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A Note on the Effect of Phosphate Rock, Triple Superphosphate, *Bradyrhizobium* and their Combinations on the Available Soil Phosphorus in Shambat Clay Soil*

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Abstract: A pot experiment was carried out to study the effect of phosphate rock (PR) at the rate of 0, 55 and 110 kg P_2O_5/ha, triple superphosphate (TSP) at the rate of 0, 45 and 90 kg P_2O_5/ha, *Bradyrhizobium* and their combinations on available soil phosphorus for two consecutive seasons (2000/01 and 2001/02). Another experiment was carried out to study the residual effect of the first season. The groundnut cultivar MH383 was used as a test crop. The results showed that both PR and TSP significantly (P>0.05) increased available soil phosphorus with increase in their rates. Although PR alone was less effective than TSP, PR became more effective when mixed with TSP. The level of available soil phosphorus in the residual experiment was significantly (P>0.05) higher than the control. *Bradyrizobuim* had no significant effect on the measured parameters. The results clearly demonstrate that mixing of PR with TSP increases the effectiveness of PR, and therefore PR could be a potential source of phosphorus in Shambat clay soil, particularly when mixed with TSP. More experiments, especially field trials, should be carried out before a final recommendation could be made.

One of the major problems that limit economically successful agricultural production worldwide is poor soil fertility. Therefore, addition of fertilizers is necessary to correct poor soil fertility by supplying the nutrients needed for optimum crop growth. Phosphorus is an essential element for plant nutrition and oftentimes is deficient and of low solubility and, therefore, has to be added as a fertilizer. In the Sudan, with the possible exception of nitrogen, no other element has been as critical in crop production as phosphorus (El Saeed 1997). Studies conducted in the Sudan indicated a positive response to phosphate fertilization (Abdel-Hafeez 2001). However, the use of the conventional water–soluble phosphorus fertilizers such as triple superphosphate (TSP) by local

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farmers is limited by its high cost. The use of phosphate rock (PR) as a source of phosphorus for plants has been known for over a century. Phosphorus fertilizers normally have a high carry over effect from one year to the next. The residual effect of phosphate was studied by many workers (El Saeed 1997; Abdel - Hafeez 2001).

Since the imported phosphate is prohibitively expensive, it becomes necessary to try a local cheaper phosphorus source. Therefore, a local source of phosphate, found in considerable amounts in different areas of Sudan (Abdalla 1993), was examined. Thus, the aim of this work was to (a) study the effect of PR, TSP, their combinations and *Bradyrhizobium* on available soil phosphorus for two consecutive seasons, and (b) study the residual effect of PR and TSP on available soil phosphorus.

A pot experiment was carried out at the Faculty of Agriculture, University of Khartoum, Shambat (lat. 15°40'N: long. 32°32'E) for two successive seasons (2000/01 and 2001/02). Another experiment was carried out in 2001/02 season to study the residual effect of the first season. The groundnut cultivar MH383 was used as a test crop. Each pot was filled with 10 kg soil. Surface samples of Shambat soil (0-30 cm) were used and analyzed 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%; silt 26.2%; and sand 19.7%.

The treatments consisted of three PR levels (0, 55 or 110 kg P_2O_5/ha) and three TSP levels (0, 45 or 90 kg P_2O_5/ha). The local PR used was obtained from Kurun in the Nuba Mountains, South Kordofan State, western Sudan. The fertilizers were applied at sowing in bands. Seedlings were inoculated with *Bradyhizobium*, strain TAL 1371, which was obtained from NIFTAL project in Hawaii, U.S.A. The treatments were arranged in a factorial completely randomized design with three replicates. After harvest, the available soil phosphorus was determined by the sodium bicarbonate method (Olsen *et al.* 1954).

The results showed that, in both seasons, the rock phosphate significantly ($P>0.05$) increased available soil phosphorus with increase in the level of PR, compared to the untreated control (Table 1). These results are in line with the findings of others (Ramesh *et al*. 1997; Indiati *et al*.). The

application of TSP significantly (P>0.05) increased available soil phosphorus with increase in the level of TSP, compared to the untreated control, in both seasons (Table 1). These results are in line with the findings of El Saeed (1997). Inoculation with *Bradyrizobuim* strains completely failed to improve nodulation in groundnut (data not shown). However, the combination of PR with TSP significantly (P>0.05) increased available soil phosphorus with increase in the level of phosphorus fertilizers, in both seasons (Table 1). The highest combination of PR with TSP treatment increased the available soil phosphorus by 124%, 115%, and 89% in the first season, second season and the residual, respectively. Ramesh *et al*. (1997) obtained similar results. Previously, El Saeed (1997) found that the combination of PR with TSP increased the available soil phosphorus by 100%. In this study, although PR alone was less effective than TSP, PR was more effective when mixed with TSP, possibly because there was an interaction between TSP and PR in the soil.

The level of available soil phosphorus in the residual experiment was significantly (P>0.05) higher than the control. This is in harmony with the findings of Abdalla (1993) who found that the phosphate rock caused a residual effect that may persist for many years.

The results clearly demonstrate that mixing PR with TSP increases the effectiveness of PR, and therefore PR could be a potential source of phosphorus in Shambat clay soil, particularly when mixed with TSP. More experiments, especially field trials, should be carried out before a final recommendation could be made.

Table 1. Effect of phosphate rock, triple superphosphate, *Bradyrhizobium* and their combinations on available soil phosphorus in ppm)

Treatment	First season	Second season	Residual effect
Control	2.5 c	2.6 c	2.3 c
1R	4.4 b	3.4 bc	2.8 bc
2R	4.9 ab	4.0 b	2.8 bc
1P	4.7 b	3.4 bc	3.4 abc
1P1R	4.4 b	4.0 b	3.6 ab
1P2R	4.4 b	4.0 b	3.1 bc
2P	4.4 b	4.5 ab	4.3 a
2P1R	5.0 ab	4.7 ab	4.3 a
2P2R	5.3 ab	5.4 a	4.3 a
B	2.7 c	2.6 c	2.3 c
1R B	4.4 b	3.4 bc	2.8 bc
2R B	4.4 b	3.8 b	2.8 bc
1P B	4.4 b	3.5 bc	3.1 bc
1P1R B	4.4 b	3.5 bc	3.6 ab
1P2R B	4.8 ab	4.7 ab	3.6 ab
2P B	4.8 ab	4.7 ab	3.1 bc
2P1R B	5.4 a	5.3 a	3.6 ab
2P2R B	5.5 a	5.6 a	4.3 a
$LSD_{0.05}$	0.9	1.2	1.1

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

0 = Control.
1P= 45 kg P_2O_5/ha (TSP)
2P= 90 kg P_2O_5/ha. (TSP)
1R= 55 kg P_2O_5/ha (PR)
2R= 110 kg P_2O_5/ha (PR)
B = *Bradyrhizobium*

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