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EFFECT OF PHOSPHATE ROCK AND TRIPLESUPERPHOSPHATE ON GROWTH AND LEAF N, P AND K CONTENTS OF GROUNDNUT (*ARACHIS HYPOGAEA* L.) GROWN ON A CLAY SOIL

[18]

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ABSTRACT

A pot experiment was carried out to investigate the agricultural value of a local phosphate rock (PR) as a source of plant phosphorus compared with that of the currently imported triplesuperphosphate (TSP) .The PR was applied at the rate of 0, 55, and 110 kg P_2O_5 /ha and the TSP was at the rate of 0, 45 and 90 kg P_2O_5 /ha. The growth and leaf contents of N, P and K of groundnut (*Arachis hypogaea* L.) grown on a clay soil were measured. The experiment continued for two seasons. Phosphatic fertilizers are of low recovery; therefore, they can remain for the next crop. Thus, the pots of the first season were set to study the residual effect of phosphorus in the second season. The results indicated that PR and TSP significantly (P>0.05) increased dry weights of shoot and root, leaf contents of N , P and available soil phosphorus. However, plant height was significantly increased by TSP only. The leaf content of K was neither affected by PR nor TSP application. The results showed a positive effect of the residual PR and TSP on the measured parameters. Moreover, the results revealed that the plant measurements obtained from PR treatments were comparable to those obtained from TSP treatments which indicate that PR can be used as a potential source of phosphorus fertilizer.

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INTRODUCTION

Phosphorus is an essential element in plant nutrition. It is often deficient and of low solubility and, therefore, it has to be added as a fertilizer. In Sudan, with a possible exception of nitrogen, phosphorus is the main limiting factor in crop production **(El Saeed 1997)**. This was the concern of many research workers in Sudan who pointed out the good response of crops to phosphorus addition **(El Tilib *et al* 2003)**. Phosphate rock (PR) is the base for the production of all water soluble phosphorus fertilizers. Finely ground PR ore had been applied directly to the soil as a low-cost fertilizer as an alternative of the water soluble phosphate fertilizers where indigenous deposits of PRs ore located. Phosphorus fertilizers normally have a high carry over effects from one year to the next. Regarding this, residual effect of PR was studied by many workers **(Abdalla 1993 and El Saeed 1997)**.

In Sudan, groundnut is produced on large areas under rainfed and irrigation systems. Mostly, the crop is not fertilized in spite of the inherently low soil fertility in terms of nitrogen and phosphorus. However, experiments conducted in different parts of the country gave an erratic and inconsistent results **(Hago, Personal Communication, 2005)**. Triplesuperphosphate, as a source of phosphorus in Sudan agriculture, is an imported commodity, hence, it is expensive. It is, therefore, necessary to try a local and cheaper source of phosphorus. This study was meant to try a local phosphate rock as source of plant phosphorus. Phosphate Rock is present in different parts of Sudan in considerable amounts, particularly, in Nuba Mountains "Kurun", Western of Sudan (**Abdalla 1993**). The aim of this work was to determine the effect of PR and TSP and their residual effect on growth and N, P and K leaf contents of groundnut (*Arachis hypogaea* L).

MATERIALS AND METHODS

Pot experiments were carried out at the Faculty of Agriculture, University of Khartoum, Shambat (latitudes 15° 40′N; longitude 32° 32′E) for two summer seasons (2001 and 2002) to examine the effect of PR and TSP on growth and leaf N, P and K contents of groundnut (*Arachis hypogaea* L)grown on Shambat clay soil. Along with this, another experiment was conducted in the second season (2002) to study the residual effect of the applied phosphatic fertilizers of the first season. Surface samples of Shambat soil, (0-30cm) were used in this study. The physical and chemical properties of the soil used were as follows: pH = 8.1; ECe= 0.52 dSm^{-1};K= 0.1 meq/l ; P= 3.3 ppm; N= 0.056%; clay =54.1%. Plastic pots (33 cm diameter and 23 cm deep) were used as experimental units and each pot was filled with 10 kg soil. Uniform size seeds of groundnut cultivar MH 383 were sown in the first week of July in all growing seasons. Five seeds were sown in each pot, and, then thinned to two plants per pot after two weeks from sowing. The treatments were arranged in a factorial completely randomized design replicated thrice. The treatments comprised three PR levels (0, 55 and 110 kg P_2O_5 /ha) and three TSP levels (0, 45, and 90 kg P_2O_5 /ha).The local PR used in this study was collected from Jabel Kurun in the Nuba Mountains, South Kordofan State, Western Sudan. The two phosphatic fertilizers were applied at sowing by band method. Seedlings were either inoculated or uninoculated with *Bradyhizobium sp.* strain TAL 1371 obtained from NIFTAL project in Hawaii, U.S.A. The pots were irrigated with tap water at 60% field capacity every three days. Plants were harvested on the third week of November of each growing season. The parameters measured were plant height, shoot and root dry weights. Leaf mineral contents of N, P, K and available soil phosphorus were determined according to procedures described by **Tandon (1993)**.

RESULTS AND DISCUSSION

Application of *Bradyhizobium sp.* showed no significant effect on all measured parameters (data not shown). The results of this study showed that the plant height was significantly increased (P>0.05) by addition of TSP in both seasons (**Table 1**). Plant height is an important growth factor. **Hago *et al* (2002)** reported similar effects for phosphorus fertilizers on Roselle (*Hibiscus sabdariffa* var. *sabdariffa* L.). This could be attributed to the positive effect of water soluble phosphatic fertilizers on plant photosynthesis and, hence, plant height. The effect of PR addition on plant height was not significant (**Table 1**) .This may be due to the relatively low solubility of the phosphorus in PR and, hence, the phosphorus level in the root sorption zone is low, particularly, in early growth stages. It may also be attributed to the low development of plant compared with its rapid growth when soluble form of phosphorus is applied (**Hammond *et al* 1986**). There were no significant differences between the overall effect of PR and TSP on plant height.

Table 1. The effect of phosphate rock and triple-superphosphate on plant height (cm)

Treatment kg P_2O_5 ha^{-1}	First season	Second season	Residual effect
	Phosphate Rock (PR)		
Control	15.3a	13.7a	13.8b
55	15.1a	14.0a	14.6a
110	15.4a	14.0a	18.4a
$LSD_{0.05}$	0.81	0.59	0.71
	Triplesuperphosphate (TSP)		
Control	14.2b	13.2b	13.5c
45	15.8a	14.0a	14.4b
90	16.0a	14.4a	15.2a
$LSD_{0.05}$	0.81	0.59	0.17

Means with similar letter(s) in each column are not significantly different at 0.05 probability level according to LSD.

Application of PR and TSP significantly (P>0.05) increased shoot and root dry weights in both seasons **(Table 2)**. The positive effect of PR and TSP on shoot and root dry weights were reported by many workers **(Hago & Osman 1999; Hago *et al* 2002 and Osman *et al* 2002)**. Shoot and root dry weights, which are ultimate produce of plant height and branch number, were increased with phosphorus fertilizers.

Table 2. The effect of phosphate rock and triple-superphosphate on shoot dry weight (S.D.W) and root dry weight (R.D.W) (g/pot)

Treatment	First season		Second season		Residual Effect	
Kg P_2O_5 ha^{-1}	S.D.W	R.D.W	S.D.W	R.D.W	S.D.W	R.D.W
			Phosphate Rock (PR)			
Control	29.0b	0.76c	23.8b	0.64b	26.8	0.66b
55	29.80a	0.81b	26.5a	0.67a	29.5a	0.73a
110	29.9a	0.87a	26.6a	0.67a	30.1a	0.73 a
$LSD_{0.05}$	0.74	0.06	2.30	0.03	1.8	0.64
			Triplesuperphosphate (TSP)			
Control	28.7b	0.75b	23.90b	0.61b	27.7b	0.68a
45	29.9a	0.84a	6.86ab	0.66a	27.7b	0.69a
90	30.1a	0.85a	26.80a	0.67a	31.2a	6.70a
$LSD_{0.05}$	0.74	0.06	2.30	0.03	1.82	0.06

Means with similar letter(s) in each column are not significantly different at 0.05 probability level according to LSD.

The results showed that application of PR or TSP significantly (P>0.05) improved the leaf content of nitrogen and phosphorus in both seasons **(Table 3)**. These results confirmed the findings of **Osman *et al* (2002) and Gorfu *et al* (2003)** who found that there was a clear improvement in nitrogen uptake when phosphorus was added on wheat. The results of this study indicated no effect of the applied PR and TSP on leaf potassium content **(Table 3)**. These results were in line with those reported by **Abdalla (1993) and El Saeed (1997)** on sorghum. This may be attributed to the belief that the soils of Sudan have enough available potassium. This investigation showed that the addition of PR or TSP significantly (P>0.05) increased available soil phosphorus with increasing level of the PR and TSP in both seasons **(Table 4)**. This was expected because the phosphatic fertilizers are of low recoveries (≅ 20%), hence, the rest remains in the soil which may raise the levels of soil phosphorous on extraction **(Elsheik *et al* 2005)**.

In the residual experiment, the application of PR or TSP significantly increased (P>0.05) plant height **(Table 1)**. These results were in conformity with those of **Menon *et al* (1995)**, who tested the residual efficiency of PR and TSP stating that plant height is increased with the fertilizer rate. Table 2 shows that the application of PR and TSP significantly increased (P>0.05) shoot and root dry weights in the residual experiment These results agreed with the findings of **Pastrana (1994)** who concluded that after a five-year experiment, on an acid soil, the effect of PR and TSP in first year was the same as that at the end of the experiment.

Table3. The effect of phosphate rock and triple super phosphate on leaf nitrogen, phosphorus and potassium %:

Season	First season			Second season			Residual Effect		
Treatment Kg P_2O_5 ha^{-1}	N%	P%	K%	N%	P%	K%	N%	P%	K%
				Phosphate Rock					
Control	1.20c	0.16 b	0.99 a	1.10c	0.16 c	1.10 a	1.40 b	0.13c	0.85 a
55	1.30b	0.16 a	1.07 a	1.20b	0.18 b	1.10 a	1.50 a	0.14b	0.87 a
110	1.40a	0.17 a	0.96 a	1.30a	0.18 a	1.20 a	1.50 a	0.16a	0.88 a
$LSD_{0.05}$	0.056	0.0056	0.1062	0.702	0.0065	0.1022	0.0623	0.009	0.1176
				Triplesuper phosphate					
45	1.31b	0.17 a	1.00 a	1.20a	0.17 b	1.10 a	1.50 b	0.15a	0.88 a
110	1.34a	0.17 a	1.10 a	1.20a	0.19 a	1.20 a	1.60 a	0.15a	0.82 a
$LSD_{0.05}$	0.056	0.0056	0.1062	0.702	0.0065	0.1022	0.0623	0.009	0.1176

Means with similar letter(s) in each column are not significantly different at 0.05 probability level according to LSD

Table 4. The effect of phosphate rock and triple-superphosphate on available soil phosphorus (ppm)

Treatment Kg P_2O_5 ha^{-1}	First season	Second season	Residual effect
	Phosphate Rock		
Control	3.8c	3.6c	3.1b
55	4.6b	4.0b	3.6a
110	4.8a	4.6a	3.7a
$LSD_{0.05}$	0.27	0.34	0.34
	Triplesuperphosphate		
Control	3.8c	3.3c	2.70b
45	4.4b	3.9b	3.80a
90	5.1a	5.0a	3.96a
$LSD_{0.05}$	0.27	0.34	0.34

Means with similar letter(s) in each column are not significantly different at 0.05 probability level according to LSD.

The effect of previously applied PR or TSP was evident on leaf phosphorus content (**Table 3**). The results indicated a significant rise of leaf phosphorus which may be due to the increased solubility of phosphorus from different sources with time, hence, enhancing the absorption of phosphate anion. These findings are in harmony with those of **Abdalla (1993)**. Moreover, the available soil phosphorus of the previously fertilized pots was significantly (P>0.05) increased over the control (**Table 4**). This was found in agreement with many previous research results (**Pastrana 1994 and El Saeed 1997**). Similarly, **Abekoe and Sahrawat (2003)** reported similar results in Ultisol of West Africa on rice crop. Since the recovery of phosphate fertilizers is often low (less than 25 %) and loss of P by leaching or gaseous evolution is negligible, the unused P must build up in the soil, providing erosion does not take place. Although most of the added phosphate fertilizers may seem to be unavailable to first crop, its effect can last a long time (**Warren 1992**).

In conclusion, the results of this study revealed that the plant measurements obtained from PR treatment were comparable to those obtained from TSP treatments. Therefore, PR can be considered as a potential source of phosphorus for crops.

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تأثير صخر الفوسفات والسيوبر فوسفات الثلاثي على نمو ومحتوى النيتروجين والفوسفور والبوتاسيوم في أوراق الفول السوداني المزروع في تربة طينية

[١٨]

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أجريت تجربة أصص لإختبار القيمة الزراعية للصخر الفوسفاتي المحلي , إمكانية إستعماله كمصدر للفوسفور الذي يحتاجه النبات مقارنة بالسوبر فوسفات الثلاثي المستورد والمستعمل حاليا كسماد فوسفوري. معدل إضافة الصخر الفوسفاتي صفر، ٥٥، ١١٠ كجم خامس اكسيد الفسفور للهكتار ومعدل إضافة سماد السيوبر فوسفات الثلاثي صفر، ٥٥ ، ٩٠ كجم خامس أكسيد الفسفور للهكتار.

تـــم قيـــاس نمو محصول الفول السوداني ومحتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم المزروع في تربة طينية لموسمين متعاقبين.

وبما أن الأسمدة الفوسفورية ذات كفاءة منخفضة فسيبقى أثرها للمحصول التالي ولهذا استعملت أصص الموســم الأول لدراسة الأثر المتبقي للفسفور في الموسم الثاني.

أوضحت النتائج أن كل من الصخر الفوسفاتي وسماد السيوبر الثلاثي أديا الى زياده معنويه (P>0.05) فى الوزن الجاف للمجموع الخضرى والجذرى ومحتوى الأوراق من النتروجين والفوسفور وفوسفور التربة المتاح، كذلك وقد تأثر طول النبات معنوياً بإضافة السيوبر فوسفات الثلاثى فقط. أما محتوى الورقة من البوتاسيوم فلم يتاثر بإضافة الصخر الفوسفاتى ولا السيوبر فوسفات الثلاثى. كما أوضحت النتائج التاثير الايجابى للأثر المتبقى لكل من الصخر الفوسفاتى والسيوبر فوسفات الثلاثى لكل المعايير المقاسة.

إضافة لذلك فقد أشارت النتائج إلى التشابه الواضح بين تأثير الصخر الفوسفوري وسماد السيدبر فوسفات الثلاثي على نمو النبات ومحتواه من العناصر لهذا من الممكن استغلال الصخر الفوسفاتي كمصدر فوسفوري للنبات.

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