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EVALUATION OF SOME PHOSPHATE FERTILIZERS ON PHOSPHORUS UPTAKE AND YIELD OF WHEAT IN TWO DIFFERENT TEXTURE SOILS

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ABSTRACT
This study was conducted to evaluate the use efficiency of three types of phosphate fertilizers (NP, DAP and TSP) on phosphorus uptake and the yield of wheat in two different texture soils. The study included an experiment (planting in plastic pots) in which five P levels of (0, 60,120, 180 and 240 Kg P_2O_5 ha^{-1}), three types of fertilizers and two soils, clay (S1) and Sandy loam (S2), were used. Wheat plant (*Triticum aestivum* L.) was used as a plant indicator. A factorial experiment, according to Complete Randomized Block Design (RCBD) with three replicates, was used. The results showed that all plant parameters significantly increased as the level of P applied increased from 0 to 240 Kg P_2O_5 ha^{-1}. The level 180 Kg P_2O_5 ha^{-1} showed higher straw, grain yield, total dry matter, P uptake, response percent and P use efficiency of 23.12, 6.84, 29.96 g pot^{-1}, 78.83 mg pot^{-1} ,50.14% and 40.51%, respectively. DAP was the best as compared with TSP and NP fertilizers and their P use efficiency were 47.85, 35.37 and 19.85% for DAP, TSP and NP respectively. The clay soil showed a superiority of increasing the plant indicators compared with the sandy loam soil. All plant parameters increased in clay soil in relative to sandy loam soil. Quadratic equation was the best for describing the relationship between P added of DAP and TSP fertilizers and all plant parameters while linear equation was the best for NP fertilizer.

KEYWORD: Fertilizer, fertilizer use efficiency, phosphorus, quadratic equation, P uptake

INTRODUCTION
Phosphorus is one of the major nutrients. All plants need large quantities for their role in the basic biological processes photosynthesis and respiration), cell formation, seed structure and contribution to the synthesis of energy compounds (ADP and ATP) RNA and DNA and cellular membranes and nucleic acids (Mengle and Kirkby, 1982; Salisbury and Ross,1985). This nutrient is second in importance to the plant and absorbed by the plants in the form of ionic is $H_2PO_4^-$ and HPO_4^{-2} and its appropriate content in the tissues of different plants is 0.2- 0.5% (Barker and Pilbeam, 2007; Fageria, 2009). The total content of phosphorus in the soil generally is between 200 - 5000 and an average of 600 mg kg^{-1} soil (Lindsay,1979) and its content is very limited compared to its total content and found that it is not more than 0.01% of its total content and its content available in the soil solution in general to 0.03 mg kg^{-1} soil (Havlin *et al*., 2005). The availability of phosphorus in the soil is affected by several factors including soil pH, carbonate minerals, clay type and content, soil erosion, organic matter, soil salinity (Baker and Pilbeam ; Samadi,2006). The low availability of phosphorus in different soil systems, especially calcite, is due to exposure to many reactions such as adsorption, sedimentation and stabilization by the carbonate minerals prevailing in them (McDowell *et al*., 2003). Because of the plant's need for large amounts of this nutrient and low of its availability, it is necessary to add phosphate fertilizers to achieve the appropriate level to get optimal production. The compounded phosphate fertilizers, especially DAP, NP and UP have increased their use recently in agricultural soils on different crops among Iraqi farmers and that these fertilizers vary in their chemical and physical properties, which in turn affect their ability to release the phosphorus of the plant and its efficiency in the process. Al-Saedy, (2000) indicated that the phosphorus release factor of MAP fertilizer increased by 8.8% compared to DAP fertilizer due to different chemical and physical properties of both fertilizers. (Khan *et al*., 2010), showed an increase in plant height, grain yield and straw of wheat plant when adding four phosphate fertilizers (SSP, TSP, NP and DAP, 92 and 183 kg P_2O_5 ha^{-1}). The fertilizer superiority at 183 kg P_2O_5 ha^{-1} was as follows: DAP <NP <TSP> SSP. In a study using three types of phosphate fertilizers, SSP, NP and DAP in the maize plant showed superiority of DAP and then SSP and NP in obtaining the highest yield of dry matter and grains (Amanullah *et al*., 2010). The results of the Al-Abdaily (2005) study showed that five levels of phosphorus, 0, 71, 179, 250, and 242 kg P_2O_5 ha^{-1} were added with three DAP, NP and TSP phosphate sources sources in two soils one clay and the other silty loam, The phosphorus level, 242 kg P_2O_5 ha-^{1} showed in an increase of 29.3, 60.4 and 174.4% for dry weight, length of plant and absorption of P in wheat plant for both cultivars respectively compared to control. Zahedifar (2011) noted that the level of 229 kg P_2O_5 ha^{-1} gave the highest value for dry matter and weight of 1000 grains and grain yield of wheat plant where it used three levels of phosphorus are 0, 115 and 229 kg P_2O_5 ha^{-1}.

Although there are some studies on the phosphorus availability of these fertilizers and their efficiency in plant growth, but these studies are still limited and did not receive these fertilizers a great deal of interest in Iraq as the focus on the fertilizer triple superphosphate (TSP). Therefore, the present study aimed to evaluate the two types of phosphate fertilizers (DAP and NP) in their phosphorus availability and their efficiency in phosphorus uptake and wheat plant yield compared to TSP fertilizers in different soil texture.

MATERIALS & METHODS

Two different texture soils were chosen and the samples of these soils were collected from the depth of 0 – 30 cm, the clay soil samples were collected from Abu Karak Township while the sandy loam samples were from the deposits of Tigris River in Hilla city. The samples were air dried, sieved through 2.0 mm sieve, and kept into big plastic containers. Some soil physical and chemical properties were evaluated according to (Jackson, 1958; Page *et al*., 1982) (table 1). A biological experiment was conducted including planting into plastic pots, carried out in the canopy of Soil Science and Water Resources Dept. – College of Agriculture, University of Babylon in the planting season of 2012 under atmospheric conditions to evaluate the use efficiency of three types of phosphate fertilizers (NP, DAP and TSP) on phosphorus uptake and the yield of wheat in two different texture soils The experiment included 5 levels of phosphorus: 0, 60, 120, 180, and 240 kg P ha^{-1} soil from NP (27:27) Di Ammonium Phosphate (DAP) (18% N, 46% P_2O_5) and Triple Super Phosphate (TSP) (46% P_2O_5). Pots of 5 Kg capacity were used, 5 Kg of both soils were weighted, and the grains of the wheat (*Triticum aestivum* L.) were planted as 10 grains per pot, reduced to 5 seedlings after 10 days of germination. Phosphorus fertilizers were added to the soil surface as a sold form. The water content was reserved at the field capacity. Nitrogen was added as 200 Kg ha^{-1} soil as urea (46% N) and potassium was added as 120 kg K_2O ha^{-1} soil as potassium sulfate, K_2SO_4 (42% K). The wheat was harvested at the final maturation (150 days after the planting) and dried under 65˚C for 48 h by the oven until weight stability. Phosphorus content in the straw and grains, were evaluated according to (Jackson, 1958). Response percentage and Fertilizer Use Efficiency (PUE) of phosphorus were calculated using the following formula (Tisdale *et al*., 1997).

TABLE 1. Soil chemical and physical properties

Property		Soil1	Soil2	Unit
pH		2.34	1.38	
ECe		7.13	7.72	dS m^{-1}
O.M		13.60	6.32	g kg^{-1}
Total $CaCO_3$		272.4	257.2	
Active $CaCO_3$		92.5	90.5	$Cmol_{+}kg^{-1}$
CEC		24.3	8.3	
Available nutrients	NH_4^+-N	54.30	25.10	mg kg^{-1}
	NO_3^--N	36.40	22.60	
	P_{Olsen}	9.73	4.95	
	K	230.0	176.0	
Particles size analysis				
Clay		733.0	89.0	g kg^{-1}
Silt		169.0	117.0	
Sand		98.0	794.0	
Texture		Clay	Sandy loam	

$$\text{Response percent} = \frac{\text{Total yield of fertilized treatment} - \text{total yield of control}}{\text{Total yield of fertilized treatment}} \times 100$$

$$\text{FUE} = \frac{\text{Uptake nutrient of fertilized treatment} - \text{uptake nutrient of control}}{\text{Nutrient added quantity}} \times 100$$

A factorial experiment was used according to Randomized Complete Block Design (RCBD) with three replicates. Regression equations were used to find the relationship between plant indicators and the added levels of phosphorus. Least Significant Difference (LSD) was used to compare the means of different treatments at 5% (Steel and Torrie, 1980).

RESULTS & DISUSSION

Straw, grains and total dry matter yield

The results (table 2 and 3) showed there were significant differences (at 5%) of straw, grains and total dry (TDM) yield among all added phosphorus levels. Increasing phosphorus levels of 60, 120, 180 and 240 kg ha^{-1} soil led to increasing straw yield of 45, 76, 112 and 88%, and grains yield of 45, 86, 151 and 138%, and TDM of 45, 78, 119 and 98% respectively, compared with control. The high response to previous plant indicators due to adding phosphorus attributed to decrement of both soils available phosphorus contents as well as the active role of phosphorus in the biological processes inside the plant and its contribution to the analysis of carbohydrates and its entry into the composition of energy-equipped compounds, cellular membranes and nucleic acids. It its contribution to the formation and division of cells and the number of branches (Mengle and Kirkby, 1982; Fageria, 2009). Obtained results agreed with those found by other studies (Al-Saedy, 2000; Sandana and Pinochet, 2014; Rami *et al*., 2015; Rusek *et al*., 2016). The level 180 kg P_2O_5 ha^{-1} achieved higher plant parameters means that the optimum level of phosphorus, which means the plant's needs and requirements, achieves the highest response. That the results obtained are consistent with the findings of several studies (Alam *et al*., 2005; Zahedifar *et al*., 2011; Rami *et al*., 2025). Khan *et al*. (2010) found an increase in the yield of straw and grain of wheat plants as the phosphorus levels increased from 0 to 92 and 183 kg P_2O_5 ha^{-1}, where the last level increased both indices by 143.0 and 168.3%, respectively, compared to control treatment. The effect of the fertilizer type was significantly higher in the plant indicators. The increase in straw yield was 77.5 and 12.6% in DAP compared to NP and TSP respectively, while the increase in grain yield was 41.7 and 14.35% and the total increase was 78.1 and 12.9% respectively. DAP fertilizer is superior to NP and TSP fertilizer due to its high solubility, dispersion and phosphorus supply to plants compared to other fertilizers (Al-Abdaily, 2005 ; Amanullah *et al*., 2010). Ali *et al*. (2012) found that DAP fertilizer was the most efficient, increasing the total grain yield and total plant yield by 5.4 and 9.0% compared to NP fertilizer.

Also, the results (table 2 and 3) showed the effect of soil texture on the yield of straw, grains and TDM which increased by 106.5, 178.9 and 119.8% in clay loam soil compared with the sandy loam soil, respectively. The first soil superiority in the increase of these indicators is due to the higher nitrogen and phosphorus content, as well as the higher exchange capacity, clay and higher organic matter compared to the second soil (Al-Saedy, 2000; Al-Abdaily, 2005).

TABLE 2. Effect type and level of phosphate fertilizer on straw and grain yield in both two soils

Soil	P Kg ha^{-1}	Straw (g pot^{-1}) NP	DAP	TSP	P level mean	Soil mean	Grain (g pot^{-1}) NP	DAP	TSP	P level mean	Soil mean
Clay	0	15.27	15.27	15.27	15.27		4.17	4.17	4.17	4.17	
	60	16.40	26.50	23.27	22.06		4.70	6.43	6.07	5.73	
	120	16.93	32.03	28.83	25.39	24.18	5.67	8.50	7.80	7.32	7.39
	180	17.80	38.77	34.10	30.22		7.43	13.00	10.07	10.17	
	240	18.67	33.70	29.87	27.41		8.80	11.00	8.90	9.57	
Fert.S1 mean		17.01	29.25	26.74			6.15	8.68	7.40		
Sandy loam	0	6.60	6.60	6.60	6.60		1.30	1.30	1.30	1.30	
	60	7.30	12.63	9.27	9.73		1.60	2.60	2.40	2.20	
	120	7.80	16.07	13.70	12.52	11.71	2.20	3.33	3.00	2.84	2.65
	180	8.10	20.97	18.97	16.01		2.50	4.23	3.80	3.51	
	240	8.80	17.07	15.17	13.68		2.80	3.80	3.63	3.41	
Fert.S2 mean		7.72	14.67	12.74			2.08	3.05	2.83		
Fert. Mean		12.37	21.96	19.50			4.12	5.84	5.11		
LSD 0.05											
Soil (S)		0.11					0.05				
Fertilizer (F)		0.13					0.07				
Level (L)		0.17					0.08				
S X F		0.19					0.09				
S X L		0.24					0.38				
F X L		0.30					0.46				
S X F X L		0.42					0.65				

Phosphorus Uptake

The results (table 3) showed a significant effect of the study factor (P level, fertilizer type and soil texture) on P uptake by plant. Increasing added phosphorus levels of 60, 120, 180 and 240 kg ha^{-1} led to increasing phosphorus uptake by plant of 88, 162, 273 and 263% respectively, for each P level compared with the control. According to the results, it could be observed that the third level (180 kg ha^{-1}) had superiority in achieving the higher phosphorus uptake by plant. The increase in the level of addition of phosphorus is due to increased its availability and increased its uptake in the plant and its contribution to the physiological processes within the plant (photosynthesis and respiration) and its introduction in the formation and maturation of seeds as well as the formation of a radical system that is efficient in absorbing water and nutrients, These results are consistent with Khan *et al*., (2010), Sandana and Pinochet, (2014) and Rami *et al*. (2015).The results (table 3) showed that the type of fertilizer significantly increased P uptake in plant by 117 and 26% with DAP compared with and NP and TSP respectively. The superiority of the first fertilizer is attributed to the other two fertilizers for their high solubility and its supply to phosphorus (Memon and Puno, 2005; Ali *et al*., 2012).

The results showed a significant effect of soil texture on phosphorus uptake by plant. The phosphorus uptake by plant had increased in clay soil of 246% compared with the sandy loam soil The first soil superiority over the second is due to the increase in these two indices due to increased nitrogen, phosphorus and clay content and the exchange capacity of positive ions and organic matter (Al-Saedy, 2000; Zheng *et al*., 2003; Yasin *et al*., 2007).

TABLE 3. Effect type and level of phosphate fertilizer on TDM and P uptake in both two soils

Soil	P Kg ha^{-1}	TDM (g pot^{-1}) NP	DAP	TSP	P level mean	Soil mean	P uptake (mg pot^{-1}) NP	DAP	TSP	P level mean	Soil mean
Clay	0	19.43	19.43	19.43	19.43	31.57	35.44	35.44	35.44	35.44	84.37
	60	21.10	32.93	29.33	27.79		42.18	85.78	62.17	63.38	
	120	22.60	40.53	36.63	33.26		51.39	112.71	92.26	85.46	
	180	25.23	51.77	44.17	40.39		60.38	165.36	133.56	119.77	
	240	27.47	44.70	38.77	36.98		69.21	158.35	125.90	117.82	
Fert.S1 mean		23.17	37.87	33.67			51.72	111.53	89.87		
Sandy loam	0	7.90	7.90	7.90	7.90	14.36	6.88	6.88	6.88	6.88	24.41
	60	8,90	15.17	11.67	11.91		10.16	23.44	15.34	16.31	
	120	10.00	19.40	16.70	15.37		14.56	35.78	25.38	25.24	
	180	10.60	25.20	22.77	19.52		18.84	53.03	41.84	37.91	
	240	11.60	20.87	18.80	17.09		22.92	46.92	37.36	35.73	
Fert.S2 mean		9.80	17.71	15.57			14.67	33.21	25.36		
Fert. mean		16.48	27.79	24.62			33.20	72.37	57.61		
LSD0.05											
Soil (S)		0.12					0.88				
Fertilizer (F)		0.14					1.08				
Level (L)		0.18					1.40				
S X F		0.20					1.53				
S X L		0.26					1.97				
F X L		0.32					2.42				
S X F X L		0.45					3.42				

TABLE 4. Effect type and level of phosphate fertilizer on response percent and PUE in both two soils

	P Kg ha^{-1}	Response (%) NP	DAP	TSP	P level mean	Soil mean	PUE (%) NP	DAP	TSP	P level mean	Soil mean
Soil	60	7.91	41.19	33.73	27.91	39.41	20.67	63.81	46.33	44.99	51.08
	120	14.00	52.05	46.95	37.61		26.27	67.96	48.09	46.06	
	180	22.98	62.46	55.99	47.15		34.15	83.98	67.24	61.79	
	240	29.24	56.53	49.87	45.21		35.19	71.19	48.07	51.49	
Fert.S1 mean		18.54	53.06	46.63			29.07	71.74	52.43		
	60	1.21	47.91	32.29	30.47	44.65	10.16	23.99	17.15	17.59	17.64
	120	21.00	59.28	52.70	44.32		10.28	25.62	20.57	19.55	
	180	25.47	68.65	65.30	53.14		10.46	27.78	21.58	19.22	
	240	31.90	62.13	57.97	50.67		11.62	18.48	13.95		
Fert.S2 mean		22.40	59.49	52.06			10.63	23.48	18.31		
Fert. Mean		20.47	56.28	49.35			19.85	47.85	35.37		
LSD 0.05											
Soil (S)		0.36					0.65				
Fertilizer (F)		0.44					0.80				
Level (L)		0.50					0.92				
S X F		0.62					1.13				
S X L		0.71					1.30				
F X L		0.87					1.59				
S X F X L		1.24					2.25				

Response percent and P use efficiency (PUE)

The results shown in Table (4) the effect of phosphorus level significantly in the response percent and PUE efficiency increasing added phosphorus levels of 60, 120, 180 and 240 kg ha^{-1} led to increasing response percent by 41, 73, 65% and PUE was 1.4, 27.3 and 3.2%, respectively. The increase in the response percent and PUE are due to the increased level of phosphorus in the soil, which has increased uptake in the plant, increasing its activity in the biological processes and supplying the energy needed to carry out these processes in the plant (Baker and Pilbeam, 2007). These results had agreed with Hossain and Sattar (2014) and Sandana Pinochet (2014).

The level 180 kg P_2O_5 ha^{-1} achieved higher response percent and PUE which represented the optimum level of wheat requirements to achieve maximum response under the conditions of current study. The obtained results had agreed with those of Al-Obaidi (2005) and Yosefi *et al*. (2011).

The results (table 4) showed that the fertilizer type had a significant effect on the response percent and fertilizer efficiency. The response percent in DAP 175 and 15% compared to NP and TSP, respectively while the PUE was 141 and 35% in DAP compared to NP and TSP fertilizers respectively. The fertilizer efficiency used in this study can be arranged as follows: DAP >TSP >NP. Al-Abdaily (2005) found that fertilizer was DAP is more efficient compared to TSP and NP as it showed the highest response percent and efficiency of fertilizer use in total yield of wheat plant. The results are also agreed with Amanullah *et al*. (2010), Khan *et al.* (2010) and Ali *et al.* (2012).

The results showed that the soil texture was significantly affected on the response percent and PUE. The highest response percent for the total wheat yield in sandy loam soil was 44.62%, whereas in clay soil it decreased by 39.41%. The response percent in sandy loam soil was 13.3% this is due to the low availability of sandy sand soil and the low content of clay, organic matter and CEC and that any addition of phosphorus through fertilizers leads to high response in the plant (Al-Saedy, 2005; Al-Arkawizi, 2010).

The PUE increased by 190% in clay soils compared to the sandy loam soil. The superiority of the first soil, compared with the second soil in fertilizer use efficiency was due to the highest availability of phosphorus, clay content and organic matter (Olsen and Watanabe, 1969).

Correlation Relationships

The results of the regression analysis (tables: 6, 7 and 8) showed a positive linear correlation between the level of addition of phosphorus to the NP fertilizer with the plant indicators in both soil table (5) and the highest correlation coefficient (r) were with the P uptake of (0.999) confirms that increasing the level of addition of phosphorus has increased its availability in both soil under study conditions, which contributed to increase its uptake in the plant and increase the indicators of the other plant and the response was a linear increase in a positive indicating that the release of phosphorus from NP fertilizer and supply of the plant did not supply the need of wheat plant even at the last level of the addition (240 kg P_2O_5 ha^{-1}) under the study conditions Current.

The results (tables: 7 and 8) showed a significant positive quadratic equation between the level of addition of phosphorus to DAP and TSP with plant indicators in both soil. These equations were the most efficient in describing the relationship between the addition of phosphorus to DAP and TSP compared with NP fertilizer. These relationships or response curves can predict the response of wheat plant to the added phosphorus as well as determine the optimal level to achieve the highest response and maximum plant yield. Many researchers have found such relationships (Fageria *et al.*, 2008; Alrashidi and Alrekani, 2010; Renata and Gorski, 2014).

TABLE 5. The relationship between plant parameters and P level of NP fertilizer according to the linear equation

Parameter	Clay soil		Sandy loam soil	
	Equation	r*	Equation	r
Straw yield	Y = 15.974 + 0.014X	0.706	Y = 6.680 + 0.0087X	0.992
Grain yield	Y = 3.756 + 0.020X	0.982	Y = 1.300 + 0.0065X	0.991
Total dry matter	Y = 19.124 + 0.034X	0.994	Y = 7.980 + 0.015X	0.996
P uptake	Y = 34.572 + 0.143X	0.999	Y = 6.520 + 0.068X	0.999
Response percentage	Y = 0.290 + 0.122X	0.997	Y = 5.760 + 0.111X	0.988
PUE	Y = 16.210 + 0.086X	0.966	Y = 9.490 + 0.0076X	0.877

*r value at 0.05 and 0.01 levels are 0.878 and 0.959

TABLE 6.The relationship between plant parameters (Y) and P level of DAP fertilizer according to the quadratic equation

Parameter	Clay soil		Sandy loam soil	
	Equation	R*	Equation	R
Straw yield	$Y = 14.92 + 0.23X – 6.21x\ 10^{-4}X^2$	0.985	$Y = 6.18 + 0.14X – 3.65x\ 10^{-4}X^2$	0.971
Grain yield	$Y = 3.70 + 0.06X – 1.21\ x10^{-4}X^2$	0.939	$Y = 1.26 + 0.03X – 1.35X^2$	0.988
Total dry matter	$Y = 18.64 + 0.29 – 7.44\ x10^{-4}\ X^2$	0.976	$Y = 7.42 + 0.16X – 4.29x10^{-4}X^2$	0.973
P uptake	$Y = 33.74 + 0.97X – 1.77\ x\ 10\text{-}3\ X^2$	0.983	$Y = 5.50 + 0.38X – 8.02x10^{-4}X^2$	0.979
Response percentage	$Y = 17.96 + 3.83X – 3.06X^2$	0.974	Y = 24.12 + 4.11X – 3.9X2	0.978
PUE	$Y = 41.13 + 3.67X – 3.15X^2$	0.794	$Y = 10.90 + 3.53X – 4.17X^2$	0.936

*R value at 0.05 and 0.01 levels are 0.878 and 0.959.

TABLE 7.The relationship between plant parameters (Y) and P level of TSP fertilizer according to the quadratic equation.

Parameter	Clay soil		Sandy loam soil	
	Equation	R*	Equation	R
Straw yield	$Y = 14.73 + 0.19X – 4.91x10^{-4}X^2$	0.980	$Y = 6.18 + 0.14X – 3.65x10^{-4}X^2$	0.930
Grain yield	$Y = 3.91 + 0.049X – 1.13X^2$	0.968	$Y = 1.26 + 0.03X – 1.35X^2$	0.513
Total dry matter	$Y = 18.63 + 0.23X – 6.02x10^{-4}X^2$	0.980	$Y = 7.42 + 0.16X – 4.29x10^{-4}X^2$	0.946
P uptake	$Y = 31.18 + 0.70X – 1.14x10^{-3}X^2$	0.975	$Y = 5.50 + 0.38X + 8.02x10^{-4}X^2$	0.961
Response percentage	$Y = 8.10 + 4.11X – 3.38X^2$	0.989	$Y = 24.12 + 4.11X – 3.39X^2$	0.994
PUE	$Y = 20.18 + 3.73X – 3.46X^2$	0.688	$Y = 10.90 + 3.53X – 4.17X^2$	0.973

*R value at 0.05 and 0.01 levels are 0.878 and 0.959.

CONCLUSIONS

DAP was the most efficient in increasing the phosphorus availability and increasing all the plant parameters compared with others phosphate fertilizers (NP and TSP) and the 180 kg P_2O_5 ha^{-1} level gave the highest value for all plant parameters.

REFERENCES

Al-Abdaily, R.S.A. (2005) Reactions of some phosphate fertilizers in calcareous soils and its effect on the growth of wheat plant MSc. Thesis Dept. of Soil and Water Recourses Sci. Coll. of Agric. & Forestry Univ. of Mousl. Mousl, Iraq.

Alam, S.M., Shah, S.A. and Iqabal, M.M. (2005) Evaluation of method and time of fertilizers application for yield and optimum P-efficiency in wheat. Songklanakarin J. Sci. Technol. 27(3), 457 – 463.

Ali, H., Srawar, N., Ahmed, S., Tariq, A. W. and Shahzad, A.N. (2012) Response of wheat crop to phosphorus fertilizers and application methods grown under agro-climatic conditions of Southern Punjab. Pak. J. Agri. Sci. 49(4), 485 – 489.

Alrashidi, S. and Alrekani, S. (2010) Effect of phosphate fertilizer and splitting on dry weight, phosphorus uptake in some growth stage for wheat *Triticum aestivum* L. with rain fed conditions. Al-Anbar Journal of Agricultural Sciences, 8(4), 128 – 138.

Al-Arkawizi, A.L.A. (2010) The effect of different levels from urea and super phosphate fertilizers in some yield components of wheat *Tritium aestivum* L. Diyala Agriculture Sciences Journal, 2 (2), 145 – 154.

Al-Obaidi, H.S.H. (2005) Efficiency of organo metallic phosphate compound in increasing extractable phosphorus on growth of wheat *Triticum aestivum* L. MSc. Thesis. Dept. of Soil and Water Recourses Sci. Coll. of Agric. Univ. of Baghdad. Baghdad, Iraq.

Al-Saedy, N.A.A. (2000) Behavior and efficiency of ammonium phosphate fertilizers in calcareous soils. MSc. Thesis. Dept. of Soil and Water Recourses Sci. Coll. of Agric. Univ. of Baghdad. Baghdad, Iraq.

Amanullah, Asif, M., Nawab, K., Shah, Z., Hassan, M., Khan, A. Z., Khalil, S. K., Hussain, Z., Tariq, M. and Rahman, H. (2010) Impact of planting density and P-fertilizer source on the growth analysis of maize, Pak. J. Bot. 42(4), 1349 2357.

Barker, A.V. and Pilbeam, D.J. (2007) Handbook of plant nutrition. Press, Boca Raton, FL.USA.

Fageria, N.K., Baligar, V.C. and Li, Y.C. (2008) The role of nutrient efficient plants in improving crop yields in the twenty first century. J. Plant Nutr. 31, 788 – 795.

Fageria, N.K. (2009) The Use of Nutrients in Crop Plants. CRC Press, Boca Raton.

Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, W.L. (2005) Soil Fertility and Fertilizers. An Introduction to Nutrient Management .Prentice – Hall, Inc., N.J.

Hossain, M.B. and Sattar, M.A. (2014) Effect of Inorganic Phosphorus Fertilizer and Inoculants on Yield and Phosphorus Use Efficiency of Wheat, J. Environ. Sci. & Natural Resources, 7(1), 75-79.

Jackson, M.L. (1958) Soil chemical analysis. Prentice-Hall, Inc., Englewood, Cliffs, N. J.USA.

Khan, M.B., Lone, M.I., Ullah, R., Kaleem, S. and Ahmed, M. (2010) Effect of different phosphatic fertilizers on growth attributes of wheat (*Triticum aestivum* L.). J. of American Science, 6 (12), 1256 – 1262.

Lindsay, W.L. (1979) Chemical Equilibria in Soils. John Wiley & sons. Inc., N.Y.

McDowell, R.W., Mahien, N., Brookes, P.C. and Poulton, P.R. (2003) Mechanisms of phosphorus solubilisation in a limed soil as a function of pH. J. Environ. Qual. 51, 685 - 692.

Memon, K.S. and Puno, H.K. (2005) Effect of different N and P levels on the yield and yield components of wheat variety pavan. Agric. Res. Station Dadu, Singdh, Pakistan. Indus. J. Plant Sci. 4, 273 -277.

Mengel, K. and Kirkby, E. (1982) Principles of Plant Nutrition. (Intern. Potash Inst., Bern, Switzer land.

Olsen, S.R. and Watanabe, F.S. (1969) Diffusion supply of phosphorus in relation to soil textural variation. Soil Sci. 110, 318 – 327.

Page, A.L., Miller, R.H. and Keeney, D.R. (1982) Methods of soil analysis. Part 2. Chemical and microbiological properties. Am. Soc. Agron. Madison, WI.USA.

Rami, H., Malik, S.S., Dhaliwal, S. S., Kumar, B. and Singh, Y. (2015) Growth and productivity of wheat affected by phosphorus-solubilizing fungi and phosphorus levels, Plant Soil Environ. 61(3), 122–126.

Renata, G.A.J. and Gorski, D. (2014) Effects of different phosphorus and potassium fertilization on contents and uptake of macronutrients (N, P, K, Ca , Mg) in winter wheat. I. Content of macronutrients, Journal of Central European Agriculture, 15(4), 169-187.

Rusek, P., Mikos-Szymanska, M., Karsznia, M., Sienkenkiewicz-Cholewa, U. and Igras, J. (2016) The effectiveness of nitrogen- phosphorus fertilization in winter wheat (*Triticum aestivum* L.) cultivation, Bulgarian Journal of Agricultural Science, 22(5), 752–755.

Salisbury, F.B. and Ross, C. W. (1985) Plant Physiology. Third edition (Wads worth Pub. Co. Belmont, California.

Samadi, A.A. (2006) Phosphorus sorption characteristics in relation to soil properties in some calcareous soils of Western Azarbaijan province. J. Agric. Sci. Technol. 8, 251 - 264.

Sandaña, P. and Pinochet, D. (2014) Grain yield and phosphorus use efficiency of wheat and pea in a high yielding environment, Journal of Soil Science and Plant Nutrition, 14 (4), 973-98.

Steel, R.G.D. and Torrie, J.H. (1980) Principles and procedures of statistics. McGraw-Hill, Inc., N.Y.

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. (1997) Soil Fertility and Fertilizers, Prentice. Hall of India, New Delhi.

Yasin, Y., Ranjha, A.M., Yasin, M. and Rashid, A. (2007) Application of Freundlich adsorption isotherm to determine phosphorus requirement of cotton crop on three different textured soils. Pak J. Agric. Sci. 44 (4), 557 - 562.

Yosefi, K., Galavi, M., Ramrodi, M. and Mousavi, S.R. (2011) Effect of bio–phosphate and chemical phosphorus fertilizer accompanied with micronutrient foliar application on growth, yield and yield components of maize. Australian Journal of Crop Science, 5(2), 175 – 180.

Zahedifar, M., Karimian, N., Ronaghi, A., Yasrebi, J., Emam, Y. and Moosavi, A.A. (2011) Effect of phosphorus and organic matter on phosphorus status of winter wheat at different part and growth stages. J. Plant Breed Crop. Sci. 3 (15), 401 - 412.

Zheng, Z., Parent, L.E. and Macleod, J.A. (2003) Influence of Soil texture on fertilizer and soil phosphorus transformations in gleyslioc Soils. Can. J. Soil Sci. 83, 395 - 403.