GROWTH AND YIELD RESPONSE OF GROUNDNUT (*Arachis hypogaea* L.) TO PLANT DENSITIES AND PHOSPHORUS ON AN ULTISOL IN SOUTHEASTERN NIGERIA

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ABSTRACT
An experiment on the optimum planting density and Phosphorus requirement of a local Groundnut (Arachis hypogaea L.) cultivar, 'Graffi' was carried out at the Crop Science Research Farm of the University of Calabar in the humid area of southeastern Nigeria, during the growing seasons of 2007 and 2008. Five Phosphorous rates 90, 20, 30, 40 and 50 kg k_2O_5/ha) were applied to five plant densities of Groundnut (47619, 57128, 71428, 95238 and 142857 plants/ha) laid out in a RCB design in three replications. Parameters assessed were plant height, branches plant, dry biomass yield/ha, filled pods/plant and seed yield/ha. Results showed significant (P=0.05) effect of planting density on plant height, while phosphorus rates influenced the number of filled pods/plant and seed yield/ha. Tallest plants with mean height of 53.2 cm were in plots containing 142,853 plants/ha, while the highest mean number of 15.2 filled pods/plant and correspondingly highest mean seed yield of 1078.3 kg/ha were obtained by applying 40 kg P_2O_5/ha to 95,238 plants/ha. It was concluded that planting the crop at 95,238 plants/ha with application of 40kg P_20_5/ha would enhance optimum productivity of groundnut in the humid areas of southeastern Nigeria.

KEY WORDS: Groundnut density, humid areas, phosphorous**,** ultisol, yield.

INTRODUCTION
Groundnut is one of the world's most popular crops cultivated throughout the tropical and sub-tropical areas where annual precipitation is between 1000 1200 mm for optimum growth of the crop. Groundnut is native to South America, Mexico and Central America (Yao, 2004). Leading world producers of the crop are China, India, Nigeria, USA and Senegal. Annual world output of unshelled nuts in 1992 was about 22.6 million metric tonnes (Ashley, 1993). Nigeria ranks third among the major producers (Borget, 1992; Nwokolo, 1996; Garba, *et al*, 2002). The total world output of the crop in 2008 was 34.8 million metric tonnes out of which Nigeria accounted for 3.8 million metric tonnes or 11% (FAO, 2008). Groundnut has high economic and nutritional potential and is an important cash crop for peasants in poor tropical countries including Nigeria. Industrially, the oil produced from the kernels is used in the manufacture of lubricants and other items ranging from shaving cream and soap to plastics. The seedcake has been used for livestock feed and fertilizer, and shells have been utilized as filter for wallboard and insulation (Onwuema and Sinha, 1991; Udoh, *et al*, 2005). Seeds are rich in nondrying cooking oil (about 45%) containing high oleic (40-47%) and moderately high (13 35%) linoleic acids (Ashley, 1993)

In Nigeria like in other developing countries where the crop is grown, groundnut is an excellent food, containing about 60% highly digestible protein, 22% carbohydrate, 4% minerals and about 8% fat (Ustimenko Bakumovsky, 1993; Smith, 200).

The groundnut plays an extremely important agronomic role in the traditional farming system as a nitrogen fixer in crop rotations (Ustimenko Bakumovsky, 1993).

Commercial production of groundnut in Nigeria is concentrated in the northern parts of the country particularly in areas between the northern Guinea and Sudan savanna zone (AERLS, 1977). However, due to the high commercial value and the attendant high demand, the crop is now gaining popularity as a cash crop for peasant households in the southern parts of Nigeria. But unlike in the northern Nigeria where specific recommendations have been made for planting densities and phosphorus fertilization for guaranteed stable yields (AERLS, 1971), such authentic and vital information are yet to be made available in the humid parts of Nigeria where the prospects for commercial cultivation of groundnut is high. The objective of this trial was to determine the optimum planting density and phosphous requirement for the crop in humid areas of southeastern Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the Crop Science Research Farm of the University of Calabar, Calabar (05^0 32^1 and $04^0 27^1$N and $07^0 15^1$ and $09^0 28^1$E). The land was under continuous cultivation of cassava, maize, melon and vegetables for three years before this trial. The land is generally flat and the vegetation was made up of mainly grasses (notably *Panicum maximum*) mixed with *Chromolaena odorata*). The relative humidity was 78% and typical of the rain forest zone of southeastern Nigeria. Annual rainfall ranged from 2000 3000mm, bimodally distributed with a peak each in July and September, and an intervening shut dry spell usually referred to as 'August break'. Maximum and minimum temperatures are 33^0C and 23^0C, respectively. Land cleaning and bed-making were done manually. Soil samples were randomly collected at 0-15 cm depth using a soil anger. All samples were bucked, mixed thoroughly and air-dried in the laboratory and grounded and sieved through a 2mm mesh for analysis using standard procedures, soil texture has sandy while the PH was 5.06, total Nitrogen (N) 0.17%, organic Carbon(C) 1.99%, phosphorus(P) 66.2mg/kg, Effective cation exchange capacity(ECEC), 7.47cmd/kg, exchange Sodium (Na), Potassium(K), Calcium(Ca) and Magnesium(Mg) were 0.19, 0.37, 2.0 and 1.0 cmol/kg respectively. Beds were 1.0m x 3.0m x 0.5m spaced 1.0m apart. Groundnut was planted at five panting density (47,619,57,142,71,428,95,238 and 142,857 plants/ha and fertilized fine phosphorus(P205) fertilizer rates (0,20,30,40 and 50kgP 05/ha). The experiment was laid out in a factorial design in RCB with three replications. A medium maturity local groundnut variety known as 'graffi' was planted in the first week of September in 2007 and 2008. Seeds were dressed with 'Apron plus' to control soil-borne insect pests and fungal diseases and planted 4 5cm deep at 2 seeds/hole and later thinned to one plant/stand during the first weeding at four weeks after planting(4WAP). During weeding soil was added to the base of plants to enhance the penetration of the pegs into the soil and pod formation/expansion. A basic application of 2kg/ha and 30kg k o/ha was done in all the plots at 3WAP while the various phosphorus rates (P 05) were incorporated during land preparation for maximum availability and update (AERLS, 1977). Data on plant, number of filled pods/plant, dry biomass yield/ha and seed yield/ha was analyzed statistically using analysis of variance(ANOVA) and means were tested using the least significant difference(LSD) at 5% level of probability(Wahua, 1999) with peaks in July and September and a short dry spell usually referred to as 'August break' between the peaks. Annual rainfall ranged from 2000mm 3000mm, while maximum and minimum temperatures were 33 c and 23 c, respectively. The soil at the experimented site had a sandy loam texture5.06phg and contained total N(0.17%), Organic Carbon(1.99%), Phosphorus(66.2mg/kg), ECEC(7.4)cmol/kg, while exchangeable Na, k, Ca, and mg contents were 0.19, 0.37, 2.0 and 9.0 Cmol/kg respectively. The land was cleared manually with a machete and tilled with a grade with ridge 0.3m tall, 3.0m long and 1.0m wide spaced 0.5m apart. Five plant population-densities of plants/ha(30,000, 60,000, 90,000, 120,000 and 150,000 plants/ha and fine levels of phosphorous (15, 20, 25, 30, 35, kg P_2O_5/ha) were studied in a factorial combination filter into a RCS design with three replications. A medium local variety of groundnut dressed with Apron plus to control soil burn diseases 4 5 and deep at 2 seeds/hole and later third to one plant/ha during first weeding at 4 weeks after planting. During weeding soil was added to the base of the plants to promote the formation and penetration of the pegs into the soil. A mixture of urea at 20kg/ha and Potassium (K_20) at 30kg/ha was applied in all plots at 4WAP while Phosphorus rate.

RESULTS AND DISCUSSION

Phosphorus level did not influence groundnut plant height but planting density significantly (P = 0.05) increased it. Tallest plants were in plots containing 142,857 plant/ha fertilized with 50kg P_2O_5/ha while

applying
50kgp /ha to 57, 142, plants/ha produced significant (P = 0.05) shortest plants (table 1). The tallest height attained by plants at the highest planting density (142,857 plants/ha) could be attributed to overcrowding effect and strong competition for growth factors especially sun light which usually promotes vertical growth in plants.

Table 1. Influence of Phosphorus rates and groundnut density on plant height (cm) at harvest.

Plant density/ha	Phosphorus rate (kgP_2O_5/ha)					
	0	20	30	40	50	Mean
47,617	57.6	58.0	45.6	48.6	46.6	50
57,142	47.0	51.0	55.3	44.3	41.3	51.3
71,428	52.6	55.6	53.3	48.6	46.6	47.8
95,238	47.3	50.6	48.3	54.6	46.6	51.7
142,857	54.0	49.0	53.3	54.6	56.0	49.5
Mean	51.7	52.8	51.1	50.1	47.4	53.2
$LSD_{(0.05)}$						-
Plant density (A)	4.43					
Phosphorus rate (B)	ns*					
A X B	ns*					

Ns* = not significant at 5% level

The number of branches developed per plant did not improve by phosphorus fertilization neither was it influenced by planting density (Table 2). However, fertilizing groundnut planted at 142,857 plants/ha with 20 kg $P_2\ 0_5$/ha appeared to have move favourable effect on the growth of the crop which is reflected by the development of more branches. On the other hand, it could he assumed that the number of branches developed by the plants is genetically influenced in the groundnut cultivar used.

Table 2. Influence of Phosphorous rate (kg P_2O_5/ha) and groundnut density on number of branches/plant at harvest.

Plant density/ha	Phosphorus rate (kg P_2O_5/ha)					
	0	20	30	40	50	Mean
47,619	10	8	8	10	11	10
57,142	10	7	9	7	7	8
71,142	11	10	10	7	7	9
95,238	8	8	9	9	11	9
142,857	8	12	10	8	9	9
Mean	9	9	9	8	9	-
$LSD_{(0.05)}$						
Plant density (A)	ns*					
Phosphorus rate (B)	ns*					
A X B	ns*					

ns* = not significant at 5% level.

Above-ground biomass yield, like the number of branches/plant, was not influenced by the planting density and the quantity of applied to groundnut (table 3). At the planting density of 47,619 and 57,142 plants/ha, the highest dry biomass yield was obtained by the use of phosphorus at the rate of 40kg p 05/ha, while increasing planting density to between 70,000 to 95,000 plants/ha produced more biomass without phosphorus applications to groundnut. Further increase in the planting density up to 142,857 plants/ha required 20 30kg p 05/ha for enhanced biomass production. The overall best mean biomass output was obtained by planting groundnut at 71,428 plants/ha.

Phosphorus fertilizer significant (p=0.05) increased the number of filled pods/plant while planting density was not effective on pod filling of groundnut (table 4). At the planting density 57,142 plants/ha, pod filling was most effective by fertilizing with 30kg p 05/ha whereas planting the crop above this density required 40kg p 05/ha for enhanced development of viable filled pods per plant. Applying phosphorus up to 50kg pod/ha had negative effect in pod filling, indicating the 40kgp 05/ha might be the adequate rate per pod filling in groundnut in Southern Nigeria, contrary to the phosphorus adequacy levels of (AERLS,1972), Yayock *et al*, 1988). Yield of the crop. The suppressive effects of phosphorus on pod filling at rate higher than 40kg pod/ha might also be attributed to low level of Nitrogen(0.17%) found in the soil which impair phosphorus nutrition.

Table 4. Influence of Phosphorus rate (kg P_2O_5/ha) and groundnut density on the number of filled pods/plants

Groundnut density (plants/ ha)	Phosphorus rate (kg P_2O_5/ha)					
	0	20	30	40	50	Mean
47619	8	8	12	14	12	10.8
57128	10	7	15	10	8	10.0
71428	8	8	12	15	10	10.6
95238	8	7	13	16	8	10.4
142857	5	7	11	21	9	10.6
Mean	7.8	7.4	12.6	15.2	9.4	-
$LSD_{(0.05)}$						
Plant density (A)	ns*					
Phosphorus rate (B)	4.0					
A x B	ns*					

n* not significant at P = 0.05

Seed yield of groundnut was favorably influenced by interaction between planting density and phosphorus rate applied. Significantly(P = 0.05) highest seed yield was obtained by fertilizing the crop planted at 95,238 plants/ha with 40kg p 05/ha which also gave the highest mean seed yield/ha across all the various phosphorus rates (Table 5). The low seed yields obtained at the lowest and highest planting density correspondingly low mean seed yield might be due to sub-optional stands and overcrowding effect respectively. The seed yield in plots fertilized with 50 kg P_20_5/ha is a reflection of the suppressing effect of the phosphorus rate on pod filling, a vital index of seed yield in grain legumes. A high positive correlation between pod filling and seed yield in groundnut has been documented (Udom *et al*, 2003).

Table 5. Influence of Phosphorus rate (kg P_2O_5/ha) and groundnut density on seed yield (kg/ha.

Plant density/ha	Phosphorus rate (kg P_2O_5/ha)					
	0	20	30	40	50	Mean
47,619	496.6	637.7	943.0	974.4	626.6	610.3
57,142	625.5	753.3	805.0	804.4	803.2	883.9
71,142	768.8	691.1	955.5	1144.4	844.4	860.8
95,238	683.3	824.4	1041.0	1189.9	705.5	888.5
142,857	515.3	798.7	955.5	998.5	766.6	808.9
Mean	617.9	735.0	997.4	1078.3	749.3	-
$LSD_{(0.05)}$						
Plant density(A)	ns*					
Phosphorus rate(B)	187.9					
A X B	420.1					

CONCLUSION

Planting density did not influence groundnut yield whereas the phosphorus rates applied increased the number of filled pods and seed yield. However for optimum seed productivity, planting the crop at 95,238 plants/ha and fertilizing it with 40kgp 05/ha would be adequate in the humid agroecological areas of Southeastern Nigeria

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