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Response of wheat (Triticum aestivum L.) grown in calcareous soils to Nano-phosphate and triple super phosphate fertilizers

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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 rates of triple superphosphate fertilizer compared to Nano-phosphate fertilizer on the vegetative growth components of wheat (Triticum aestivum L.). Triple super phosphate fertilizer at rates 0, 30, 60 and 90 kg P ha-1 was applied to soil at planting, while Nano-phosphate fertilizer at rates 0, 5, 10 and 15 kg P ha-1 was added as a foliar on the plant at the stages of branching and elongation, Height of the plant and flag leaf area at the flowering stage, the number of days from planting to 50% heading, and from 50% heading to full maturity, and the dry weight of the plant was measured at the 50% heading stage. The results showed no significant differences in the studied traits (plant height, flag leaf area and The number of days from planting to 50% heading and from 50% heading to full maturity and dry weight) 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 rates from of 0 to 90 kg of triple superphosphate and from 0 to 10 kg of P ha-1 of Nano phosphate fertilizer led to an increase in growth parameters, but increasing Nano fertilizer to 15 kg of P ha-1 reduced in all growth parameters. The results also indicated the superiority of the Ibaa99 cultivar in the characteristics (plant height and number of days from planting to 50% heading and dry weight), while the Jad cultivar was superior in traits (flag leaf area and number of days from 50% heading to full maturity).

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, global production amounted to 778.52 million kg for the year 2022 (USDA,2022), while at the level of Iraq, the production rate reached 4234 thousand kg 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 Coenzymes (NADP, NADPH, NADH, FAD) and the participation of the nitrogen element in the processes of formation of DNA, RNA, phospholipids and phosphoproteins (almwsaly, 2018). Phosphorus added to the soil through chemical fertilizers subjected to fixation through processes adsorption and precipitation reactions (Zhu et al., 2018), which represent the biggest problems affecting the low availability of phosphorous in soil. Phosphorous fixation in Soil is affected by many factors, some related to the element and other related to soil properties such as ph , caco3 , mgco3 salinity, 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 their release into the soil by reduced fixation processes, thus reduced pollution causesr (Davari et al., 2017) Ditta (2016) and Chhipa (2017) reported incorporation of macronutrients such as nitrogen (N), phosphorous (P), potassium (K), sulfur (S), calcium (Ca) and magnesium (Mg) with nanomaterials increasing their availability to plant, Liu and Lal (2014) that adding nano-phosphorous instead of traditional phosphorous prevents its fixation in the soil and increases its availability to plant, Iqbal, (2019) reported that adding Nano-phosphate fertilizers to the soil leads to a reduction in the amount of traditional fertilizers added, which reduces Soil pollution as compared with rates

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of phosphate fertilizers. As a result of the lack of studies showing the role of Nano-fertilizers in the growth and yield of wheat crop 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 at agriculture college, university of basrah Al-Haritha district 30 km north of the centre of Basra governorate during the winter agricultural season of 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 some physical and chemical characteristics Table (1) where determined.

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	$g\ Kg\ soil^{-1}$
Caco3		28.00	
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

The study included using two sources of phosphate fertilizer: triple superphosphate (P20%) added at rates (0, 30, 60 and 90) kg ha-1 and Nano-phosphate fertilizer (P20%), produced by the Iranian-source Sepehr Parmes Company (P20%) at rates (0, 5, 10 and 15)) kg ha-1 applied as foliar on plant at branching and elongation stages with the addition of 15 kg P ha-1 when planting. The seeds of IPA-99 and Jad cultivars where planted in experimental plot (2*3) cm on 14-11-2021 at a seed average of 120 kg h^{-1} and irrigated immediately of the planting Each plate contains (10) lines 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 replicate and another. nitrogen fertilizer was (Urea) at rate of 180 kg/ha-1 (Al-Abdullah, 2015) was applied for all experimental plots, nitrogen was applied at three equal doses often emergence, tillering and the elongation stage. Potassium fertilizer (K_2So_4) at rate at 100 kg ha-1 was applied to all experimental plot at planting time. Periods (days) between emergency and 50% heading. 50% heading to maturity were recorded dry weight was measured at 50% heading, plant high and flag leaf area was measured at 100% flowering

leaf area = max leaf length x max width x 0.95 (Thomas, 1975).

The plant dry weight was obtained through selecting ten random plant sample from experimental plots then oven reed 70 c until the weight was stable, the experimental was used the randomized complete block design by factorial experiment method and use the t-test to compare between fertilizer sources.

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

S.O.V	Plant height		Flag leaf area		Number of days from planting to 50 % heading		Number of days from 50 % heading to full maturity		Dry Weight	
	LSD	M.S	LSD	M.S	LSD	M.S	LSD	M.S	LSD	M.S

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Varieties (V)	2.625	304.309	2.860	27.82	1.207	450.667	1.887	408.375	377.4	1412320.
P-Rate (P)	3.713	202.216	4.045	126.64	1.706	8.944	2.668	9.042	533.8	1829584.
V*P	5.251	0.653	5.720	0.69	2.413	0.556	3.773	0.375	754.9	8004.

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

S.O.V	**Plant height**		**Flag leaf area**		**Number of days from planting to 50 % heading**		**Number of days from 50 % heading to full maturity**		**Dry Weight**	
	LSD	**M.S**	**LSD**	**M.S**	**LSD**	**M.S**	**LSD**	**M.S**	**LSD**	**M.S**
Varieties (V)	3.343	228.23	3.437	0.22	1.255	459.375	1.778	384.000	374.3	2328151.
P-Rate (P)	4.728	122.07	4.861	53.45	1.775	5.597	2.515	5.000	529.3	1150123.
V*P	6.686	1.73	6.875	1.85	2.510	1.153	3.557	1.000	748.6	12129.

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

S.O.V	**significantly**
Plant height	N.S
Flag leaf area	N.S
Number of days from planting to 50 % spike	N.S
Number of days from 50 % spike to full maturity	N.S
Dry Weight	N.S

Results

Plant Height (cm)

The statistical analysis results in table 2 (a & b) that there was a significant effect of phosphorus of both sources on plant height, As it increased from 91.32 to 104.28 cm then phosphorous rates increased from 0 to 90 kg H-1 in the form of triple superphosphate for Iba99 cultivars Ibaa99, and from 84.75 to 96.21 cm For Jad cultivar Figure (1-a), the results also show that the maximum plant height appeared when Nano-fertilizer was added at the level of 10 kg H-1, As it increased from 91.32 to 101.37 cm for IPA99 and from 84.75 to 95.09 cm for jad, however increase Nano-phosphorous To 15 kg ha-1 to a decreased plant height to 100.29 and 93.12 cm for both cultivars Ibaa99 and jad respectively Figure (1-b). The results also indicated a significant effect of the cultivars, as the IPA99 cultivars superiority the Jad cultivar in plant height for both sources of fertilizer and for all rates of added phosphorous. The average plant height of the IPA99cultivars was 98.15 cm and 91.03 cm for the Jad cultivars in the treatment of triple superphosphate fertilizer Figure (1-a) while The average plant height of the cultivar IPA99was 97.63 cm and 91.46 cm 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

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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 plant height and for all added rates

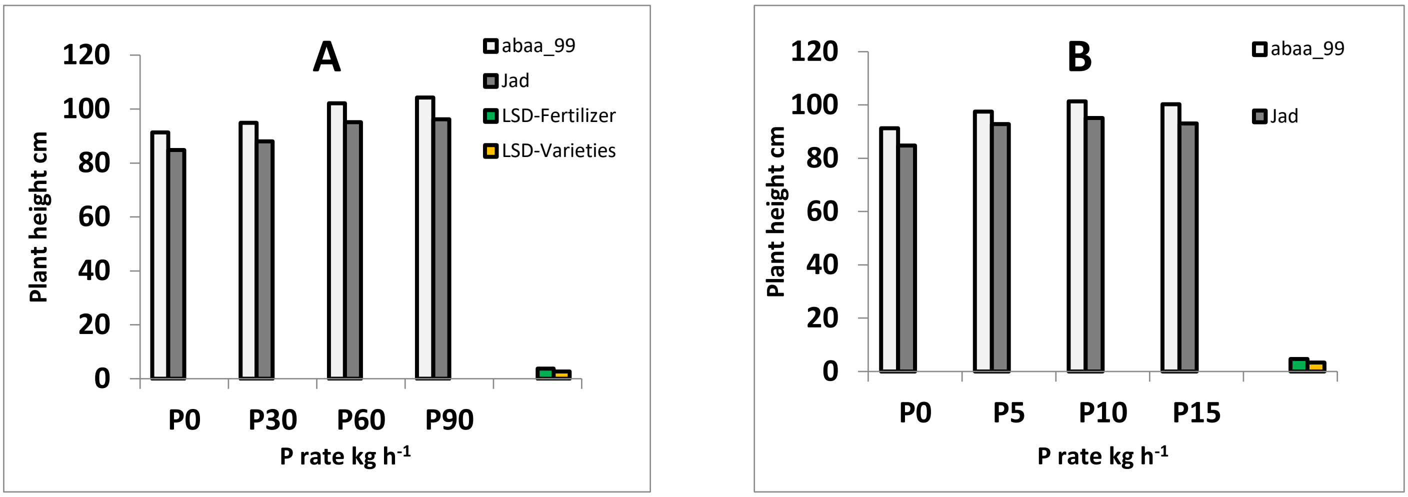

FIG. (1) Effect of Cultivars and phosphorus rates on height of wheat plant. A-triple supper phosphate B-Nano phosphate

Flag leaf area (cm^2)

The results of the statistical analysis in Table 2 (B-A) showed a significant effect of phosphorus of both sources in flag leaf area, as it increased from 36.77 to 47.92 cm2 when the added phosphorous rates increased from 0 to 90 kg H-1 in the form of triple superphosphate for the cultivars IPA99, and increased from 39.52 to 49.69 cm2 For Jad cultivars, Figure (2A-), the results also showed that the highest increase in the area of the flag leaf appeared when adding Nano-fertilizer at the level of 10 kg H-1, as it increased from 36.77 to 45.63 cm 2 for the cultivars Ibaa99 and increased from 39.52 to 46.26 cm 2 for the cultivars Jad, while an increase Nano-phosphorous added to 15 kg H-1 reduced the area of the flag leaf to 43.13 and 42.28 cm2 for both cultivars Ibaa99 and Jad, respectively (Fig. (2B-). The results also that the Jad cultivars outperformed the IPA99cultivars in the area of the flag leaf for both fertilizer sources and for all rates of added phosphorus. The average area of the flag leaf for the cultivars IPA99was 42.26 cm2 and 44.55 cm2 for the Jad cultivars in the treatment of triple superphosphate fertilizer (Figure 2A). -), while the average plant height of the cultivar IPA99was 41.82 cm2 and 42.31 cm2 for the cultivar Jad in the treatment of nano-fertilizer (Fig. (2B-). The results did not show a significant effect of interaction between cultivars and fertilizer exporters. The results of the T-test (Table 3) did not show significant differences between the two fertilizer sources in the area of the flag paper and for all added rates.

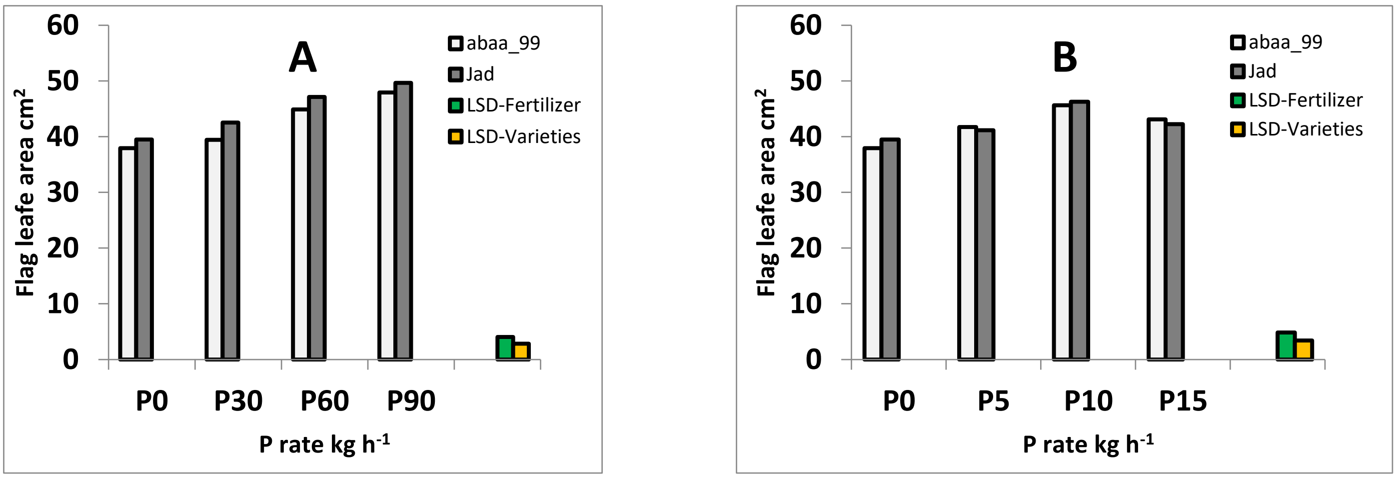

Fig. (3) Effect of Cultivars and phosphorus rates flag leaf area of wheat plant. A-supper phosphate B-Nano phosphate

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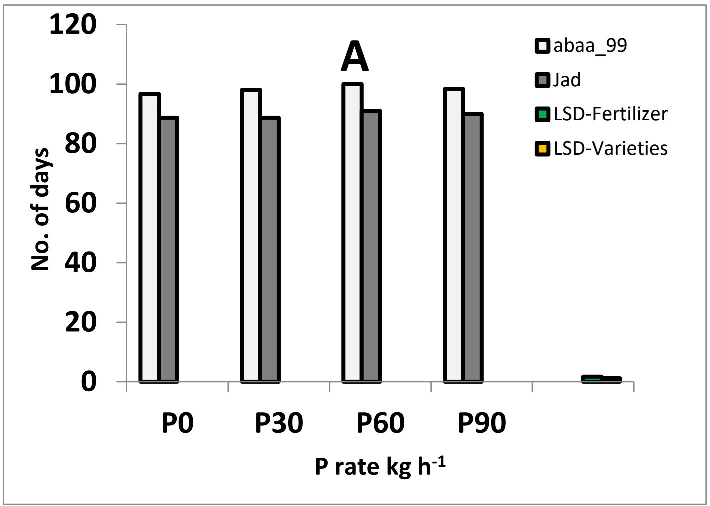
Number of Days to 50% heading

The results of the statistical analysis Table (B & A) 2) that there was a significant effect of phosphorus on the number of days from heading to 50% downturn, as it increased from 96.67 to 100.00 days when the added phosphorous rates increased from 0 to 60 kg H-1 in the form of triple superphosphate for the IPA99 cultivar, And from 88.67 to 91.00 days for the Jad cultivar (form A-3), and the results also show that the most number of days appeared when adding Nano-fertilizer at the level of 10 kg ha-1, as it increased from 96.67 to 100.00 days for the variety Iba_99 and from 88.67 to 90.00 cm for the jad cultivar, however increase Nano-phosphorous rate to 15 kg h^{-1} a decreased in the number of days to 97.67 and 89.33 days for both cultivars Iba_99 and jad, respectively (Figure B-3). The results also indicated the moral effect of the cultivars, as the Ibaa-99 variety outperformed the jad variety in the number of days from planting to 50% heading for both fertilizer sources and for all rates of added phosphorous. The average plant height of the Ibaa-99 variety reached 98.25 days and 89.58 days for the Jad variety in the treatment of triple superphosphate fertilizer. Figure (3A-) While the average plant height of the variety Iba_99 reached 98.08 days and 89.33 days for the Jad variety in the treatment of nano-fertilizer (Figure 3B-), the results did not show a significant effect of the interaction between the varieties and the two sources of fertilizer. 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 the number of days from planting to 50% heading and for all added rates.



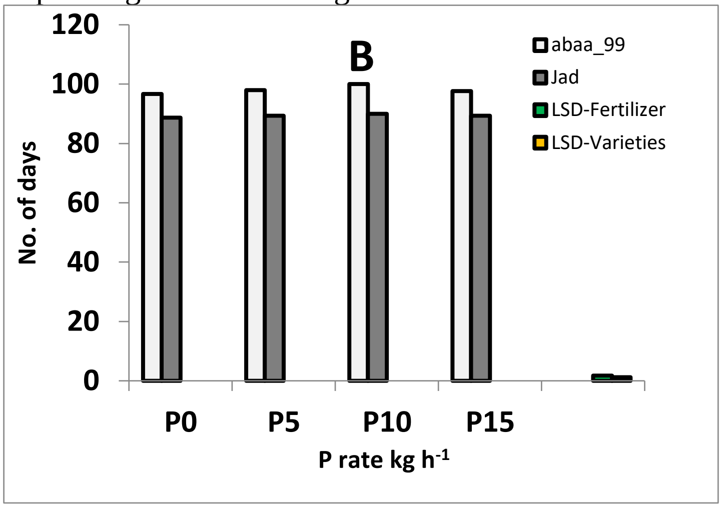


fig. (3) Effect of Cultivars and phosphorus rates Number of days from planting to 50% heading of wheat plant. A-supper phosphate B-Nano phosphate

Number of days from 50% heading to full maturity

The results of the statistical analysis in Table 2 (B&A) showed that there was no significant effect of increasing phosphorous rates on the number of days from 50% to full maturity, as it increased from 47.33 to 49.33 days when the added phosphorous rates increased from 0 to 90 kg H-1 triple superphosphate for the variety. IPA99, the results also recorded an increase from 55.00 to 58.00 days for the Jad cultivar Figure (4A-), and the results showed that the highest increase in the number of days from 50% heading to full maturity was when adding nano-fertilizer at the level of 10 kg ha-1, which increased from 47.33 To 49.00 days for the cultivar IPA99and an increase from 55.00 to 57.67 days for the Jad cultivar, while the increase of nano-phosphorous added to 15 kg H-1 led to a decrease in the number of days to 48.33 and 55.00 days for both cultivars IPA99and jad, respectively Figure (4B-) the results indicated the Jad cultivar outperformed the Ibaa-99 variety in the number of days from 50% heading to full maturity for both fertilizer sources and for all rates of phosphorus added. while the average number of days for the IPA99 cultivar was 48.17 days and 56.17 days for the serious variety in the treatment of nano-fertilizer Figure (4B-), while the results did not show a significant effect of the interaction between the varieties and the two sources of fertilizer, and the results of the T-test did not appear. Table 3) There are significant differences between the two sources of triple super phosphate fertilizer and Nano fertilizer in the number of days from 50% heading to full maturity and for all added rates.

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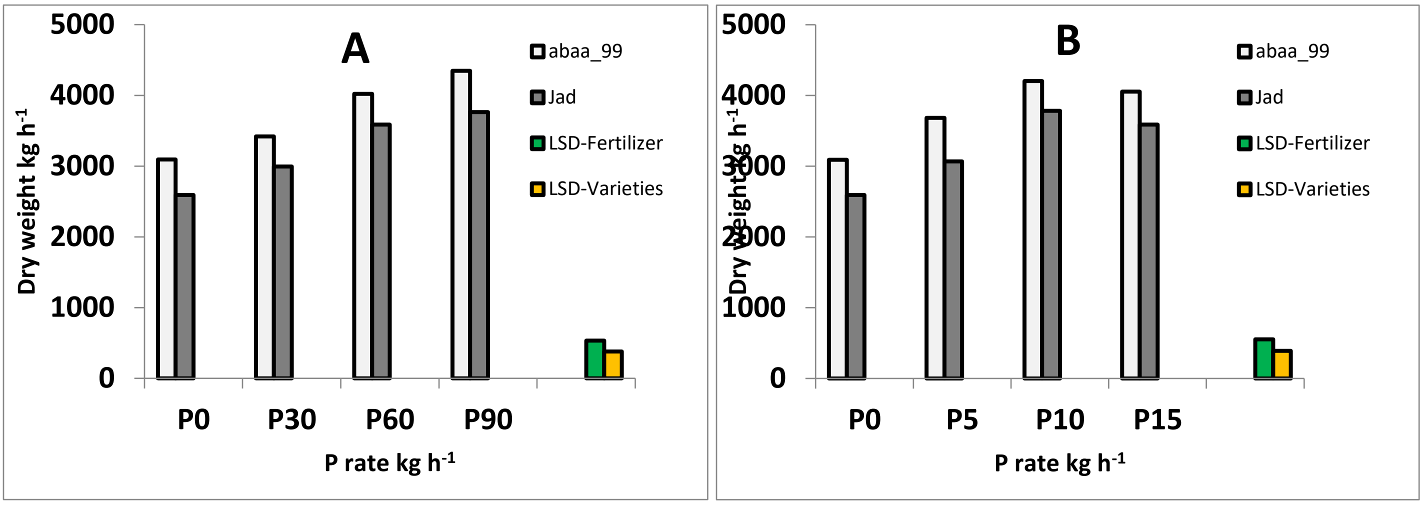

Fig. (4) Effect of Cultivars and phosphorus rates Number of days from50% heading to full maturityof wheat plant. A-supper phosphate B-Nano phosphate

Dry Weightu

The results of the statistical analysis in Table 2 (B&A) showed a significant effect of increasing phosphorous rates in the dry weight of the plant, as it increased from 3092.00 to 4345.00 kg ha-1 when the added phosphorous rates increased from 0 to 90 kg ha-1 triple superphosphate of the IPA99 cultivar, as recorded The results showed an increase from 2593.00 to 3762.00 kg ha-1 for the Jad cultivar (fig. 5-a), and the results showed that the highest increase in dry weight was when adding nano-fertilizer at the level of 10 kg ha-1, as it increased from 3092.00 to 4202.00 kg ha-1 for the IPA-99 cultivar as recorded an increase from 2593.00 to 3782.00 kg ha-1 for the Jad cultivar , while the increase of nano-phosphorous added to 15 kg ha^{-1} led to a decrease in the dry weight to 4055.00 and 3588.00 kg ha^{-1} for both cultivars IPA99 and Jad, respectively Figure (5) -b) The results also indicated that there was a significant effect of the cultivars, as the cultivar Iba_99 outperformed the cultivar Jad in the dry weight of the plant for both sources of fertilizer and for all rates of phosphorous added. The average dry weight of the IPA-99 cultivar was 3719.00 kg ha-1 and 3234.00 kg ha-1 for the Jad cultivar in Treatment of Triple Super Phosphate Fertilizer Form (A-5) The average dry weight of the IPA99 cultivar was 3758..00 kg ha-1 and 3258..00 kg ha-1 of the cultivar Jad in the treatment of nano-fertilizer (Fig. (5-b), while the results did not show a significant effect of the interaction between the cultivars and the two sources of fertilizer, and the results of the T-test did not appear. Table 3) There are significant differences between the sources of triple super phosphate fertilizer and nano fertilizer in the dry weight of the plant and for all rates added

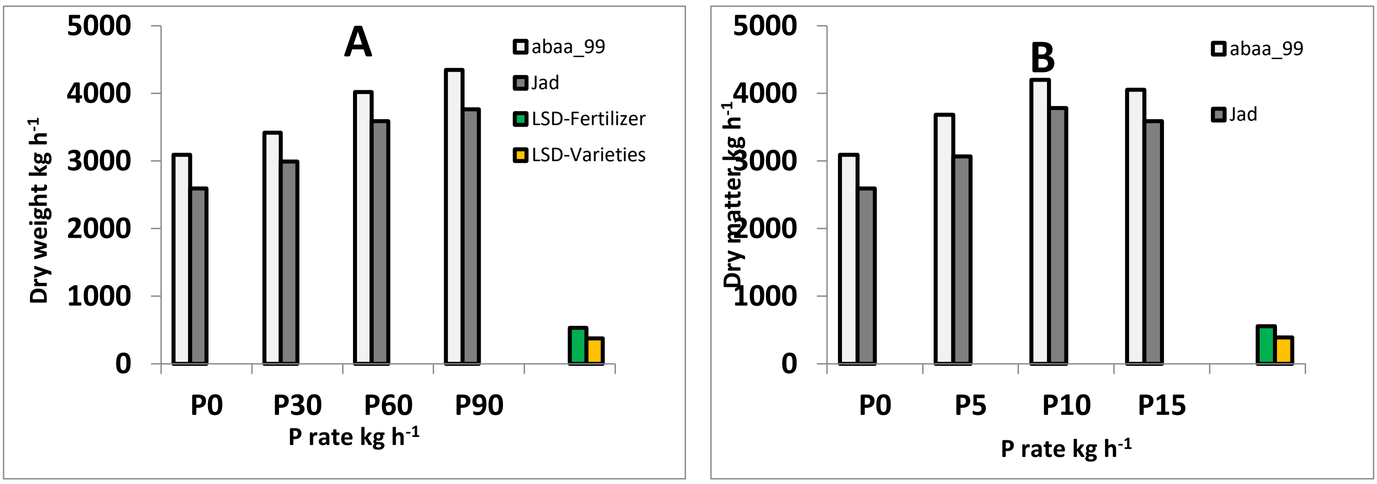

Fig. (5) Effect of Cultivars and phosphorus rates on dry plant weights of wheat plant . A-supper phosphate B-Nano phosphate

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Discussion

The results of the T-test Table (3) showed that there were no significant differences in plant height (Fig. 1), the area of the flag leaf (Fig.2), the number of days from planting to 50% heading, figure (3), and the number of days from 50% spike to full maturity, figure (4).) as well as in the dry weight of the plant at the stage of 50% heading, 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 plant height (Fig. 1) and the number of days from planting to 50% heading, Fig. (3) And the dry weight figure (5), while the Jad cultivar was higher in the characteristics of the number of days from 50% heading to full maturity (Fig. 4) and the area of the flag leaf (Fig. 2) 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 (Jaddoa etal, 2017) and the varieties differ in the area of the flag leaf and the number of days to reach the growth stages as a result of the variation in their ability to absorb nutrients and their thermal needs during the different stages of growth, which is due to the differences in their genetic factors (Anees et al, 2017), that the variety outweighs Iba_99 In dry weight, it may be the result of its superiority in plant height and its closeness to the Jad variety in the area of the flag leaf.

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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