and chemical properties of field soils before planting.

Properties	Unit	Value
Electrical conductivity (EC)	ds/m^{-1}	4.82
pH	-	7.5
Organic matter (OM)	Mg Kg^{-1}	0.25
Nitrogen	Mg Kg^{-1}	0.714
Available phosphor	Mg Kg^{-1}	5.4
Available Iron	Mg Kg^{-1}	2.4
Available Zinc	Mg Kg^{-1}	0.43
Available potassium	Mg Kg^{-1}	2.7
Sand	%	54.17
Silt	%	41.25
Clay	%	4.58
Soil texture		Loam silt

3. Results and Discussion

3.1 Number of the spikes m^{-2}

The results of Table 2 indicate that the Iraqi variety has the highest number of spikes m^{-2} attained (445.32) spike m^{-2}, while AL-Ezz variety recorded the lowest mean of number of spikes attained (337.66) spike m^{-2}, and the reason may be due to the variation between the different wheat varieties which perhaps may be due to genetic difference between varieties and the ability of each variety to transform the tillers into tillers carrying fertile spikes depending on its ability to produce the largest carbon metabolize products. Similar results were obtained by AL-Abody (2019), while (1.5) gm^{-1} concentration gave the highest mean attained (441.60) spike m^{-2} with a significant difference from control treatment (0) gm L^{-1}, which gave the lowest mean attained (338.82) spike m^{-2} and the reason may be due to the speed access of the added fertilizer and its metabolizing in metabolic sites through the speed of penetration to reach the cells faster than it helped on the continuity of metabolic processes [Rajasekar *et al*. (2017)]. As for the effect of interaction between the varieties and the concentrations of nano-iron, Iraq variety at concentration (1.5) gmL^{-1} gave the highest mean attained (499.65) spike m^{-2}, while the AL-Ezz variety at concentration (0) gm L^{-1} gave the lowest mean attained (312.33) spike m^{-2}. 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.

3.2 Number of grains $spike^{-1}$

The results of Table 3 showed that the Iraq variety gave the highest number of grains in the spike attained (50.37) grain $spike^{-1}$, while the AL-Ezz variety recorded the lowest number of grains attained (30.55) grain $spike^{-1}$. The reason may be due to the influence of the genetic factor and thus difference of its response to environmental conditions which led to its distinctiveness in this attribute, which was reflected in the increase nutrition of new emerging sites with its requirements of needed processed food to increase its nods, which affected in the number of grains in the spike. This finding was consistent with AL-Abody (2019). The higher concentration (1.5) gm L^{-1} gave the highest mean attained (46.35) grain $spike^{-1}$ with an increasing from control treatment (0) gm L^{-1}, which recorded the lowest mean attained (34.80) grain $spike^{-1}$. The reason may

Table 2: Effect of varieties and levels of Nano-Iron fertilizer and the interaction on the mean of the number of spikes Number of the spikes m^{-2}.

Varieties	The concentration Nano- Iron fertilizer (gm L^{-1})				Varieties Mean
	0	0.5	1	1.5	
Iraq	372.33	444.00	465.32	499.65	445.32
AL-Noor	354.32	387.64	436.67	494.77	418.35
Al-Hashimiyah	316.31	335.66	360.00	405.33	354.32
Al-Ezz	312.33	326.00	345.66	366.67	337.66
Mean of nano concentration	338.82	373.32	401.91	441.60	
L.S.D. (0.05)	Varieties = 0.50		Nano concentration= 0.50		Interaction=1.00

be due to the role of iron that increases the fertilization opportunity and transform each fertile florets into grain, also the efficiency of photosynthesis process by the action of chlorophyll content pushed into increase the products with metabolizing substances which gave a suitable chance to decrease the abortion of florets as a result to decrease the nutritional product during growth and evaluation stages of florets and this result agreed with AL-Rifai (2006). As for the effect of interaction between the varieties and the concentrations of nano-iron, Iraq variety at concentration (1.5) gm L^{-1} gave the highest mean attained (54.60) grain $spike^{-1}$, while AL-Ezz variety at concentration (0) gm L^{-1} gave the lowest mean attained (26.36) grain $spike^{-1}$.

3.3 Weight of 1000 grain (gm)

The results of Table 4 showed a significant effect of this attribute, as AL-Ezz variety gave the highest mean of the weight of 1000 grain attained (35.80) gm while Iraq variety recorded the lowest weight of (26.16) gm. the reason may be due to the low number of the grain of the spike (Table 3). The varieties also differ in the duration of nutrients accumulation in the grains, which led to an increase in the weight of the grain and this agreed with AL-Abody (2019). Also, the fertilization was significantly affected in this attribute, as the high concentration of nano-iron (1.5) gm L^{-1} gave the highest mean attained (35.15) gm with a significant difference from the control treatment (0) gm L^{-1}, which gave the lowest mean attained (29.25) gm. As for the effect of interaction between the varieties and the concentrations of nano-iron, AL-Ezz variety at the concentration (1.5) gm L^{-1} gave the highest mean attained (40.23) gm while the Iraq variety at the concentration (0) gm L^{-1} gave the lowest mean attained (23.86) gm.

3.4 The grains yield (ton ha^{-1})

The results of Table 5 indicate that Iraq variety gave the highest mean of the grains yield attained (5.580) tons ha^{-1}, while AL-Ezz variety recorded the lowest grains yield attained (3.762) tons ha^{-1}, and the reason may be due to the increase in the grains yield belongs to the increasing in the number of spikes (Table 2) and the number of grains in the spike (Table 3). The reason of the exceeding of Iraq variety in this attribute may be due to the genetic difference that makes the variety showing its maximum genetic potential to exceeding between the varieties. This result agreed with what achieved by AL-Abdullah (2015 and AL-Abody (2019) who indicated the difference of varieties in their studies in the grain yield. The highest mean of nano-iron fertilizer (1.5) gm L^{-1} gave the highest mean attained (4,944) tons ha^{-1} with a significant difference from control treatment (0) gm L^{-1} which gave the lowest mean attained (4,031) tons ha^{-1}. The increase in the grains yield is an indicator of the crop's response to

Table 3: Effect of varieties and levels of nano-Iron fertilizer and the interaction on the mean of the number of the grains $spike^{-1}$.

Varieties	The concentration Nano – Iron fertilizer (gm L^{-1})				Varieties Mean
	0	0.5	1	1.5	
Iraq	44.63	50.15	52.12	54.60	50.37
AL-Noor	37.53	39.76	48.56	50.96	44.20
Al-Hashimiyah	30.70	33.56	42.80	45.36	38.10
Al-Ezz	26.36	29.53	31.80	34.50	30.55
Mean of nano concentration	34.80	38.25	43.82	46.35	
L.S.D.(0.05)	Varieties = 0.11		Nano concentration= 0.11		Interaction=0.23

Table 4: Effect of varieties and levels of Nano-Iron fertilizer and the interaction on the mean of the weight of 1000 grain.

Varieties	The concentration Nano- Iron fertilizer (gm L^{-1})				Varieties Mean
	0	0.5	1	1.5	
Iraq	23.86	24.80	26.60	29.40	26.16
AL-Noor	29.96	31.53	32.60	34.76	32.21
Al-Hashimiyah	30.80	33.56	35.16	36.23	33.93
Al-Ezz	32.36	34.26	36.36	40.23	35.80
Mean of Nano concentration	29.25	31.04	32.68	35.15	
L.S.D.(0.05)	Varieties = 0.11		Nano concentration = 0.11		Interaction = 0.22

Table 5: Effect of varieties and levels of Nano-Iron fertilizer and the interaction on the mean of the grains yield.

Varieties	The concentration Nano- Iron fertilizer (gm L^{-1})				Varieties Mean
	0	0.5	1	1.5	
Iraq	5.013	5.243	5.873	6.193	5.580
AL-Noor	4.033	4.113	4.650	4.740	4.384
Al-Hashimiyah	3.850	4.022	4.210	4.353	4.131
Al-Ezz	3.230	3.526	3.803	4.490	3.762
Mean of Nano concentration	4. 031	4.226	4.634	4.944	
L.S.D.(0.05)	Varieties = 0.028		Nano concentration = 0.028		Interaction = 0.057

feeding with micronutrients and a reflection of the fertilizer efficiency. The reason of exceeding the grain yield at the high concentrations is due to its exceeding in the yield components, the number of spikes m^{-2} (Table 2) and the number of grains $spike^{-1}$ (Table 3) and this result agreed with AL-Rifai (2006). As for the interaction between the varieties and the concentrations of nano-iron, Iraq variety at the concentration (1.5) gm L^{-1} recorded the highest mean attained (6.193) ton ha^{-1}, whilst AL-Ezz variety at the concentration (0) gm L^{-1} the lowest mean of this attribute attained (3.230) ton ha^{-1} and the reason may be due to increasing the yield components at this combinations.

4. Conclusion

We conclude from the previous results, exceeding of Iraq variety with the fertilization level (1.5) gm L^{-1} by giving the highest mean of all studied attributes except weight of 1000 grain, therefore we recommend planting this variety with using a high level of nano-iron fertilizer (1.5) gm L^{-1} to obtain the higher grain yield of wheat crop.

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