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EFFECT OF NANO-PHOSPHATE AND TRIPLE SUPER PHOSPHATE FERTILIZERS ON GROWTH AND YIELD OF WHEAT (TRITICUM AESTIVUM L.) GROWN IN CALCAREOUS SOILS

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Abstract
A field experiment was carried out at the Agricultural Research Station of the College of Agriculture - University of Basrah during the winter season of 2021-2022 to study the effect of adding different levels of triple superphosphate fertilizer compared to Nano-phosphate fertilizer on the vegetative growth characteristics of wheat (Triticum aestivum L.). Triple super phosphate fertilizer at levels 0, 30, 60 and 90 kg Pha-1 when planting, and Nano-phosphate fertilizer at levels 0, 5, 10 and 15 kg Pha-1 was added as a sprinkler on the plant at the stages of branching and elongation, Crop growth rate from 50% heading stage to full maturity, Dry weight, phosphorus concentration in dry matter and phosphorus up take at the end of the season. The results showed no significant differences in the studied traits (Crop growth rate from 50% heading stage to full maturity, Dry weight, phosphorus concentration in dry matter and phosphorus up take) between the two sources of phosphate fertilizer despite the added amount of Nano-fertilizer representing (1/4) of the amount of triple superphosphate fertilizer, and the results also indicated that the increase in phosphorous levels The addition of 0 to 90 kg of triple superphosphate and from 0 to 10 kg of Pha-1 of Nano phosphate fertilizer led to an increase in growth vocabulary, but the addition of Nano fertilizer at the level of 15 kg of Pha-1 led to a decrease in all growth vocabulary. The results indicated the superiority of the cultivar Ibaa-99 in the characteristics (Dry weight, phosphorus concentration in dry matter and phosphorus uptake).

Introduction
Wheat (Triticum aestivum L.) is a major source of human food in many developing countries, providing approximately 50% of the daily calories for the population of these countries due to containing high quality of fibers, proteins, minerals, vitamins, antioxidants, and carbohydrates. (Elsahookie et al., 2021). Strategically in global food security, where it ranks first in terms of production, consumption and cultivated area in the world, where global production amounted to 778.52 million tons for the year 2022 (USDA,2022), while at the level of Iraq, the production rate reached 4234 thousand tons for a cultivated area of 2366 thousand hectares (Directorate of Agricultural Statistics, 2021). Phosphorous (P) is one of the major essential elements of the plant, as it plays important roles in plant nutrition. It is the first responsible for providing energy for many vital processes in the plant cells, and it is called the key to life, through its direct entry into the process of forming energy-saving compounds (ATP, ADP) and enzymatic chaperones (NADP, NADPH, NADH, FAD) and the participation of the nitrogen element in the processes of formation of DNA, RNA, phospholipids and phosphoproteins (Al-Mosili, 2018). Phosphorus added to the soil

through chemical fertilizers is subjected to stabilization processes as a result of several reactions, the most important of which are adsorption and precipitation reactions (Li et al., 2015; Zhu et al., 2018), which represent the biggest problems affecting the low availability of phosphorous in soil. The reason for this is attributed to the chemical behaviour of phosphorous in Soil, which is affected by many factors, some of which are related to the same element, and some of them are related to soil properties, the sources indicated that the efficiency of phosphorus use ranges between 20-30 (Reis et al. 2022). Nano-fertilizers (NFs) are Nano-sized materials that deliver nutrients to the plant and control the slow release into the soil or the speed of its absorption when spraying in a controlled manner, thus preventing its loss and non-pollution of soil and water (Davari et al., 2017) between Ditta (2016) and Chhipa) 2017) that the incorporation of macronutrients such as nitrogen (N), phosphorous (P), potassium (K), sulfur (S), calcium (Ca) and magnesium (Mg) with nanomaterials led to providing the right amount of macronutrients to crops and reducing production costs, Liu mentioned and Lal, (2014) that adding nano-phosphorous instead of traditional phosphorous prevents its fixation in the soil and increases its readiness, which leads to an increase in production, between Iqbal, (2019) that adding Nano-phosphate fertilizers to the soil leads to a reduction in the amount of traditional fertilizers added, which reduces pollution Soil resulting from adding high levels of phosphate fertilizers. As a result of the lack of studies showing the role of Nano-fertilizers in the growth and planting of wheat compared to triple super phosphate fertilizer in the southern region of Iraq, this study was conducted.

Materials and Methods

The study was conducted in the agricultural research station in Al-Haritha district of the College of Agriculture / University of Basra, which is about 30 km north of the centre of Basra governorate during the winter agricultural season 2021/2022. Soil samples were collected from different sites randomly from the experiment site at a depth of (0-30) cm before planting, the samples were dried, then fined and ground, and then mixed with each other and one composite sample was taken from them to estimate the physical and chemical characteristics shown in Table (1) before planting in the Laboratory of Marine Sciences Centre - University of Basrah.

Table (1) some chemical and physical properties of field soil before planting

traits		**value**	**unit**
PH		7.45	-
Ec		7.16	dSm^{-1}
Organic matter		1.64	g Kg $soil^{-1}$
$CaCo_3$		280.00	g Kg $soil^{-1}$
Available Nutrients	**N**	49.6	mg Kg $soil^{-1}$
	P	9.07	
	K	168.1	
Soil Separators	**Silty**	260.45	g Kg $soil^{-1}$
	clay	420.70	
	loam	318.85	
soil texture		**Silty Clay Loam**	

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The study included the use of different levels of two sources of phosphate fertilizer, namely triple superphosphate (P20%) and nano-phosphate fertilizer (P20%), produced by the Iranian-source Sepehr Parmes Company (P20%). Using the disc harrows, the soil was manually leveled, and the experimental land was divided into plates, the area of one plate (2 x 3 = 6 m2). Each plate contains (10) lines with a length of (3) m for the line and a planting distance of (20) cm between one line and another, leaving a distance of (1 m). Between the experimental units and a distance of (2m) between one repeater and another, the seeds were planted at a rate of 120 kg hectare-1 (Al-Fahdawi, 2012) on 13/11/2021 by sedimentation inside the lines and then irrigated immediately afterwards and irrigation operations continued whenever needed, nitrogen fertilizer was added (Urea) at a level of 180 kg/ha-1 (Al-Abdullah, 2015) in three equal batches, the first after emergence, the second in the branching stage, and the third in the elongation stage. Triple superphosphate fertilizer was added at levels (0, 30, 60 and 90) kg ha-1 when planting. Nano fertilizer by spraying plants at levels (0, 5, 10 and 15) kg hectar-1 in the tillering stage and in the elongation stage with the addition of 15 kg P ha-1 when planting the comparison treatment was sprayed with distilled water when spraying the fertilizer on plants in nano fertilization treatments, potassium was added at the level of 100 kg ha-1 when planting.

The Crop growth rate, Phosphorous uptake and Phosphorous use efficiency were calculated using the following equations:

Equation 1:

$$CGR = (W2 - W1)/(t2 - t1) \times 1/A$$

Where:

W1 = Dry weight of plant (g) per m at time t_1

W2 = Dry weight of plant (g) per m at time t_2

A = Land area (m^2)

The Formula by (Radford, 1967).

Equation 2:

Haynes) 1980 ,P uptake= P concentration in dry matter × Dry weight (

Equation 3:

PUE = (P uptake at P dose – P uptake in P_o) / (P applied) × (100)

The Phosphorous concentration were measured using uv-spectrophotometer method by (Page et al, 1982)

The dry weight was calculated by taking ten plant samples randomly from the experimental units after neglecting the terminal lines during the stage of 50% heading. The samples were placed in paper bags and transferred to the laboratory of the Field Crops Department to be cleaned of dust and then dried at a temperature of 70 degrees until the weight was stable. Then I converted the numbers to ton ha^{-1}. Manual weeding operations were carried out whenever needed, and aphids were controlled on 01/26/2022 using a systemic insecticide, Super Janta type, containing the active substance Dimethoate at 40%. On 3/21/2021, the experiment was covered with netting to avoid grain loss because of the birds.

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Results:

Table (2) A and B show the results of the statistical analysis of the study parameters and Table (3) the results of the T-test for comparison between the two sources of phosphate.

Table (2) Analyze of variance of experiment treatments (A) supper phosphate

S.O.V	CGR		Dry weight		P concentration		P UPTAKE		PUE	
	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S
Varieties (V)	N.S	0.013538	2.860	4004934.	1.207	0.0408375	1.887	42.000	377.4	2.033472.
P-Rate (P)	0.051	0.000124	4.045	12366196.	1.706	1.1503819	2.668	270.839	533.8	88.762906.
V*P	N.S	0.000161	N.S	0.69	N.S	0.556	N.S	0.375	754.9	2.304772

Table (2) Analyze of variance of experiment treatments (B) Nano phosphate

S.O.V	CGR		Dry weight		P concentration		P UPTAKE		PUE	
	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S	L.S.D	M.S
Varieties (V)	N.S	0.03586**	2.860	5684562.**	1.207	0.082837	1.887	408.375	7.4	526.0485**
P-Rate (P)	0.055	0.26107**	4.045	3091551.*	1.706	0.507215	2.668	9.042	3.8	1.3945*
V*P	N.S	**Nn.s**	N.S	kn.s	N.S	0.015682	N.S	0.375	4.9	23.3850**

Table (3) T-test to compare the two types of fertilizers

S.O.V	T values	significantly
Plant height	**-0.37**	N.S
Dry weight	**1.04**	N.S
Number of days from planting to 50 % spike	**1.15**	N.S
Number of days from 50 % spike to full maturity	0.847	N.S
Dry Weight	-6.97	0.001**

CGR (g day^{-1} m^{2})

The statistical analysis results showed in table 2 (a & b) that there was a significant effect of phosphorus levels on Crop growth rate, As it increased from 0.26 to 0.37 **g day^{-1} m^{2}** when the added phosphorous levels increased from 0 to 90 kg ha-1 in the form of triple superphosphate Figure (1-a), the results also show that the maximum Crop growth rate appeared when Nano-fertilizer was added at the level of 10 kg ha-1 , As it increased from 0.26 to 0.36 **g day^{-1} m^{2}**, while the increase in Nano-phosphorous added To 15 kg ha-1 to a decrease in Crop growth rate to 0.35 **g day^{-1} m^{2}** Figure (1-b). The results did not show a significant effect of the cultivars, as the Ibaa-99 cultivars superiority the Jad cultivar in Crop growth rate for both sources of fertilizer and for all levels of added phosphorous. The average Crop growth rate of the Ibaa-99 cultivars was 0.32 **g day^{-1} m^{2}** and 0.31 **g day^{-1} m^{2}** for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (1-a) while The Average Crop growth rate of the cultivar Ibaa-99 was 0.32 **g day^{-1} m^{2}** and 0.32 **g day^{-1} m^{2}** for the cultivar Jad in the treatment of Nano-fertilizer Figure (1-b), the results did not show a significant effect of the interaction between the cultivars and the fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two sources of triple super phosphate fertilizer and Nano fertilizer in Crop growth rate for all added levels.

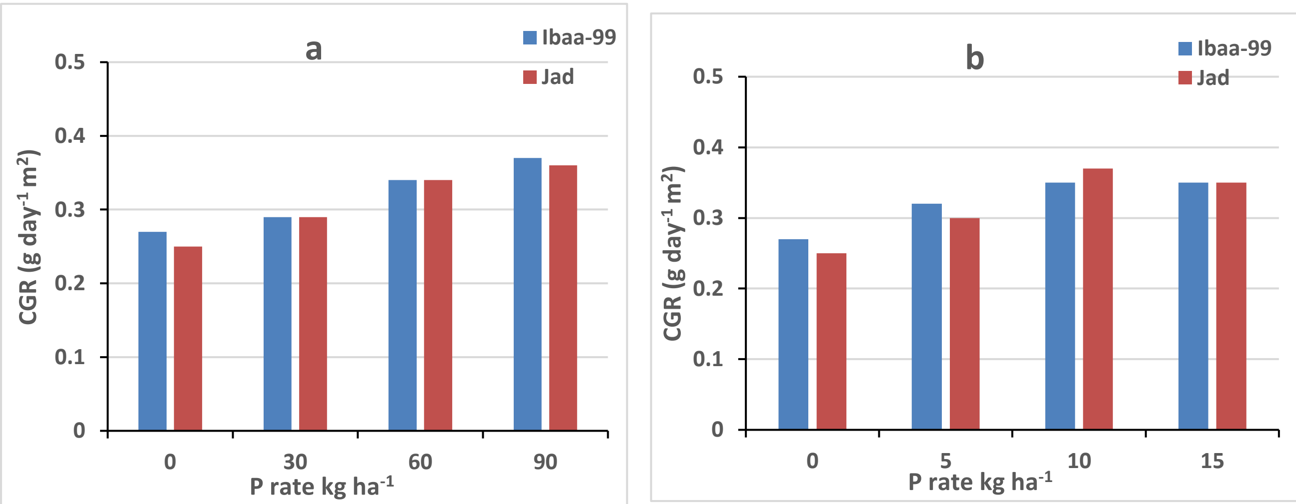

fig.(1) Effect of Cultivars and phosphorus rates on Crop growth rate of wheat plant. A-triple supper phosphate B-Nano phosphate
Dry Weight (Kg ha^{-1})

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The statistical analysis results showed in table 2 (a & b) that there was a significant effect of phosphorus levels on dry weight, As it increased from 5257 to 8900 **Kg ha^{-1}** when the added phosphorous levels increased from 0 to 90 **Kg ha^{-1}** in the form of triple superphosphate Figure (2-a), the results also show that the maximum dry weight appeared when Nano-fertilizer was added at the level of 10 **Kg ha^{-1}**, As it increased from 5257 to 8001 **Kg ha^{-1}**, while the increase in Nano-phosphorous added To 15 kg ha-1 to a decrease in dry weight to 7532 **Kg ha^{-1}** Figure (2-b). The results show a significant effect of the cultivars, as the Ibaa-99 cultivars superiority the Jad cultivar in dry weight for both sources of fertilizer and for all levels of added phosphorous. The average dry weight of the Ibaa-99 cultivars was 7835 **Kg ha^{-1}** and 7018 **Kg ha^{-1}** for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (2-a) while The Average dry weight of the cultivar Ibaa-99 was 7341 **Kg ha^{-1}** and 6751 **Kg ha^{-1}** for the cultivar Jad in the treatment of Nano-fertilizer Figure (2-b), the results did not show a significant effect of the interaction between the cultivars and the fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two sources of triple super phosphate fertilizer and Nano fertilizer in dry weight rate for all added levels.

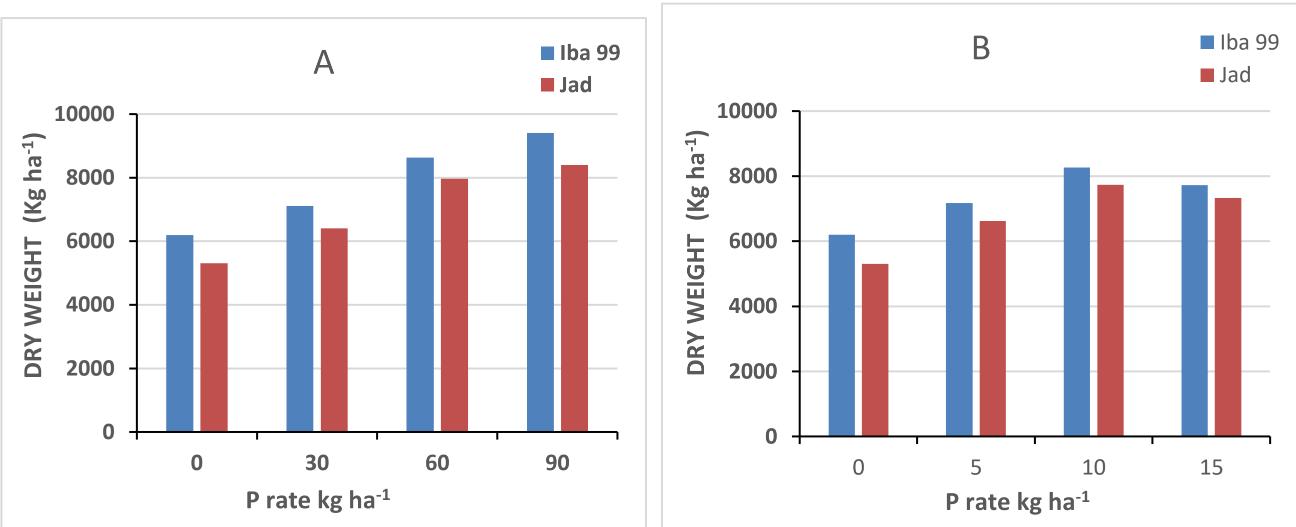

Fig. (2) Effect of Cultivars and phosphorus rates on dry weight of wheat plant. A-triple supper phosphate B-Nano phosphate

P concentration in dry matter (g Kg^{-1})

The statistical analysis results showed in table 2 (a & b) that there was a significant effect of phosphorus levels on phosphorus concentration in dry matter, As it increased from 1.98 to 2.90 **g Kg^{-1}** when the added phosphorous levels increased from 0 to 90 **Kg ha^{-1}** in the form of triple superphosphate Figure (3-a), the results also show that the maximum phosphorus concentration in dry matter appeared when Nano-fertilizer was added at the level of 10 **Kg ha^{-1}**, As it increased from 1.98 to 2.68 **g Kg^{-1}**, while the increase in Nano-phosphorous added To 15 kg ha-1 to a decrease in phosphorus concentration in dry matter to 2.40 **g Kg^{-1}** Figure (3-b). The results show a significant effect of the cultivars, as the Ibaa-99 cultivars superiority the Jad cultivar in

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phosphorus concentration in dry matter for both sources of fertilizer and for all levels of added phosphorous. The average phosphorus concentration in dry matter of the Ibaa-99 cultivars was 2.49 **g Kg^{-1}** and 2.41 **g Kg^{-1}** for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (3-a) while The Average phosphorus concentration in dry matter of the cultivar Ibaa-99 was 2.43 **g Kg^{-1}** and 2.31 **g Kg^{-1}** for the cultivar Jad in the treatment of Nano-fertilizer Figure (3-b), the results did not show a significant effect of the interaction between the cultivars and the fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two sources of triple super phosphate fertilizer and Nano fertilizer in phosphorus concentration in dry matter rate for all added levels.

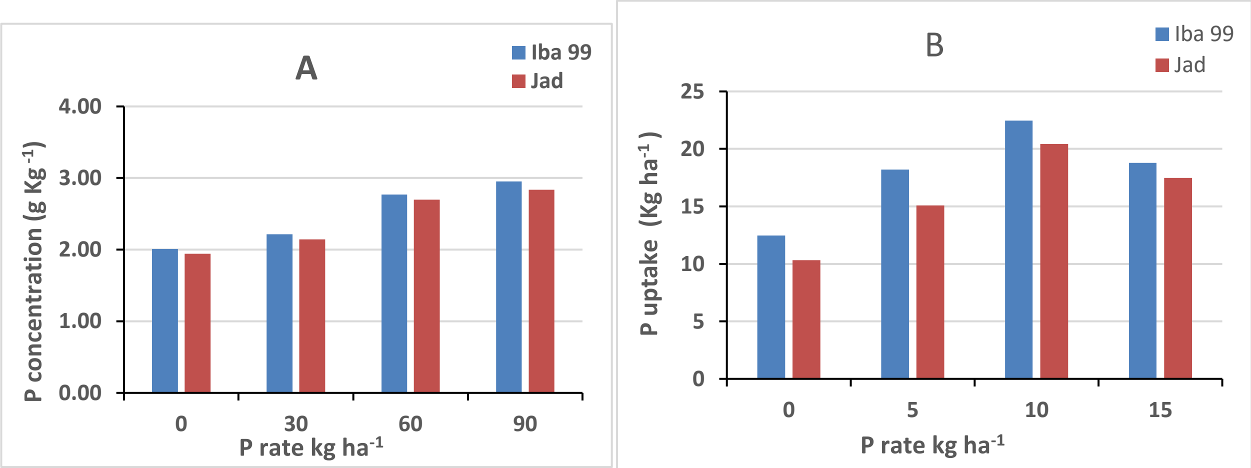

fig. (3) Effect of Cultivars and phosphorus rates on phosphorus concentration in dry matter of wheat plant . A-supper phosphate B-Nano phosphate

P uptake (Kg ha^{-1})

The statistical analysis results showed in table 2 (a & b) that there was a significant effect of phosphorus levels on phosphorus uptake, As it increased from 11.39 to 25.79 **Kg ha^{-1}** when the added phosphorous levels increased from 0 to 90 **Kg ha^{-1}** in the form of triple superphosphate Figure (4-a), the results also show that the maximum phosphorus uptake appeared when Nano-fertilizer was added at the level of 10 **Kg ha^{-1}**, As it increased from 11.39 to 21.45 **Kg ha^{-1}**, while the increase in Nano-phosphorous added To 15 kg ha-1 to a decrease in phosphorus uptake to 18.12 **Kg ha^{-1}** Figure (4-b). The results show a significant effect of the cultivars, as the Ibaa-99 cultivars superiority the Jad cultivar in phosphorus uptake for both sources of fertilizer and for all levels of added phosphorous. The average phosphorus uptake of the Ibaa-99 cultivars was 19.97 **Kg ha^{-1}** and 17.33 **Kg ha^{-1}** for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (4-a) while The Average phosphorus uptake of the cultivar Ibaa-99 was 17.97 **Kg ha^{-1}** and 15.82 **Kg ha^{-1}** for the cultivar Jad in the treatment of Nano-fertilizer Figure (4-b), the results did not show a significant effect of the interaction between the cultivars and the fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two sources of triple

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super phosphate fertilizer and Nano fertilizer in phosphorus uptake rate for all added levels.

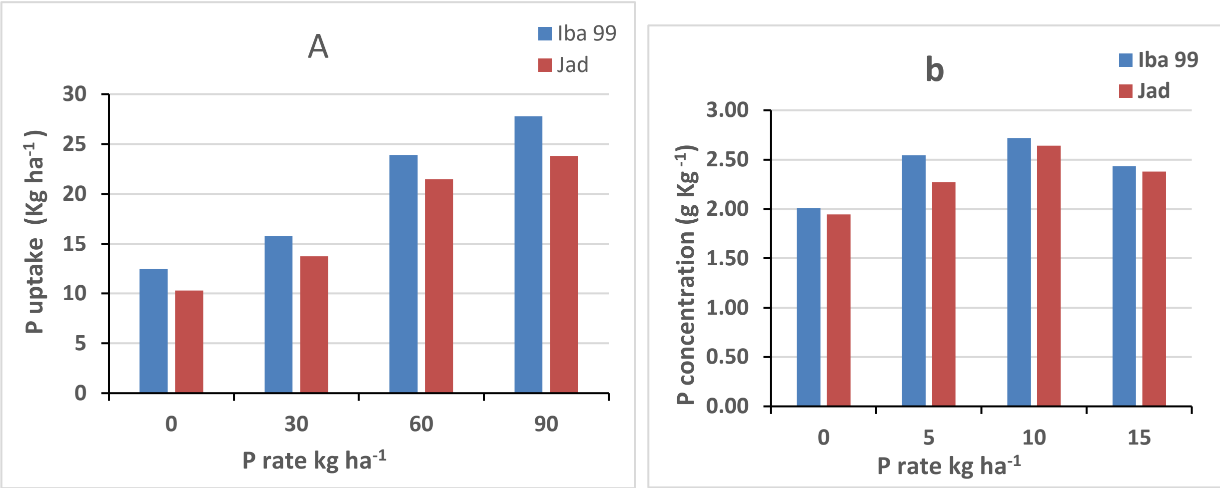
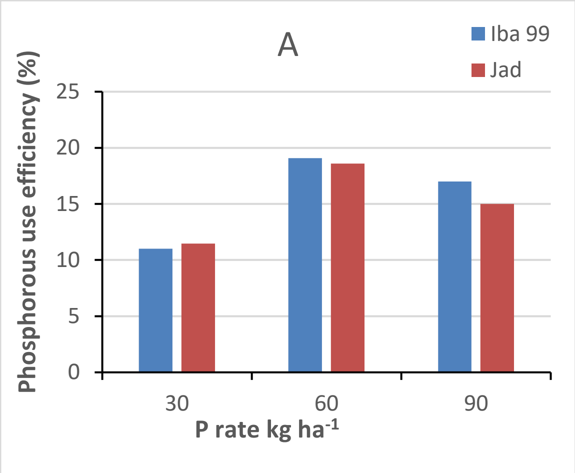


fig. (4) Effect of Cultivars and phosphorus rates on phosphorus uptake of wheat plant . A-supper phosphate B-Nano phosphate

Phosphorous use efficiency (%)

The statistical analysis results showed in table 2 (a & b) that there was a significant effect of phosphorus levels on Phosphorous use efficiency, As it increased from 11.23 to 18.84 **%** when the added phosphorous levels increased from 30 to 60 **Kg ha^{-1}** in the form of triple superphosphate Figure (5-a), the results also show that the maximum Phosphorous use efficiency appeared when Nano-fertilizer was added at the level of 10 **Kg ha^{-1}**, As it increased to 40.24 **%**, while the increase in Nano-phosphorous added To 15 kg ha-1 to a decrease in Phosphorous use efficiency to 22.44 **%** Figure (5-b). The results show a significant effect of the cultivars, as the Ibaa-99 cultivars superiority the Jad cultivar in Phosphorous use efficiency for both sources of fertilizer and for all levels of added phosphorous. The average Phosphorous use efficiency of the Ibaa-99 cultivars was 15.70 % and 15.02 % for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (5-a) while The Average Phosphorous use efficiency of the cultivar Ibaa-99 was 29.94 and 29.38 % for the cultivar Jad in the treatment of Nano-fertilizer Figure (5-b), the results show a significant effect of the interaction between the cultivars and the fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two sources of triple super phosphate fertilizer and Nano fertilizer in Phosphorous use efficiency rate for all added levels.



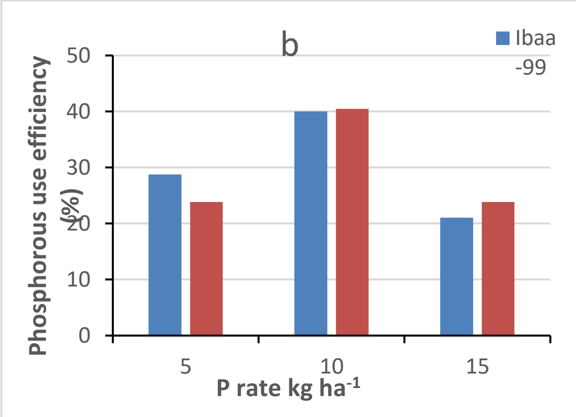


fig. (3) Effect of Cultivars and phosphorus rates on Phosphorous use efficiency of wheat plant . A-supper phosphate B-Nano phosphate

Discussion

The results of the T-test Table (3) showed that there were no significant differences in CGR (Fig. 1), dry weight (Fig.2), phosphorus concentration in dry matter, figure (3), phosphorus uptake, figure (4).) as well as in the Phosphorous use efficiency, Fig. (5) between the two sources of phosphate fertilizer used in the study, although the added amount of nano-fertilizer represents about (1/4) of the amount of triple superphosphate fertilizer, but the composition and properties of nano-fertilizer have an effective role In its effect on the plant due to its high solubility, effective concentration and tight targeting of nanoparticles that allow it to deliver nutrients to specific and targeted sites in living systems, as well as its contribution to improving the photosynthesis process by increasing the content of chlorophyll and increasing the plant's ability to withstand stress (Rai et al., 2015) These results agreed with (Al-Shammari and Al-Ansari, 2022), (Hanon Mohsen et al., 2022), (Al-Juthery et al., 2022), (Burhan and Al-Hassan, 2019) and (AL-Abody et al. 2021). And (AL-shammary and Huthily, 2019) indicated increase growth parameters by adding nano-fertilizers, a The results showed that increasing the rates of phosphate fertilizer from 0 to 90 kg h^{-1} as triple super phosphate fertilizer and from 0 to 10 kg h^{-1} nano phosphate fertilizer an increase all growth vocabulary (Figures 1, 2, 3, 4 and 5). Phosphorous plays an important role in plant nutrition and providing energy for many vital processes as well as in the process of forming a strong radical group that contributes to increasing the absorption of elements, increasing growth and cell division. The results also showed that the increase of nano-phosphorous to 15 kg h^{-1} led to a decrease in all growth parameters, the results indicated the superiority of the IPA99 cultivar over the Jad cultivar Jad in the characteristics of CGR (Fig. 1), dry weight (Fig.2), phosphorus concentration in dry matter, figure (3), phosphorus uptake, figure (4).) as well as in the Phosphorous use efficiency, Fig. (5) for both sources of fertilizer, the inherency between the varieties under study in the height of the plant due to the additional gene, which This trait falls under its influence, which is due to the differences in their genetic factors .

Conclusion

The results showed the possibility of reducing the amount of phosphate fertilizer added to wheat plants using Nano-phosphate fertilizer to 1/4 of the added amount of triple super phosphate fertilizer without affecting productivity

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