NJBAS

Available online at http://www.ajol.info/index.php/njbas/index
Nigerian Journal of Basic and Applied Science (March, 2012), 20(1): 49-54

ISSN 0794-5698

Influence of Cultivar and Sokoto Phosphate Rock Levels on the Yield and Yield Components of Groundnut (*Arachis hypogaea* L.) in Dry Sub-Humid Sokoto Area, Nigeria

***[1]M. Musa, [2]A. Singh, [1]L. Abubakar, [3]S.S. Noma, [1]J. Alhassan and [1]B.S. Haliru**
[1] Department of Crop Science, Usmanu Danfodiyo University, Sokoto, P.M.B. 2346, Sokoto, Nigeria.
[2]School of Biosciences, University of Nottingham, Malaysia Campus, Jalan Broga, 43500 Semenyih, Selangor Darul Ehsan, Malaysia.
[3]Department of Soil Science, Usmanu Danfodiyo University, Sokoto, P.M.B. 2346, Sokoto, Nigeria
[Corresponding author email: mbmukhtar@yahoo.com; ☎: 08060882512]

ABSTRACT: Locally and easily available rock phosphate could be a sustainable source of phosphorus for legumes production in this region, where, phosphorus deficiency is one of the major problems to crop production. As such, field experiments were conducted during 2007 and 2008 rainy seasons at the Dry land Teaching and Research Farm of Usmanu Danfodiyo University, Sokoto to study the effect of cultivar and Sokoto phosphate rock (SPR) on the performance of groundnut (*Arachis hypogaea* L.) in the semi-arid zone of Nigeria. Treatments consisted of factorial combination of two groundnut cultivars (Ex-Dakar and RMP-12) and four levels of Sokoto phosphate rock (0, 60, 120 and 180 kg ha^{-1}) laid out in a randomized complete block design replicated three times. Results revealed that pods per plant, pod yield, kernel yield, shelling percentage and harvest index were higher in Ex-Dakar. Also, results obtained revealed no significant effect of SRP on the performance of the parameters observed. Thus, from the findings of this research it could be concluded that Ex-Dakar cultivar could be planted for increased groundnut production in the area. Groundnut cultivars under study did not respond to Sokoto rock phosphate application in the semi-arid zone.

Keywords: *Arachis hypogaea,* Sokoto phosphate rock , Ex-Dakar, RMP-12.

INTRODUCTION

Groundnut (*Arachis hypogae*a L.), is a valuable cash crop for millions of small scale farmers in the semi-arid tropics. It generates employment on the farm and in marketing, transportation and processing (Gibbon and Pain, 1985; De Waele and Swanevelder, 2001; Gibbons *et al.*, 2002). The seeds contain high quality edible oil (50%) easily digestible protein (25%) and carbohydrates (20%). The crop is a valuable source of vitamins E, K and B (Coffelt, 1989; Nwokolo, 1996; De Waele and Swanevelder, 2001).

Despite the immense importance of groundnut, the yield in Nigeria [1.02 t ha^{-1} (FAOSTAT, 2005)] is very low when compared to some other African countries. Therefore, there is the need to find alternative ways to improve the yield performance of the crop. Phosphorus (P) is normally the most limiting nutrient for the growth of leguminous crops in the regions (Chien and Menon, 1995). Sokoto has abundant supplies of rock phosphate but yet is under-exploited resource. With appropriate processing, rock phosphate could be used to promote the cultivation of groundnut and other legumes (Gibbons *et al.*, 2002; Ezekiel and Gabriel, 2006).

One way the yield of groundnut can be improved is through the identification of a more suitable cultivars. Reddy *et al.* (1993) reported that the yield of groundnut can be increased up to 30-89% provided high yielding varieties are identified. Also, through the use of phosphate rock (PR) which is relatively cheaper and important potential alternative to conventional water soluble P fertilizers. Sokoto PR is reported to contain 14.3 % P. The neutral ammonium citrate-soluble P_2O_5 is relatively high (3.1 to 3.7 % P_2O_5) which compares favorably with PR from other countries. It is confirmed that the efficiency as a source of P is more in acid soils and wetter areas of Nigeria (IART, 1994; Adediran and Sobulo, 1998; Ezekiel and Gabriel, 2006). Research has shown that Sokoto phosphate rock (SPR) could be directly applied to the soil (Ezekiel and Gabriel, 2006). Aliyu and Singh (2008) reported an increase in both yield and yield components of cowpea with the application of 25 kg SRP ha^{-1}.

The present study was undertaken to determine the influence of cultivar and phosphate rock levels on the performance of groundnut in the study area.

MATERIALS AND METHODS

A field trial was conducted in 2007 and 2008 rainy seasons at the Dryland Teaching and Research Farm of Usmanu Danfodiyo University, Sokoto. Sokoto is located in the Sudan Savanna ecological zone of Nigeria on Latitude $13^0 01^1$N; Longitude $5^0 15^1$E and at an altitude of about 350 m above sea level. The climate of the area is semi-arid with mean (20 years mean) annual rainfall of about 600 mm (Kowal and Knabe, 1972). The area is characterized with erratic and scanty rainfall (Singh, 1995). The relative humidity ranges from 21-47 % in the dry season and 51-79 % during the rainy seasons. Temperature ranges from 14 to 41 ^{0}C. The annual rainfall data in 2007 and 2008 cropping season were 452.5 and 667.6 mm respectively (Sokoto Energy Research Center (SERC), Sokoto). Textural class of the soil in the experimental site was sand. The soil is slightly acidic (pH 6.75 in H_20), low in organic carbon (0.56 g/kg), low in available phosphorus (0.21 mg/kg), low in Ca (0.27 cmol kg^{-1}) and low in total nitrogen (0.04%).

Treatments consisted of factorial combination of two cultivars of groundnut [Ex-Dakar (SAMNUT-14) and RMP-12 (SAMNUT-10)] and five levels of phosphate rock (0, 60, 120 and 180 kg ha^{-1}) laid out in a randomized complete block design (RCBD) replicated three times. In both 2007 and 2008, the land was prepared by mechanical ploughing using tractor and the soil was leveled using a hoe. Plots measuring 4m x 3m ($12m^2$) were demarcated and ridged at 75 cm inter-row spacing. Ground phosphate rock 14.3 % P (Ezekiel and Gabriel, 2006) was sourced from Sokoto Phosphate Rock Beneficiation Plant located off Abdullahi Fodiyo Road, Sokoto. The rates (0, 60, 120, and 180 kg ha^{-1}) were applied broadcasted basally and subsequently incorporated into the soil to a depth of 10-15 cm in order to facilitate greater dissolution. Seeds of the two groundnut varieties [EX-Dakar and RMP-12 released by IAR in 1988 (IAR, 1989)] were sourced from Sokoto Agricultural and Rural Development Authority (SARDA), Sokoto. Sowing was done on the ridges. Two seeds were dibbled at about 5-8 cm depth at a plant-plant distance of 20 cm. Sowing was carried out on 9th July and 23rd June for 2007 and 2008, respectively. Weeding was carried out manually at 4 and 8 weeks after sowing to ensure good crop establishment. Harvesting was carried out from the net plot at physiological maturity. The crop was air-dried under the tree shade to a constant weight, as harvesting was at the onset of the dry season when the relative humidity was usually very low. Threshing, sorting and shelling were all manually carried out. The moisture content at the time of weighing was determined to be 10%. Harvest index (the percentage of dry matter partitioned to the kernels) was determined by taking the ratio of the grain yield divided by the total dry matter multiplied by hundred.

Data were collected on pods per plant, pod yield, kernel yield, shelling percentage and harvest index. The data were subjected to analysis of variance (ANOVA) using SAS (SAS Institute Inc. Cary, NC, USA.) computer software. Least significant difference (LSD) was adopted for means separation.

RESULTS AND DISCUSSION

Pods per plant

Significant effect of cultivar on number of pods per plant was observed in both years of trial and the combined. Ex-Dakar recorded significantly (P<0.05) higher number of pods per plant than RMP-12 in both 2007, 2008 and the combined (Table 1).

Table 1: Pods per plant of groundnut as influenced by cultivar, phosphate rock and their interaction in 2007, 2008 cropping seasons and the combined

Treatment	Number of pods per plant		
	2007	2008	Combined
Cultivar (C)			
Ex-Dakar	28[a]	53[a]	41[a]
RMP-12	11[b]	29[b]	20[b]
SE	1.1	1.7	1.0
Significance	*	*	*
Phosphate rock (PR)(kg ha^{-1})			
0	21	44	33
60	19	41	30
120	21	40	31
180	17	40	29
SE	1.6	2.5	1.5
Significance	ns	ns	ns
Interactions			
C x PR	ns	ns	ns

Means in a column followed by same letter (s) in superscript within a treatment group are not significantly different using LSD at 5% level, ns = not significant, *= significant

The superiority of Ex-Dakar could be attributed to the shorter rain duration received in both years that suffices Ex-Dakar cultivar but does not allow the long duration (130-150 days) cultivar (RMP-12) to express its full genetic potentials which is in support of De Waele and Swanevelder (2001), Gibbon and Pain (1985) and Gibbons *et al.* (2002). No significant (P>0.05) effect of phosphate rock on pods per plant was observed in both 2007, 2008 and the combined. The findings could be attributed to low dissolution and low release of P under condition of low rainfall in Sokoto. This is in harmony with the earlier report by Ezekiel and Gabriel (2006), which stated that low rainfall of semi-arid zone in Nigeria would be inadequate for the dissolution of Sokoto phosphate rock.

Pod Yield

Significant (P<0.05) effect of cultivar with respect to pod yield of groundnut was observed in both seasons and the combined (Table 2). Results indicated Ex-Dakar to be superior to RMP-12 in terms of pod yield in both years and the combined. The performance of Ex-Dakar could be attributed to its early maturing (90-100 days) and drought tolerant ability (IAR, 1989) to escape late season drought. However, the finding is contrary to IAR (1989) reporting RMP-12 to be more superior (2800-3500 kg ha^{-1}) than Ex-Dakar (2000-2800 kg ha^{-1}). Similarly, Omokanye *et al.* (2001) working on IAR varieties at Shika, Zaria reported the superiority of RMP-12 for both forage and grain production but Shika, Zaria is in sub-humid zone (Omokanye *et al.,* 2001). No significant (P>0.05) effect of phosphate rock on the pod yield of groundnut was observed in both years of trial and the combined.

Table 2: Pod yield of groundnut as influenced by cultivar, phosphate rock and their interaction in 2007, 2008 cropping seasons and the combined

Treatment	Pod yield (kg ha^{-1})		
	2007	2008	Combined
Cultivar (C)			
Ex-Dakar	1559[a]	4587[a]	3073[a]
RMP-12	804[b]	1789[b]	1297[b]
SE	50.58	173.29	90.25
Significance	*	*	*
Phosphate rock (PR)(kg ha^{-1})			
0	1115	3237	2176
60	1212	3356	2284
120	1202	3072	2137
180	1196	3087	2142
SE	71.44	245.07	127.64
Significance	ns	ns	ns
Interactions			
C x PR	ns	ns	ns

Means in a column followed by same letter (s) in superscript within a treatment group are not significantly different using LSD at 5% level, ns = not significant, *= significant.

Kernel Yield

Results revealed significant (P<0.05) effect of cultivar on the kernel yield of groundnut in 2007, 2008 and the combined (Table 3). Ex-Dakar significantly out yielded RMP-12 in both years of trial and also in the combined analysis. The higher performance of Ex-Dakar with respect to kernel yield could be attributed to its ability to escape drought as evidenced from its early (90-100 days) maturing ability (IAR, 1989). Duncan *et al.* (1978) on the contrary, reported length of the pod filling period among the three physiological processes to explain most yield variation in groundnut. Omokanye *et al.* (2001) reported RMP-12 to be promising for both forage and seed production. The contradiction could be attributed to shorter rain duration received during the trial as De Waele and Swanevelder (2001) reported moisture stress to be the most limiting factor to groundnut production in the tropics. No significant (P>0.05) effect of phosphate rock was observed on the kernel yield of groundnut in both years of trial and the combined.

Shelling Percentage

Significant (P<0.05) effect of cultivar on the shelling percentage of groundnut was observed in 2007, 2008 and the combined (Table 4). Ex-Dakar recorded significantly higher shelling percentage compared to that recorded by RMP-12 in 2007, 2008 and the combined. The finding here could be attributed to the thinner shells of the Ex-Dakar cultivar. Phudenpa *et al.* (2004) reported small seed size to be associated with high shelling percentage because of the thinner shells. Also this is in agreement with the earlier report by many researches (Gibbon and Pain, 1985; De Waele and Swanevelder, 2001 and Gibbon *et al.,* 2002). No significant (P>0.05) effect of phosphate rock on the shelling percentage of groundnut in both 2007, 2008 cropping seasons and the combined was observed.

Table 3: Kernel yield of groundnut as influenced by cultivar, phosphate rock and their interaction in 2007, 2008 cropping seasons and the combined

Treatment	Kernel Yield (kg ha^{-1})		
	2007	2008	Combined
Cultivar (C)			
Ex-Dakar	1139^{a}	3080^{a}	2109^{a}
RMP-12	500^{b}	1032^{b}	766^{b}
SE	37.5	105.8	56.1
Significance	*	*	*
Phosphate rock (PR)(kg ha^{-1})			
0	763	2120	1442
60	854	2072	1463
120	823	2002	1412
180	838	2029	1433
SE	53.0	149.6	79.4
Significance	ns	ns	ns
Interactions			
C x PR	ns	ns	ns

Means in a column followed by same letter (s) in superscript within a treatment group are not significantly different using LSD at 5% level, ns = not significant,
*= significant

Table 4: Shelling percentage of groundnut as influenced by cultivar, phosphate rock and their interaction in 2007, 2008 cropping seasons and the combined

Treatment	Shelling percentage (%)		
	2007	2008	Combined
Cultivar (C)			
Ex-Dakar	73.72^{a}	67.81^{a}	70.76^{a}
RMP-12	61.83^{b}	58.03^{b}	59.96^{b}
SE	1.102	1.087	0.774
Significance	*	*	*
Phosphate rock (PR)(kg ha^{-1})			
0	65.00	63.22	63.61
60	69.50	61.22	65.36
120	68.67	62.94	65.81
180	68.94	64.39	66.67
SE	1.558	1.537	1.094
Significance	ns	ns	ns
Interactions			
C x PR	ns	ns	ns

Means in a column followed by same letter (s) in superscript within a treatment group are not significantly different using LSD at 5% level, ns = not significant,
*= significant.

Harvest Index

Significant (P<0.05) effect of cultivar on harvest index of groundnut was observed in both 2007, 2008 and the combined (Table 5). Ex-Dakar cultivar recorded statistically higher harvest index than RMP-12 in 2007, 2008 and the combined. The superiority of Ex-Dakar could be attributed to its erect growth habit and less leafy character (IAR, 1989). This finding is in harmony with the report of Gibbon and Pain (1985) who reported early maturing varieties of erect growth habit to have higher harvest index than the late maturing that are leafy and of spreading growth habit. Also, Craufurd *et al*. (2002) working on peanut genotypes found Spanish genotypes to partitioned more (49 and 41 %) dry matter to pods and seeds than the Virginia genotypes (27 and 22 %), and hence had higher seed harvest index. Therefore, Ex-Dakar as a Spanish type is expected to have higher harvest index than RMP-12 which is a Virginia type of groundnut (IAR, 1989). No significant (P>0.05) effect of phosphate rock was observed on the harvest index of groundnut in both 2007, 2008 and the combined.

Table 5: Harvest Index of groundnut as influenced by cultivar, phosphate rock and their interaction in 2007, 2008 cropping seasons and the combined

Treatment	Harvest Index (%)		
	2007	2008	Combined
Cultivar (C)			
Ex-Dakar	36.58[a]	35.08[a]	35.83[a]
RMP-12	20.75[b]	17.89[b]	19.32[b]
SE (±)	0.760	0.822	0.559
Significance	*	*	*
Phosphate rock (PR)(kg ha^{-1})			
0	26.94	27.39	27.17
60	28.83	25.83	27.33
120	29.61	25.83	27.72
180	29.28	26.89	28.08
SE (±)	1.074	1.162	0.791
Significance	ns	ns	ns
Interactions			
C x PR	ns	ns	ns

Means in a column followed by same letter (s) in superscript within a treatment group are not significantly different using LSD at 5% level, ns = not significant, *= significant.

CONCLUSION

From the findings of this research, Ex-Dakar cultivar could be adopted for increased groundnut production in dry sub-humid agro-ecological zone. However, direct application of Sokoto rock phosphate is not recommended for increased groundnut production in the study area due to low dissolution under low rainfall conditions.

REFERENCES

Adediran, J.A. and Sobulo, R.A. (1998). Agronomic evaluation of phosphorus fertilizers developed from Sokoto phosphate rock in Nigeria. *Communication in Soil Science and Plant Analysis*, **29:** 2415-2428.

Aliyu, L.S. and Singh, A. (2008). Yield and yield components of cowpea (*Vigna unguiculata* (L.) Walp.) as influenced by Sokoto phosphate rock and placement methods in the semi-arid zone of Nigeria. *Nutrient Cycling in Agro-ecosystem,* **81:** 255-265.

Chien, S.H. and Menon, R.G. (1995). Factors affecting the agronomic effectiveness of phosphate rock for direct application. *Fertilizer Res.,* **41:** 227-234.

Coffelt, T.A. (1989). Peanut. *In*: G. Robbelen, R. K. Downy, and A. Ashri, (eds). *Oil Crops of the World*: Their Breeding and Utilization. New York: McGraw-Hill Publishing Company. Pp. 319-338.

Craufurd, P.Q., Vara, P.V., Prasad and Summerfield, R.J. (2002). Dry matter production and rate of change of harvest index at high temperature in peanut. *Crop Science,* **42:** 146-151.

De Waele, D. and Swanevelder, C.J. (2001). Groundnut. *In:* Romain, H.R. (ed) *Crop Production in Tropical Africa.* DGIC Belgium, Pp743-763.

Duncan, W.G., Mc Cloud, D.E., McGraw, R.L. and Boote, K.J. (1978). Physiological aspects of peanut yield improvement. *Crop Science,* **18:** 1015-1020.

Ezekiel, A.A. and Gabriel, O.O. (2006). Benefits of phosphate rocks in crop production: Experience on benchmark tropical soil areas in Nigeria. *Journal of Biological Sciences,* 6 **(6):** 999-1004.

FAOSTAT (2005). Food and Agricultural Organizations Statistics. http://www.fao.org (Last updated February 2005) accessed on 01/05/2007

Gibbon, D. and Pain, A. (1985). *Crops of the Drier Regions of the Tropics (1st ed.).* Longman Publishing Company, Singapore. 155pp

Gibbons, R., Nigam, S. and Chater, S. (2002). *The Tropical Agriculturalist- Groundnut.* Macmillan Education Ltd. London and Oxford. 146pp

IAR (1989). Institute for Agricultural Research. *Code and Descriptor List of Crop Varieties.* IAR, Samaru. Ahmadu Bello University, Zaria, Nigeria.

IART (1994). Institute for Agricultural Research and Training. Boosting the Supply of Agricultural Raw Materials for Industrial Use. Final Report Submitted to RMRDC on On-farm Trial of Agro Mineral and Fertilizer Sources Developed from Sokoto Rock Phosphate. *In: RMRDC Publication,* 97: 189-193.

Kowal, J.M. and Knabe, D.T. (1972). *An Agroecological Atlas of the Northern Nigeria*. ABU Press, A.B.U. Zaria, Nigeria. Pp.128

Nwokolo, E. (1996). Peanut (*Arachis hypogaea* L.). *In*: E. Nwokolo and J. Smartt (eds.) Food and Fee from Legumes and Oilseeds. New York: Chapman and Hall. Pp. 49-63.

Omokanye, A.T., Onifade, O.S., Olorunju, P.E., Adamu, A.M., Tanko, R.J. and Balogun, R.O. (2001). The Evaluation of dual-purpose groundnut (*Arachis hypogaea* l.) varieties for fodder and seed production at Shika, Nigeria. *The Journal of Agricultural Science,* **136:**1:75-79.

Phudenpa, A., Jogloy, S., Toomsan, B., Wongkaew, S., Kesmala, T. and Patanothai, A. (2004). Heritability and phenotypic correlation of traits related to N_2-fixation and agronomic traits in peanut (*Arachis hypogaea* L.) *Songklanakarin Journal of Science and Technology,* **26(3):** 317-325

Reddy, L.J., Nigam, S., Subrahmanyam, N.P. and Reddy, R.G.S. (1993). Registration of ICGV-86590, peanut cultivar. *Crop Science*, **33:** 357-358.

Singh, B.R. (1995). Soil management strategies for the semi-arid ecosystem in Nigeria. The case of Sokoto and Kebbi States, *African Soils,* **25:** 317-320.