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THE GROWTH AND YIELD PERFORMANCE OF GROUNDNUT (*Arachis hypogea*) UNDER VARIOUS FERTILIZER INPUTS ON AN ALFISOL IN MINNA, SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

The response of groundnut variety SAMNUT 22 to various fertilizer inputs was examined on a field experiment at the Teaching and Research Farm of the Federal University of Technology, Minna during the 2010 cropping season. A total area of 0.06 ha was cleared, harrowed, ploughed and ridged. Thirty plots of size 4 x 3.5 m were marked out at plot spacing of 1m and replicate spacing of 2m. soil samples were taken randomly from 20 points at soil depth of 0-20 cm with the aid of an auger. Samples taken were bulked to form a composite, air dried and screened through a 2mm sieve to remove contaminants. Physicochemical properties of sub-samples were determined using the methods described by IITA, 1997. Seeds of groundnut variety, SAMNUT 22 were planted on the 24thof July, 2010 at an inter and intra row spacing of 75cm x 25cm at the rate of 3 seeds per stand. Seedlings were later thinned to two seedlings per stand at two weeks after planting(WAP), prior to fertilizer treatments. There were five treatments as follows: SSP at 30 kg P ha^{-1}; Rock phosphate at 30 Kg P ha $^{-1}$; SSP + Urea at 30Kg P ha^{-1} and 20 Kg P ha $^{-1}$ respectively; SSP + Agrolyzer at 30 Kg ha^{-1} and 900g ha^{-1} respectively and the Zero fertilizer treatment. All the treatments were arranged in a Randomized Complete Block design replicated 3 times. Tissue sampling was done destructively within the two inner ridges when the plants were at mid-flowering while harvesting was done at physiological maturity. Data collected were statistically analyzed and results revealed that apart from shoot biomass, nodule No. % P in leaf and seed, fertilizer treatments affected growth, nodulation and yield parameters of SAMNUT 22 significantly at $P<0.05$. Plots without fertilizer treatments were not the poorest in response. They recorded the best nodule weight and number and the second-best yield. Plants that were supplied with Rock phosphate gave significant improvement in leaf number, module weight and yield compared with those receiving SSP alone. Inclusion of SSP to Urea significantly improved plant height and leaf number than when plants received Zero fertilizer application and SSP alone.

Key words: Growth, nodulation, yield response, Groundnut variety, fertilizer inputs**.**

INTRODUCTION

Groundnut (*Arachis hypogaea*.) is an annual soil enriching, self-pollinated legume, cultivated widely in the arid and semi-arid regions of the world (400 N and 40° S), in temperature regimes ranging from warm temperate to equatorial. It is an important oilseed crop of the semi-arid tropics-SAT (Fletcher *et al*., 1992; Tarimo, 1997; Anon, 2004; ICRISAT, 2008), and ranks thirteenth (13th).

Groundnuts are staple food in a number of developing countries. (Peanut CRSP, 1990). Groundnuts are protein rich fruits that grow well in semi-arid regions (Schilling and Gibbons, 2002). They are also grown as a protein source and source of income. It is a good source of edible oil for humans as well as a nutritive feed supplement (as protein cake) for livestock (Goldsworthy and Fisher, 1987).), in importance among world crops (Hatam and Abbasi, 1994). In Ghana, groundnut is grown by smallholder farmers, on a small scale, both in pure stands and in crop mixtures, especially with cereals. Yields obtained from the crop are traditionally low due to a combination of factors including: unreliable rains, little technology available to small scale farmers, pest and disease occurrences, poor seed technology and agronomic practices as well as increased cultivation on marginal lands. Also, non-supportive small-scale policies have negatively impacted on groundnut production in Ghana (Atuahene-Amankwa *et al*., 1990). Furthermore, cultivation of the crop is considered a woman's domain. Despite the numerous problems facing groundnut cultivation, it ranks as the number one grain legume grown, especially in the northern parts of Ghana by about 90% of farm families (Tsigbey *et al*, 2003; Nub *et al*., 2005).

Like other legumes, groundnut has the additional advantages of adding symbiotically (biologically) fixed nitrogen to the soil. In many parts of arid climates, virtually every part of the crop is useful (from seed to vine and shell) after harvest. As far as nitrogen is concerned, cropping systems (rotations or mixtures) including a legume is reported to have shown in many cases, very significant benefits for the yields of accompanying (mixed cropping) or subsequent non-legume crops (Oldto *et al*., 2004; Schilling and Misari, 1992). In most parts of Africa, to enable the farm family meet its household food and cash requirements, many subsistence farmers practice mixed or intercropping in which legumes form an important, and always an integral part of the system (Kafiriti, 1994, Abulu, 1978). In Ghana, groundnut is fairly intercropped, it is grown largely in pure stands from home compounds to large fields (Atuahene-Amankwa *et al*., 1990).

Establishment of sole groundnut crop using unsuitable varieties often lead to lower yields ha^{-1} as a result of sub-optimum plant densities, leading to poor utilization of crop growth resources and under-utilization of scarce land and/or soil in the face of pressing need for cash income by the farm family (Kafiriti, 1994; Schilling and Masari, 1992). There is therefore the need to come up with groundnut varieties and minimum chemical inputs that will enable farmers in different agro-ecological zones to produce the crop without significant increase in production cost and land area. This is expected to increase groundnut production nationally without decreasing the annual production of cereal. To this end, SAMNUT22 a variety of groundnut was cultivated in a field experiment. The aim was to determine its growth, nodulation and yield response to various fertilizers inputs on an Alfisols in Minna, the Southern Guinea Savanna Zone of Nigeria.

MATERIALS AND METHOD

Study Area and soil description

The study was carried out at the research farm of the School of Agriculture and Agricultural Technology, Federal University of Technology Minna, permanent site located at kilometer sixteen (16 km) along Minna-Bida road from the month of August to December 2010. Minna lies within the Southern Guinea

Savanna of Nigeria (Latitude 9°49'N and Longitude 6°10'E).

It has a sub-humid tropical climate with a mean annual rainfall of 1200mm. 90% of this rainfall is between the month of July and August, the temperature is below 22^0C; the peak is 40^0C, ie in the month of (February and March) and 36^0C in the month of (November to December) (Juo, 1981). The soils from Minna are derived from the basement complex rock: They are shallow to very deep soils overlying deeply weathered gneisses and magnetite. Some of these soils are underlain by iron pan to a varying depth. The soils are strong brown to a red sandy clay or clay with gravely loamy sand or sandy surface soil layer (FDALRI, 1999). In Minna, the most predominant soil type is the ferruginous tropical soil which is basically derived from the basement complex rocks, and also from the old sedimentary rocks. These ferruginous tropical soils are ideal for the cultivation of Maize (zea mays), Millet (panicum miliaceurn) and ground nut (Arachis hypogeal). The vegetation in Minna is characterized by tall grasses, wood land which is interspersed with tall dense species.

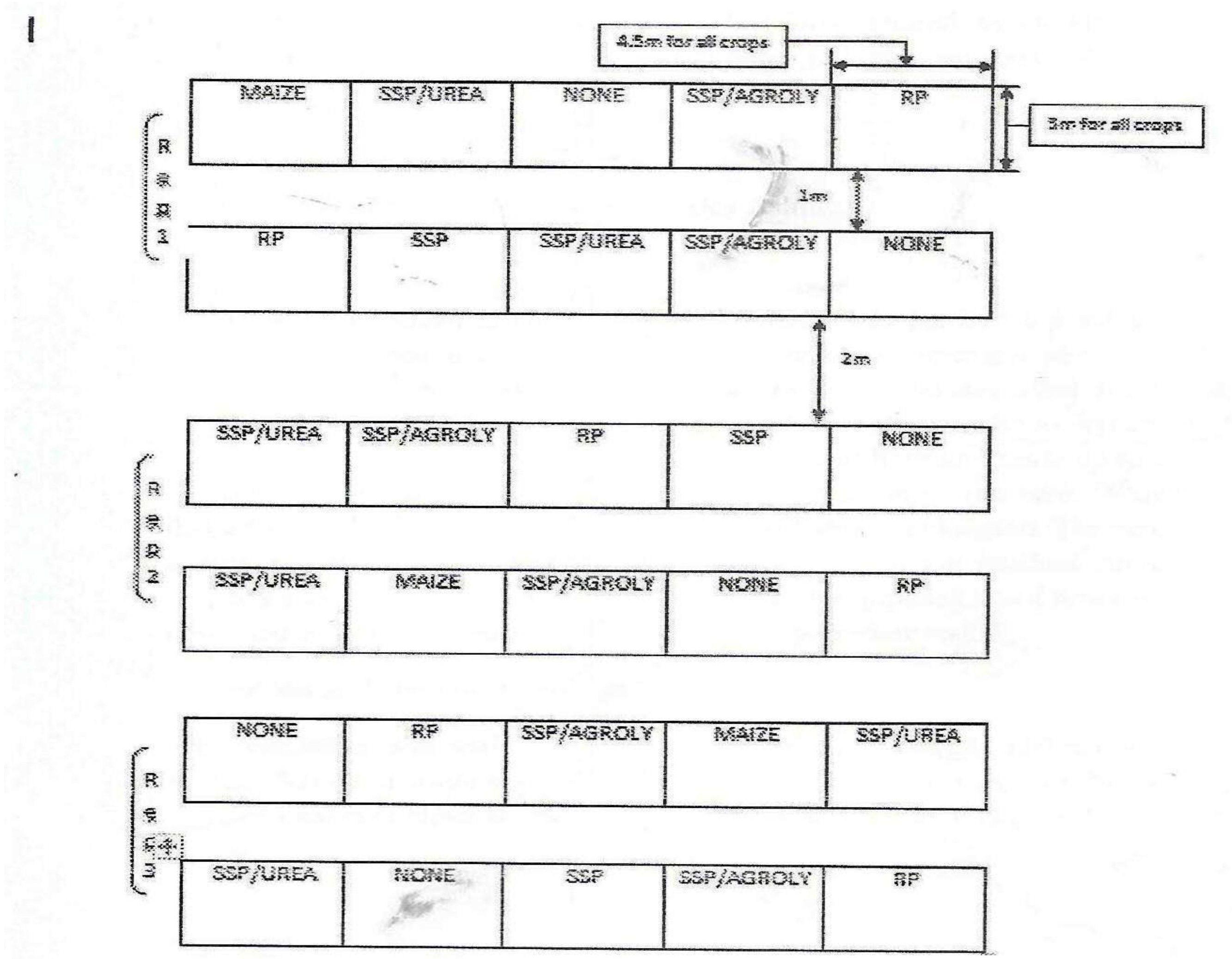
Soil Sampling and Analysis

The soil samples were collected at random on the field at a depth of 0 to 20cm, using a soil auger. A total number of 20 soil samples were collected and air dried. The soil samples were crushed and sieved with 2mm and 0.5mm sieve mesh, after which the sub-samples were taken from the composite sample for the determination of physico-chemical properties as follows; determination of soil pH in water and 0.01M $CaCl_2$ solution using pH meter, determination of soil particle size using hydrometer method (Bouyoucous, 1962), organic carbon in the soil was determined by dichromate oxidation and titration with ferrous ammonium sulphate (Walkey, 1947), available P was extracted by bray-1 extraction and it was determined using colorimeter. The exchangeable base was determined after the extraction with neutral 1N NH_4 OAC, Ca^{2+} and Mg^{2+}, using Na-EDTA titration method (Agbenin, 1995), Exchangeable acidity was also extracted with 1NKCl.

Land Preparation, Experimental Design and Treatment

During the research, the total land area of 24.5m by 25m was cleared, after which it was harrowed and ridged. The land was then marked out and divided into three replicates out of which each replicate contained two blocks. There were a total number of six blocks in all. Each of this block was divided into sub-plots of 4m by 3.5m, maintaining a space of 1m between each block and a space of 2m between each replicate.

Five different fertilizer treatments were applied as follows; single super phosphate at 30kg Pha^{-1}, Rock phosphate 30kg Pha^{-1}, Single Super Phosphate at 30kg Pha^{-1} and Urea at 20kg ha^{-1}, Single Super Phosphate at 30kg Pha^{-1} and Agrolyzer at 900gha^{-1} and Zero fertilizer treatment.The reference groundnut variety was SAMNUT 22 obtained from N2 Africa Project. The experiment was arranged in a randomized complete block design as shown overleaf.



Experimental layout

Planting and cropping management

Groundnut variety SAMNUT22 was planted on 2nd of August 2010. Two seeds were planted per hole at intra row spacing of 25cm and inter row spacing of 75cm. Manual weeding was also done twice before Harvesting; the first weeding was at 2weeks after planting while the second weeding was before flowering.

Biomass sampling and Harvesting

The shoot biomass weight, plant height, days to 50% flowering and podding, nodulation,

Performance of groundnut as influenced by fertilizer

leaf number were taken at 50% flowering by destructively sampling of four plants within the two inner ridges. Harvesting was done after the groundnut had fully matured, by pulling the plants from the soil, plucking the pods, sun drying and threshing. Yield data were collected after harvesting.

Determination of Phosphorus in Plant Tissue (Dry Ashing)

Procedure

0.5g of finely grounded and oven dried (60°C) plant material was put into a 30m1 porcelain crucible. The sample was placed in a muffle furnace for 6-8 hours at a temperature of 450°C to a grayish white ash. The sample was cooled on top of asbestos sheet, and then 20m1 of 20% HCl was added and placed on a hot plate at low heat under ventilation to evaporate to dryness. Then 10ml of 0.1 N HCl was added and filtered into a 50m1 volumetric flask and made up to volume with 0.1N HC1 solution. lml of the sample solution was pipetted into a test tube, followed by 5m1 of distilled water and then 4m1 of vanado-molybdate to a yellow coloration. The percentage transmittance was then determined at 400um by plotting it against the standard curve for P pipetted 0, 2, 4, 6, 8 and 10m1. 25m1 P standard solution was then pipetted into a series of 100m1 volumetric flasks and color developed according to the same procedure stated.

Data collection and statistical Analysis

Growth, nodulation and yield data were subjected to statistical analysis using the statistical package, Statistical System Analysis version 2.2 for window copyright by SAS inc. (2002) to determine treatment effect at 5% level of significance. Duncan multiple tests were used to separate means. Pearson correlation analysis was used to determine whether linear relationship exist between the parameters.

RESULTS AND DISCUSSIONS

Physico-chemical properties of the soil

The results of the physical and chemical properties of the soil at 0-20cm depth are shown in (Table 1). The soil was classified as sandy clay loam, with sand % as 75.88, clay % as 23.42 and silt % as 0.70. The soil was slightly acidic with pH of 6.91 in water and pH of 6.41 in $CaC1_2$, and the percent organic carbon was low (6.5g kg^{-1}). Available Phosphorus was low (9.00 mg Kg^{-1}) and consequently, Total Nitrogen was low (<0.30g Kg-1) justifying the need for exogenous N supply in the form of pre-plant N application or in-season N fertilizer application. The Exchangeable Ca (3.10cmol Kg^{-1}) in the-Exchangeable bases was higher than others, followed by Mg and K with their values as 1.00cmol Kg^{-1} and 0.48cmo1 Kg^{-1} respectively and the Na was the least with the value 0.29 c mol Kg^{-1}. The Effective Cation Exchange Capacity was also low (<8.0 cmol Kg^{-1}).

Table .1: Some physico-chemical properties of the soil at the Experimental Farm prior to Groundnut Cultivation.

Parameter	Value
Sand (g kg^{-1})	758.8
Silt (g kg^{-1})	7.00
Clay (g kg^{-1})	234.2
Textural class	Sandy clay loam
pH in $CaCl_2$	6.41
pH in H20 (1:2:5)	6.91
available P (mg kg^{-1})	9.00
total Nitrogen (g kg-1)	0.28
Organic C (g kg^{-1})	6.50
Exchangeable cations (cmol kg^{-1})	
Mg^{2+}	1.00
Ca^{2+}	3.10
K^{+}	0.48
Na^{+}	0.29
Exchangeable Acidity (cmol kg^{-1})	
Al^{3+} +H^{+}	1.38
ECEC (cmol kg^{-1})	6.25

Correlation Coefficient between the pairs of Growth and nodulation of yield parameters of groundnut

Table 2 is the table of coefficient between the parameters measured. Plant height showed a positive correlation ($p<0.05$) with shoot biomass and number of leaves. The shoot biomass shows a positive correlation ($p<0.05$) with number of leaves. Number of leaves also showed a positive correlation with leaf P value.

The number of days to 50% flowering showed a positive correlation with 50% podding ($p<0.01$) and nodule weight ($p<0.05$). 50% podding was positively correlated with nodule weight while % leaf damage was negatively correlated with yeild in Kg ha^{-1} ($p<0.01$).

Uzoma, Jamiyo, Bala, Adeboye and Osunde NJSS/23(2)/2013

Table 2: Correlation Coefficient between Growth and Nodulation Parameters.

	Plt hgt (cm)	Leaf No. (plt^{-1})	Shoot bio (gplt^{-1})	Leaf dam (%)	DF 50%	DF 50%	Nod No. (plt^{-1})	Nod wgt (gplt^{-1})	Pod No. (plt^{-1})	Yield (kgha^{-1})	%P (seed)	%P (leaf)	%N (seed)	%N (leaf)
Plt hgt (cm)	1													
Leaf No. (plt^{-1})	0.69**	1												
Shoot biom (gplt^{-1})	0.84**	0.73**	1											
Leaf dam (%)	0.60*	0.26	0.60*	1										
DF 50%	0.22	0.37	0.22	-0.17	1									
DF 50%	0.08	0.12	0.32	0.17	0.27	1								
Nod No. (plt^{-1})	0.80**	0.78**	0.81**	0.63*	0.11	-0.03	1							
Nod wgt (gplt^{-1})	0.76**	0.82**	0.91**	0.57*	0.15	0.26	0.92**	1						
Pod No. (plt^{-1})	0.71**	0.87**	0.76**	0.50	0.09	-0.02	0.89**	0.86**	1					
Yield(kgha^{-1})	0.98**	0.59*	0.83**	0.68**	0.16	0.08	0.80**	0.76**	0.68**	1				
%P(seed)	0.30	0.02	0.16	0.48	0.17	-0.01	0.38	0.19	0.25	0.41	1			
%P(leaf)	0.54*	0.49	0.42	0.66**	-0.07	0.12	0.59*	0.51	0.44	0.54*	0.33	1		
%N(seed)	0.17	0.09	0.19	0.34	-0.08	0.08	0.26	028	0.40	0.24	0.32	-0.01	1	
%N(leaf)	0.36	0.30	0.47	0.55*	-0.29	-0.19	0.70**	0.64**	0.57*	0.43	0.27	0.22	0.21	1

P < 0.05 not significant ***p < 0.05 significant** **** p < 0.01**

Table 3: Growth, Nodulation and yield parameter of Groundnut as affected by various Fertilizer inputs

Inputs	Plant height (cm)	Shoot biomas (gplt^{-1})	Leaf number	Nodules number	Nodules weight (gplt^{-1})	% leaf damage	Days to 50% flowering	Days to 50% podding	Pod number	% P in leaf	% P in seed	Yield (kgha^{-1})
None	36^{c}	32^{b}	211^{c}	8^{a}	0.4^{b}	50.7^{b}	32^{a}	58^{a}	6^{c}	0.011^{a}	0.031^{a}	339.8^{a}
SSP	41^{bc}	55^{a}	205^{c}	8^{a}	0.3^{b}	63.3^{a}	31^{c}	57^{b}	10^{a}	0.010^{a}	0.020^{a}	266.7^{b}
RP	39^{bc}	61^{a}	266^{bc}	7^{a}	0.4^{a}	56.7^{ab}	32^{a}	58^{a}	7^{c}	0.015^{a}	0.033^{a}	330.9^{ab}
SSP & Urea	47^{a}	59^{a}	452^{a}	8^{a}	0.4^{a}	51.7^{b}	32^{ab}	58^{ab}	8^{abc}	0.014^{a}	0.041^{a}	393.8^{a}
SSP & Agro	43^{ab}	61^{a}	388^{ab}	8^{a}	0.4^{a}	56.3^{ab}	31^{bc}	58^{ab}	10^{ab}	0.011^{a}	0.028^{a}	344.4^{ab}

Means with different letters indicated in the columns are significantly different ($P<0.05$).

Growth, Nodulation and Yield Parameters of Groundnut

Groundnut is in dire need of Phosphorus and responses to Phosphorus application has been reported by some authors (El-Habbacha *et al*.,2005). In our result, leaf number and plant height were significantly affected by Phosphorus application ($P<0.05$) (Table 2). Plants supplied with Phosphorus alone were taller and heavier than those without fertilizer application justifying the role P plays in assimilate translocation. These plants were better when inclusion of either Urea or Agrolizer was supplied; the addition of Urea to Single Super Phosphate doubled the leaf number effect produced by sole Single super phosphate probably because urea at 20kg N ha^{-1} was sufficient to enhance growth of leaves.

Although, phosphorus has the ability to increase leaf area just as Nitrogen, it does not affect the power of the leaves to translocate carbohydrates to the roots (Osunde pers.com). It is therefore expected that plants supplied with phosphorus will not be susceptible to leaf damage. Conversely, % leaf damage was increased even by fertilizer application with the highest increase observed for Single Super Phosphate plants.

Plants supplied with Single super phosphate alone and those supplied with Single super phosphate and Agrolyzer flowered earlier only by one day probably because of the P supplied. Phosphorus has been reported to enhance floral initiation and growth and plants have been observed to abort flowering in the absence of P. Agrolizer containing Zn, Cu have also been reported to enhance floral initiation. The lowest nodule number of 7 recorded by plants supplied with Rock phosphate and the lowest nodule weight of 0.3g $plant^{-1}$ produced by the plants receiving Single Super Phosphate alone suggested that this variety of groundnut may not need external supply of Phosphorus to nodulate. This also meant that the variety was P efficient giving the prevailing condition at the time of cultivation.

Pod number per plant was high when Single Super Phosphate was supplied alone or in combination with Agrolizer due to the fact that plants had enough time to produce more pods because they flowered earlier (Table 2). Aside that, Phosphorus has been reported to enhance floral initiation and subsequent production of pods .Averagely, Rock phosphate alone and Single Super Phosphate mixed with Urea produced the best seed and leaf P value compared with the control due to a higher assimilation of the P content of these fertilizer sources alone or in mixture. The high yield of SAMNUT22 at the second-best position when no fertilizer was applied justifies the probability of the variety being P-efficient. The best Yield obtained (393.8kg ha^{-1}) was not even statistically different from that of the control.

In conclusion, application of Phosphorus fertilizer in a single or in a combined form improved all the plant growth parameters that were observed. The application of Single Super Phosphates in a combined form with Urea gave a better yield response when applied to (SAMNUT22). Further studies should however be carried out to investigate the P- use efficiency of SAMNUT22 under various prevailing environmental conditions and management practices.

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