Effect of Super Phosphate Fertilizer Type on Yield and Yield Attributes of Wheat Plant Grown in Clay Soil

Hussein, Magda A. & Khater, M. A.*
Soil & Agriculture Chemistry Dept., Fac. of Agric. (Saba Bacha), Alexandria Univ., *Agronomy Dept., Fac. Of Agric., Damenhour, Alexandria Univ., Egypt.

ABSTRACT

Two field experiments were conducted at the Experimental Station, Faculty of Agriculture (Saba Bacha), Alexandria University at Abis region during 1/2002 and 2/2003 growing seasons of to study the effect of five phosphorus fertilizer rates (0, 7.5, 15, 22.5 and 30 Kg P_2O_5 / fed.) and two types of super phosphate fertilizer (fine powder and granular particle size 1-5 mm) on the growth, yield and its attributes, as well as soil available-P and P-content in leaves of wheat plants (sakha 8) grown in clay soil. The obtained results could be summarized as follows:

Increasing phosphorus rate from 0.0 to 30 Kg P_2O_5 / fed. caused significant increases in all characters in both seasons except plant height in the first seasons which was increased insignificantly, 1000-grain weight increased significantly with increasing P rate up to 15 Kg P_2O_5 / fed. in both season ,while grain yield increased significantly with increasing P rate up to 22.5 Kg P_2O_5 / fed in the first season and up to 15 Kg P_2O_5 / fed in the second season.

Types of super phosphate had a significant effect on all characters in both seasons, except plant height in the first season as well as number of spikes / m^2, number of grains / spike and 1000-grain weight in both seasons. Granular super phosphate was better than fine powder in affecting at all studied characters.

Available-P in soil and P-content in wheat leaves increased significantly with increasing the phosphorus fertilizer rates. Available-P decreased with increasing the age of plant, while P-content increased with increasing the age of plant in both seasons. A positive significant correlation between soil available-P at each particle size and P-content in the leaves of wheat plant at both seasons.

Generally the wheat plants grown in the clay soil responded to phosphorus application at each particle size (fine powder or granular particle size). The granular particle size was better than fine powder of super phosphate types due to the low surface area of the granular and reduces the sorption of P in soil.

INTRODUCTION

Phosphorus is considered essential nutrient for plant growth and productivity. It is a component of nucleic acid, nucleic protein and energy-rich compounds such as AMP, ADP, ATP through which plants store energy to carbohydrates and nitrogenous compounds and it is a part of certain coenzymes (Mengel and Kirkby, 1987). It is stated that, if the phosphorus supply to cereals is inadequate during early stages of development, a reduction in number of ears per unit area results and hence a depression in crop yield (Mengel and Kirkby, 1987). Application of P had a significant effect of available-P (Askar *et al.*, 1986 and Shams *et al.*, 1986) and P concentration in leaves (Hamissa *et al.*, 1984 and Askar *et al.*, 1986).

The grain yield increased significantly with increasing rates of P (Ahmed and Khan,1977) . Phosphorus rates significantly affected grain and straw yields, umber of spikes / m^2. Higher values for grain and straw yields were obtained om 30 Kg P_2O_5 / fed. (Hagras, 1985). Concerning the needs of wheat to P ertilizer in Egypt light texture soil areas, results of a few studies took places there showed a response by grain and straw yields as well as most of their attributes (El-Nagar *et al.,* 1989), Fayed, 1992 and Bassiouny *et al.,* 1993). Moreover, Abdul-Galil *et al.,* (1997) found that phosphorus fertilizer significantly increased wheat grain filling rate.

The present study was to evaluate the effect of several rates of P as super phosphate fertilizer with two different particle size on yield and its attributes of wheat grown in clay soil. In addition, the effect of P fertilizers on the soil available-P and P contents of wheat leaves were studied. Such information is necessary before recommending the best particle size of the super phosphate fertilizer.

MATERIALS AND METHODS

Two field experiments were conducted at Experimental Station, Faculty of Agriculture (Saba Bacha) Alexandria University at Abis region during 1/2002 and 2/2003 growing seasons using wheat plants (Var. Sakha 8) grown in clayey soil.

Soil physical and chemical characteristics were determined at the beginning of the growing seasons before application of phosphorous fertilizer. The analysis of soil samples collected from the plough layer (30 cm depth) was done according to the methods outlined by Page *et al.,* (1982) and the data are shown in Table 1.

Table 1. Initial physical and chemical properties of the soil used in field experiments for the two seasons

Soil properties	Values	
	1/2002 season	2/2003 season
Sand %	26.9	25.87
Silt %	31.7	30.60
Clay %	41.4	43.53
Soil texture	Clay	Clay
$PH_{(1:1)}$	8.46	8.53
$EC_{(1:2)}$ (dS m^{-1})	1.97	1.87
Total $CO_3^=$ %	8.92	8.86
Organic-C %	1.56	1.67
Available-K mg/Kg soil	374	387
Available-P mg/Kg soil	6.46	7.56

A split plot design with 3 replication was used. The main plots represent the phosphorus rates (0, 7.5, 15, 22.5 and 30 Kg P_2O_5 /fed.) as super phosphate (15% P_2O_5) were randomly. While, types of super phosphate fertilizer (fine powder or granular (1-5 mm)) were randomly assigned to the sub-plot. The super phosphate was mixed with the 30 cm top layer of the soil before planting. The area of the sub-plot was 2 x 3 m including 10 rows, 3m length and 20 cm apart. Wheat (*Triticum aestivum,* L) variety sakha 8 was grown at 15 and 19 November in the first and second seasons, respectively. All plots had received the recommended dose of 100 Kg N / fed. as ammonium nitrate (33.5 % N) and 50 Kg K / fed. as potassium sulphate (48 % K_2O) in two equal doses. The first dose was applied after (21 days from planting) and the second one was applied before the second irrigation. Wheat was harvested at maturity stage (15 and 19 April) in the first and second seasons, respectively.

Soil and plant samples were collected 3 times during the growth period (60, 100 days after germination and at harvesting) in both seasons. Available soil phosphorus was extracted with 0.5 M $NaHCO_3$ (pH 8.5) (Olsen and Sommers 1982) and P in the extract was analyzed colorimetrically (Murphy and Riley, 1962). Samples of plant leaves were dried in oven at 65 C and ground to pass a 40 mesh screen.. After digesting 0.5 gram sample in H_2SO_4 and H_2O_2 mixture (Lowther, 1980), P was determined colorimetrically (Murphy and Riley, 1962). Plant height (cm), spike length (cm), number of spikes /m^2, number of grains /spike, 1000 grain weight (gm), grain yield (ardab/fed.) and straw yield (ton /fed.) were determined at harvest.

The data were statistically analyzed according to Steel and Torrie (1982) and treatments means were compared by LSD at 5 % level. The correlation coefficient was made according to Snedcor and Cochran, (1967) using costat program.

RESULTS AND DISCUSSION

Results presented in Tables (2 and 3) show that the effect of phosphorus rates and super phosphate type on yield, yield attributes and P-content in leaves wheat as well as soil available-P for the two seasons.

A – Growth:

A.1 – Effect of phosphorus rates:

The results in Table (2) show that the effect of phosphorus rates on plant height of wheat plants. It is clear that addition P increased significantly the plant height in the second season due to the increase of P rates to 30 Kg P_2O_5 / fed. while, plant height was no significant effect in the first season. Hamissa *et al.,* (1984) found that the application of phosphorus at the rate of 30 Kg / ha. increased significantly the plant height of barley plants.

A.2 – Effect of super phosphate type:

The results in Table (2), clearly indicate that the super phosphate type significantly affect the plant height in the second season, while in the first season was no significant. The highest value of plant height was used granular super phosphate.

Table 2. Growth, yield and yield attributes of wheat plants as affected by phosphorus fertilizer rates and super phosphate type.

Treatments: Rates of P (P_2O_5 Kg/fed)	Treatments: Super phosphate type	Plant height (cm) 1/2002	Plant height (cm) 2/2003	Spike length (cm) 1/2002	Spike length (cm) 2/2003	No. of spikes/m² 1/2002	No. of spikes/m² 2/2003	No. of grains/spike 1/2002	No. of grains/spike 2/2003	1000-grain weight (gm) 1/2002	1000-grain weight (gm) 2/2003	Grain yield (ardab/fed) 1/2002	Grain yield (ardab/fed) 2/2003	Straw yield (ton/fed) 1/2002	Straw yield (ton/fed) 2/2003
Control		94.67	82.67	9.00	9.00	340.67	337.00	32.00	35.00	44.07	43.50	14.32	14.37	2.90	3.04
7.5	Fine	96.67	87.33	9.33	9.67	344.33	339.33	33.00	36.00	47.43	45.70	14.78	15.13	3.06	3.18
	Granular	97.67	90.00	10.00	10.33	346.00	341.67	33.67	37.33	48.33	47.33	15.59	16.30	3.21	3.23
Average		**97.17**	**88.67**	**9.67**	**10.00**	**345.17**	**340.50**	**33.33**	**36.67**	**47.88**	**46.52**	**15.19**	**15.72**	**3.14**	**3.21**
15.0	Fine	101.00	91.33	10.30	11.67	348.33	341.67	35.00	37.33	49.63	48.50	15.97	16.63	3.33	3.37
	Granular	101.67	100.00	11.60	12.00	351.00	345.33	35.33	38.00	52.30	52.00	17.39	18.02	3.40	3.41
Average		**101.33**	**95.67**	**10.95**	**11.83**	**349.67**	**343.50**	**35.17**	**37.67**	**51.12**	**50.08**	**16.69**	**17.33**	**3.37**	**3.39**
22.5	Fine	103.00	101.67	12.00	12.66	352.67	346.67	36.00	38.33	47.40	47.20	16.94	16.75	3.47	3.43
	Granular	103.33	104.33	13.00	13.66	354.67	347.33	36.67	38.67	46.63	46.26	16.95	16.53	3.52	3.47
Average		**103.17**	**103.00**	**12.50**	**13.17**	**353.67**	**347.00**	**36.33**	**38.50**	**47.02**	**44.83**	**16.95**	**16.64**	**3.50**	**3.45**
30.0	Fine	104.67	104.33	13.00	14.33	359.33	348.33	38.00	38.67	46.10	45.06	16.18	16.07	3.60	3.43
	Granular	106.00	105.67	14.00	14.67	361.00	350.33	39.33	39.00	45.06	44.70	16.15	16.03	3.63	3.58
Average		**105.33**	**105.00**	**13.50**	**14.50**	**360.17**	**349.33**	**38.67**	**38.83**	**45.58**	**44.83**	**16.17**	**16.05**	**3.62**	**3.51**
Average of type	Fine	100.00	93.47	10.73	11.47	349.07	342.60	34.80	37.07	46.99	45.99	15.64	15.79	3.27	3.29
	Granular	100.67	96.53	11.53	11.93	350.67	344.33	35.40	37.60	47.27	46.67	16.08	16.25	3.33	3.35
Statistical significant $LSD_{0.05}$															
Rates (R)		N.S.	7.480	1.566	2.529	7.332	6.655	2.091	1.971	1.084	1.999	0.678	0.557	0.104	0.123
Type (T)		N.S.	2.418	0.332	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.243	0.374	0.034	0.054
R x T		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.684	1.775	0.546	0.838	N.S.	N.S.

A.3 – Interaction effect:

The interaction between phosphorus rates and super phosphate type (R x T) in Table (2) show no significant effect on plant height in both seasons.

B – Yield and its attributes:

B.1 Effect of phosphorus rates:

Results presented in Table (2) indicate that each P increment resulted in a significant effect on spike length, number of spikes / m^2,number of grains / spike, 1000 grain weight, grain yield and straw yield in the both seasons. Increasing phosphorus rates from 0 up to 22.5 Kg P_2O_5 / fed. in the first season and up to 15 Kg P_2O_5 / fed. in the second season increased significantly the grain yield. Similar results were obtained by Gardner and Jackson (1976), Ahmed and Khan (1977), Garica and Torres (1978), Black (1982), Maxwell *et al.*, (1984) Hagras (1985) and Fiedler *et al.*, (1989).

B.2 – Effect of super phosphate type:

The results in Table (2) indicate that the super phosphate type significantly effect on spike length, grain yield and straw yield in both the seasons except, spike length in the second season. The result showed that the granular super phosphate was better than the fine material of super phosphate due to fact that the granular material reduce the surface contact between the particle of the fertilizer and soil particle which reduce the P fixation and increased available-P for plant uptake.

Phosphorus levels had a significant effect on straw yield in both seasons. Increasing P rates from 0 to 30 Kg P_2O_5 / fed. increased significantly straw yield. These results are in accordance with those obtained by Garica and Torres (1978), Black (1982) and Hagras (1985). Increasing P rates up to 30 Kg P_2O_5 /fed. increased significantly number of spikes / m^2 and number of grains / spike (Table 2). Similar results were found by Black (1982) and Hagras (1985). Results recorded in Table (2) reveled that increasing P rates from 0 to 15 Kg P_2O_5 / fed. significantly increased 1000-grain weight in both seasons.

B.3 – Interaction effect:

The effect of interaction between phosphorus rates and super phosphate type had a significant effect on 1000-grain weight and grain yield in the both seasons (Table 2). On the other hand, the (R x T) interaction effect in Table (2) show that spike length, number of spikes/m^2, number of grains/spike and straw yield were not affected by the tried P increments.

C – Soil available-P and P-content in leaves:

C.1- Effect of phosphorus rates:

Results of soil available-P and P-content in leaves of wheat during the growth different stages are presented in Table (3). Soil $NaHCO_3$-extractable P significantly decreased from 6.2 and 6.48 at 60 days after planting to 3.47 and 3.96 at 100 days after planting and to 2.56 and 2.70 ppm at harvest stage,

Table 3. Soil available-P and P-content in leaves of wheat as affected by phosphorus rate and super phosphate type.

Treatments		Available-P, mg/Kg soil						P-content in leaves (%)					
		60 days after planting		100 days after planting		At harvest		60 days after planting		100 days after planting		At harvest	
Rates of P (P_2O_5 Kg/fed)	Super phosphate type	1/2002	2/2003	1/2002	2/2003	1/2002	2/2003	1/2002	2/2003	1/2002	2/2003	1/2002	2/2003
Control		6.20	6.48	3.47	3.96	2.56	2.70	0.116	0.100	0.152	0.136	0.182	0.171
7.5	Fine	8.75	9.36	6.62	6.84	3.70	4.74	0.221	0.173	0.232	0.177	0.239	0.187
	Granular	12.38	13.38	7.26	7.55	5.55	6.35	0.236	0.196	0.233	0.217	0.264	0.245
Average		**10.57**	**11.37**	**6.94**	**7.20**	**4.63**	**5.55**	**0.228**	**0.185**	**0.233**	**0.197**	**0.252**	**0.216**
15.0	Fine	14.95	14.99	12.38	13.19	8.11	8.67	0.259	0.199	0.266	0.206	0.274	0.235
	Granular	15.59	16.28	14.95	15.00	10.03	10.24	0.294	0.258	0.325	0.260	0.352	0.271
Average		**15.27**	**15.64**	**13.66**	**14.09**	**9.07**	**9.45**	**0.276**	**0.229**	**0.295**	**0.233**	**0.313**	**0.253**
22.5	Fine	19.00	19.35	18.15	18.34	11.53	12.06	0.340	0.212	0.350	0.231	0.387	0.259
	Granular	22.42	22.93	21.14	21.31	19.00	16.47	0.351	0.267	0.365	0.294	0.411	0.330
Average		**20.71**	**21.14**	**19.64**	**19.83**	**15.27**	**14.27**	**0.346**	**0.240**	**0.357**	**0.263**	**0.399**	**0.294**
30.0	Fine	26.06	25.68	23.41	22.97	21.35	20.93	0.338	0.309	0.387	0.319	0.393	0.323
	Granular	26.79	27.49	24.45	25.79	22.14	24.07	0.408	0.325	0.430	0.374	0.434	0.372
Average		**26.42**	**26.59**	**23.93**	**24.38**	**21.75**	**22.50**	**0.373**	**0.317**	**0.409**	**0.333**	**0.414**	**0.348**
Average of type	Fine	14.99	15.17	12.80	13.06	9.45	9.82	0.255	0.226	0.277	0.220	0.295	0.235
	Granular	16.67	17.31	14.25	14.72	11.86	11.97	0.258	0.229	0.301	0.257	0.329	0.278
Statistical significant $LSD_{0.05}$													
Rates (R)		0.620	0.493	1.254	0.833	0.781	1.319	0.099	0.065	0.062	0.053	0.051	0.092
Type (T)		0.453	0.431	0.588	0.691	0.214	0.778	N.S.	N.S.	N.S.	N.S.	0.016	0.039
R x T		1.014	0.963	1.317	1.546	0.478	1.742	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

respectively for the soil without P application (control) in the both seasons, respectively. Similar trend was found in the soil treated with P at the rates of 7.5, 15, 22.5, 30 Kg P_2O_5 / fed. This decrease in soil available-P could be attributes to either plant uptake or the conversion of P to less soluble compounds. More P was removed in soil with less initial available-P i.e. in the first season removal of P were 2.56, 4.63, 9.07, 15.27 and 21.75 ppm, at harvest when P applied to the soil at the rates of 0, 7.5, 15, 22.5 and 30 Kg P_2O_5 / fed. The corresponding values in the second season were 2.7, 5.55, 9.45, 14.27 and 22.5 ppm. Olsen *et al.*, (1954) reported that 10 ppm was the critical P level for wheat in natural soil. This result could indicate that more P response obtained with soils which have initial low available-P at the high P application rates. This result sustains those recorded by Shams *et al.*, (1986). Soil available-P was increased significantly with increasing P rates increased. This result agreement with Shams *et al.*, 1986, Askar et al., 1986 and Tara et al., 1999).

Results in Table (3) show also that, P concentration in leaves increased significantly with applied P at 60, 100 days after planting and at harvest and with increasing P rates in the both seasons. Similar result was found by Askar *et al.*, (1986). The concentration of the P in leaves may be a good indicator of soil P status if these processes are operating in parallel manner.

C.2 – Effect of super phosphate type:

Results in Table (3) show the available-P in soil increased significantly by increasing P rates as granular super phosphate after 60 and 100 days from planting and at harvest. At harvest, P-content in wheat leaves increased significantly by increasing P rates as granular super phosphate, while P-content in leaves increased insignificantly by increasing P rates as granular super phosphate after 60 and 100 days from planting in both seasons. This trend was reported by others Walter *et al.*, (1985). This could be explained on the basis, that P added as granular material, may affect P-sorption reaction in soils. Khadr *et al.*, (1984) showed that low surface area of the granular P material reduces the sorption of P in soils.

C.3 – Interaction effect:

The effect of interaction between phosphorus rates and super phosphate type had a significant effect on available-P in soil at 60, 100 days after planting and at harvest in the both seasons. While the interaction effect between P rates and super phosphate type in Table (3) were without significant effect on P-content in leaves of wheat.

D – Correlation study

Grain yield response to P rates was used to generate regression response equations under each particle size (Table 4). These equations can be used to determine the P rate that would have to be supplied to produce the same grain yield at each particle size application in similar soil conditions.

When polynomial equations express the relationship between the grain yield and the applied rates of P, Balba and Ali Balba (1975) used to compare the rectilinear slopes of the polynomial equations to evaluate the relative efficiency of that nutrient as affected by variable growth conditions. If the linear slopes were compared for evaluating the efficiency of P applied under fine particle size and granular particle size, the results will be as follows, 1.0 : 1.72 = 0.18 : 0.31 in the first season and1.0 : 1.57 = 0.23 : 0.36 in the second season.

Table 4. Regression models describing the relationship of P applied rate with grain yield in both seasons

Super phosphate type	Regression equation (Y = grain yield/fed X = P applied rates)	r
	Season 2001 / 2002	
Fine super phosphate	$Y = 14.082 + 0.18\,X - 0.003\,X^2$	0.870
Granular super phosphate	$Y = 14.16 + 0.31\,X - 0.008\,X^2$	0.658
	Season 2002 / 2003	
Fine super phosphate	$Y = 14.12 + 0.23\,X - 0.005\,X^2$	0.779
Granular super phosphate	$Y = 14.39 + 0.36\,X - 0.010\,X^2$	0.431

Soil available-P was linearly correlated with the P applied rate for the different particle size. This relationship is expressed by simple regression equations and presented in Fig. 1. The available-P with each particle size was positively correlated with P applied rate. The comparison of the equations slopes gives a quantitative expression for the efficiency of P at the particle size. The efficiency of P granular particle size increased to 1.16 % as compared with the efficiency at the P fine particle size in the first season and 1.21 % in the second season. It could be concluded from these results that the efficiency of P applied for increasing available-P was increased as the granular particle size used.

The relationship between P content in leaves and P applied was expressed by a straight line equation at each the particle size (Table 5). A significant positive relationship was found between P leaves content and P applied rates at two particle size. The comparison of the slopes of the two equations gives a quantitative expression of the efficiency of P at the different particle size. The efficiency of P granular particle size increased 1.18 % as compared with the efficiency of fine particle size in the first season and 1.20 % in the second season.

Table 5. Simple regression equations for relating the P content of leaves with P applied rate in two seasons

Super phosphate type	Regression equation (Y = P-content in leaves X = P applied rates)	r
	Season 2001 / 2002	
Fine super phosphate	$Y = 0.181 + 0.0076\,X$	0.971^{**}
Granular super phosphate	$Y = 0.198 + 0.009\,X$	0.980^{**}
	Season 2002 / 2003	
Fine super phosphate	$Y = 0.160 + 0.005\,X$	0.980^{**}
Granular super phosphate	$Y = 0.180 + 0.006\,X$	0.991^{**}

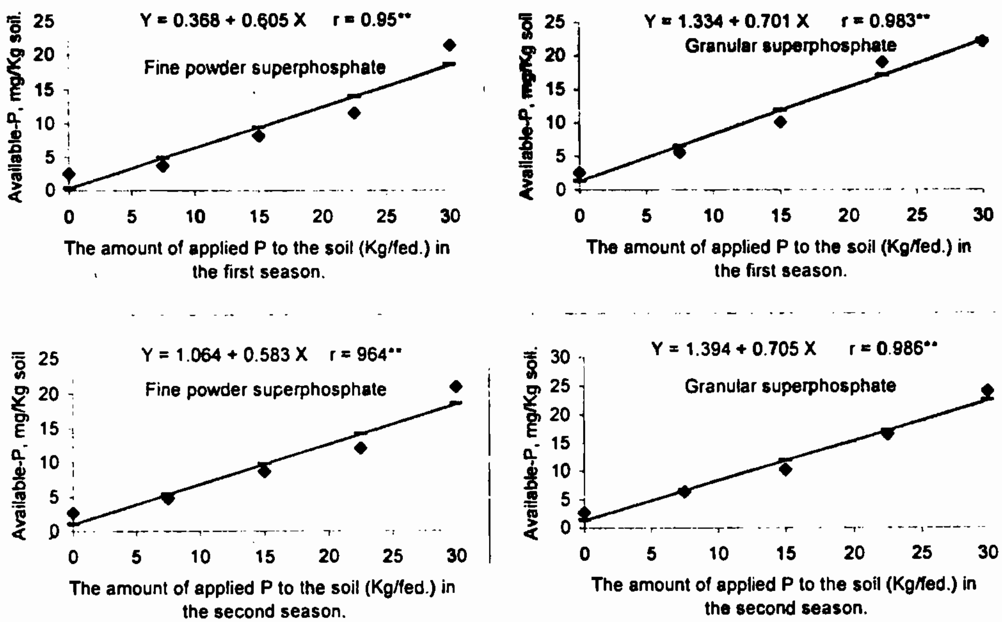

Fig.1:The effect of P application on available-P in soil at harvest for the two type of superphosphate.

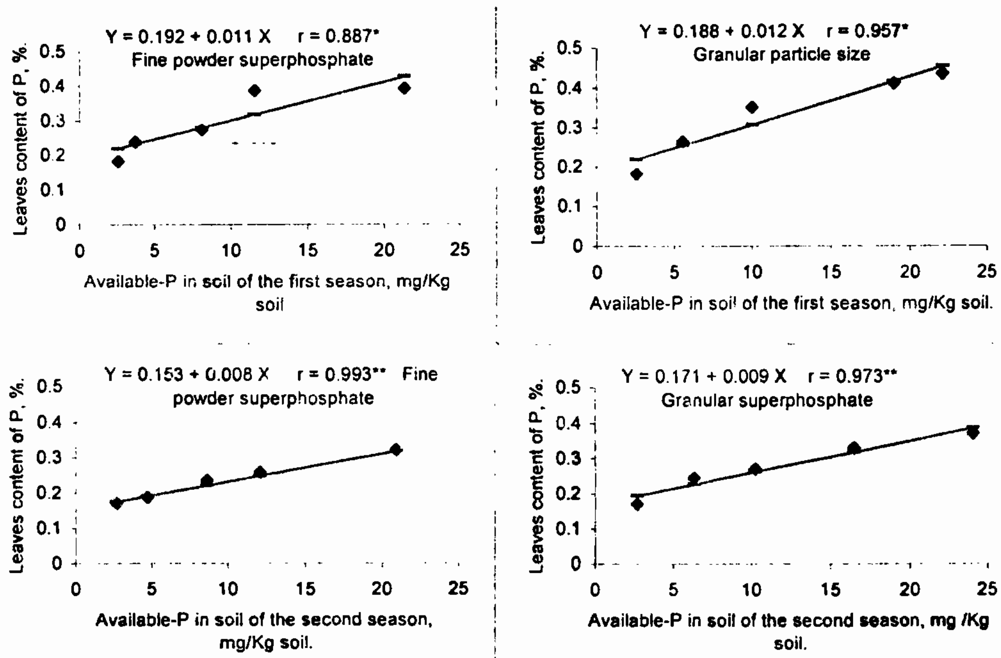

Fig.2:The relationship between leaves content of P with soil available-P for the types of superphosphate

The relationship between P content and available-P with both particle size was evaluated (Fig. 2). The r values obtained for the linear relationship between leaves P content and available-P with fine particle size were 0.887 * and 0.993** in both seasons, respectively, while granular particle size 0.957** and 0.973** in two seasons, respectively.

Generally the wheat grown in the clay soil responded to phosphorus application using the two types of super phosphate (Fine or granular particle size), The granular super phosphate was better than the fine powder of super phosphate due to the fact that low surface area of the granular particle size reduce the sorption of P retension in soil.

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الملخص العربي

تأثير نوع سماد السوبر فوسفات على محصول ومكونات محصول القمح النامي في أرض طينية

ماجدة أبوالمجد حسين و ماهر عوض الله خاطر*
قسم الأراضي والكيمياء الزراعية-كلية الزراعة-سابا باشا- جامعة الإسكندرية
*قسم المحاصيل-كلية الزراعة-دمنهور-جامعة الإسكندرية

أقيمت تجربتان حقليتان في محطة التجارب الزراعية بكلية الزراعة (سابا باشا) – جامعة الإسكندرية بمنطقة أبيس خلال موسمي ٢٠٠١/٢٠٠٢ و٢٠٠٢/٢٠٠٣ لدراسة تأثير معدلات التسميد الفوسفاتي (٠ ، ٧,٥، ١٥، ٢٢,٥ و٣٠ كجم فو٢أ٥ / فدان) و نوعين من سماد السوبرفوسفات (الناعم والمحبب الذي تتراوح حجم حبيباته بين ١ – ٥ مم) على نمو ومحصول القمح صنف سخا ٨ والفسفور المتاح في التربة ومحتوى أوراق القمح من الفسفور وذلك لصنف القمح سخا ٨ وكانت النتائج المتحصل عليها كالتالي:-

١. زادت معنويا كل الصفات في كلا موسمي الزراعة عند زيادة معدلات الفسفور من صفر إلى ٣٠ كجم فو٢أ٥ /فدان ماعدا طول النبات في الموسم الأول وكان وزن ١٠٠٠ حبة زاد معنويا بزيادة معدلات الفسفور حتى ١٥ كجم فو٢أ٥ / فدان في كلا موسمي الزراعة، بينما زاد معنويا محصول الحبوب بزيادة معدلات الفسفور حتى ٢٢,٥ كجم فو٢أ٥ /فدان في الموسم الأول و ١٥ كجم فو٢أ٥ في الموسم الثاني.
٢. أثر حجم حبيبات السوبرفوسفات معنويا على كل الصفات في كلا موسمي الزراعة ماعدا طول النبات في الموسم الأول وعدد السنابل / م٢ وعدد الحبوب / سنبلة ووزن ١٠٠٠ حبة في الموسم الثاني. وقد أثبتت التجربة أن السوبرفوسفات المحبب أفضل من السوبرفوسفات الناعم لكل الصفات تحت الدراسة.

٣. زاد الفسفور المتاح في التربة ومحتوى الأوراق من الفسفور زيادة معنوية بزيادة معدلات التسميد الفوسفاتي كما اتضح من التجربة أن الفسفور المتاح في التربة قل بزيادة عمر النبات بينما زاد محتوى الأوراق من الفسفور بزيادة عمر النبات وذلك في كلا موسمي الزراعة.

٤. وجد ارتباط إيجابي معنوي بين الفسفور المتاح في التربة لكل من السوبر فوسفات الناعم والمحبب ومحتوى الأوراق من الفسفور في كلا موسمي الزراعة.

٥. اتضح أن نباتات القمح النامية في تربة طينية تستجيب للتسميد الفوسفاتي عند استخدام السوبرفوسفات (الناعم والمحبب) ويفضل استخدام السوبرفوسفات المحبب عن السوبرفوسفات الناعم وذلك بسبب انخفاض مساحة السطح مما يقلل من تثبيت الفسفور في التربة.