GROWTH AND NODULATION OF GROUNDNUT FERTILIZED WITH INORGANIC N AND P ON DIFFERENT PEDONS IN MINNA, NIGERIA

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ABSRTACT

Growth and Nodulation of groundnut fertilized with inorganic N and P was evaluated on different pedons of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Gidan Kwano campus, Minna in the month of March, 2013. There are 4 treatments as follows: control, 25kg N ha^{-1}, 60 kg P ha^{-1} and 25 kg N ha^{-1} + 60kg P ha^{-1}. There were also 4 locations as pedon one, pedon two, pedon three and pedon four. The pot experiment was arranged in a Complete Randomized Design (CRD) replicated 3 times. Result revealed that the effect due to the interaction between fertilizer and location was not significant. However location significantly affected plant height, nodule number and nodule weight. Fertilizer only affected leaf number. Planting groundnut (SAMNUT 22) in pedon 3 support good growth and nodulation.

INTRODUCTION

Groundnut (*Arachis hypogaea L.)* is an important cash and food grain legume crop grown for its edible oil and protein-rich kernels in Sudan Savanna and Northern Guinea Savanna of Nigeria. It is one of the most popular and crops cultivated in more than 100 countries in six Continents (Nwokolo, 1996). It is grown in 25.2 million hectares with a total production of 35.9 million metric tons (FAO, 2006). It is sometimes grown as a sole crop in rotation with cereals to reduce striga infestation and improve soil fertility. Phosphorus (P) deficiency is the most frequent nutrient stress for growth and development of grain legumes including groundnut in the Nigerian Savanna (Kamara *et al.,* 2008). It is one of the most popular commercial crops in Nigeria and accounted for 70% of the total Nigeria export earning between 1956 and 1967 but declined, to almost half of the existing level of 1.7 million hectares (Larinde, 1999), between 1956 and mid 1980s due to combined effect of drought and disease (Misari *et al.*, 1980), and production was at 23,390,000 metric tons in 2002 (Larinde, 1999). Groundnut is a safe, cheap and renewable nitrogen source for crops not capable of fixing N_2 and therefore good for agriculture as well as the environment (Vance, 2001). Application of nitrogenous fertilizer is not required but that lower doses of nitrogen would be sufficient to raise a good crop. However, soil physico-chemical constraints, among other problems, pose an important barrier to actualizing optimum utilization of the benefits of N_2-fixation (Graham and Vance, 2003). It is an important annual legume in the World and it is mainly grown for oilseed, food, and animal feed (Pande *et al.,* 2003). It is the chief crop rotation component in many Sub-Saharan Countries. Groundnut does best in sandy-loam and loamy soils, and in black soils with good drainage. Heavy and sticky clays are not suitable for groundnut cultivation because the pod development is hampered in these soils. The objective of the study is to evaluate the growth and nodulation characteristics of groundnut (SAMNUT 22) as affected by application of inorganic N and P in different pedons of the Teaching and Research Farm of Federal University of Technology, Minna.

MATERIALS AND METHODS

Study area

The study was carried out at the glass house of School of Agriculture and Agricultural Technology Federal University of Technology, Gidan Kwano, Minna (latitude 09^0 31′ 59.5″ N and longitude 006^0 27′ 11.4″ E, 251.6 m above the sea level), in the Southern Guinea Savanna of Nigeria. The physical features around Minna consist of gently undulating high plains developed on basement complex rocks made up of granites, migmatites, gneisses and schists. Inselbergs of "Older Granites" and low hills of schists rise conspicuously above the plains. Beneath the plains, bedrock is deeply weathered and constitutes the major soil parent material (saprolites) (Ojanuga, 2006). Climate of Minna is sub – humid with mean annual rainfall of about 1284 mm and a distinct dry season of about 5 months duration occurring from November to March. The mean maximum temperature remains high throughout (about 33.5°C) particularly in March and June (Ojanuga, 2006).

Soil sampling and analysis

The soil samples were collected from the depth of 0 – 15 cm from four pedons of the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano, Minna. Pedon 1 is located at longitude 6⁰ 26′ 5.29″E and latitude 9⁰31′ 34.40″N, 253 m above sea level, Pedon 2 has a longitude of 06⁰ 25′00.94″E and latitude of 9⁰ 32′03.50″ N, 217 m above sea level, pedon 3 is located at longitude 6⁰ 26′49.10″E and latitude 9⁰ 30′ 39 46″N, 205 m above sea level. Pedon 4 is located at longitude 6⁰ 26′ 24″ E and latitude 9⁰30′ 47.7″N, 195 m above sea level. The samples were bulked according to the n, sieved using 2 mm sieve, then 4kg of soil was collected in 12 sampling bags for each pedon. All 48 pots were arranged at the glass house while a representative sample was collected for physico-chemical properties. The soil samples were air-dried, sieved and analysed for the following: Soil particles size analysis by hydrometer method. pH was determined by using pH meter in both water and 0.01M CaCl (Soil solution ratio 1:2). Total nitrogen was estimated by Kjedhal method. Organic carbon was determined by Walkley Black method. Available phosphorous was determined colorimetrically after Bray-1 extraction. Exchangeable bases were extracted with neutral 1N NH_4OAC. Sodium and potassium were measured by using flame photometer. Calcium and Magnesium by Na EDTA titration. Exchangeable acidity was extracted with 1N KCl (Agbenin, 1995).

Treatment and experimental design

4 kg of soil was filled in a pot, 12 pots for each pedon, making a total of 48 pots for the 4 pedon. The experiment was 4 x 4 factorial experiment filted to Complete Randomized Design (CRD) with three replications. The factors are; control, 25 kg N ha^{-1}, 60 kg P ha^{-1}, 25 kg N ha^{-1} + 60 kg P ha^{-1} and four pedon.

Agronomics practices

The pots filled arranged in the glass house were watered for three days before planting. The groundnut seed (Samnut 22) were selected and planted on the 3rd of May, 2013 at four (4) seeds per pot. The plants were thinned to two plants per pot at 2 weeks after planting (WAP) and fertilizer was applied the same day. Weeding was done manually at 2 and 5 WAP. Water application was on daily bases (as the plant required). Plants were harvested 8 WAP. Shoots were cut at soil level, roots were also washed, nodules were collected, counted and weighed. The plant height was taken at harvesting, biomass fresh weight, number of leaf at physiological maturity, dry biomass weight and dry nodules weight, were taken.

Statistical analysis

Growth and Nodulation data were subjected to analysis of variance (ANOVA) and the least significance difference (LSD) were used to separate significantly different means at 5% probability level.

RESULTS AND DISCUSSION

The physico-chemical properties of the four pedons

The physico-chemical properties of the four pedons were shown in Table 1. The textural classes of the soils were sandy clay loam. The pH in H_2O were slightly acidic. It implies that some plant nutrients may be readily available in the soil. Brandy and weil (2010) reported that release of some plant nutrients fall between pH 5.5 – 7.0. The available phosphorous was rated medium in pedon 1, 2 and 4 but high in pedon 3. The organic carbon and total nitrogen were low in all pedon. The low organic contents of the soils are characteristics of the savanna due partly to rapid decomposition and mineralization of organic matter and to poor management (i.e sometimes burning of crop residues by farmer). Calcium was low in pedon 1, 3 and 4 but medium in pedon 2.

Magnesium was medium in pedon 3 and 4 but high in pedon 1 and 2. Potassium was low in pedon 1 and 3 but medium in pedon 2 and 4. Sodium was medium in all the pedons. The dominance of calcium on the exchange site may be attributed to calcium being the least easily lost from the soil exchange complex. It has being said to be the most abundant cation in exchange complex of nearly all soils that are not as acidic as to have high aluminium saturation (Brandy and Weil, 2010).

Growth and nodulation characteristics of groundnut as affected by fertilizer treatment under four pedons

Growth and nodulation characteristics of groundnut as affected by fertilizer treatment on different four pedons were shown in Table 2. Plant height (cm) of groundnut was significantly affected ($P < 0.05$) by pedon but not by fertilizer treatment. Pedon 3 produced the tallest plants (17.2cm). The shortest plants were observed at pedon 4. The difference in height of plants in pedon 1 and 2 were not statistically different ($P > 0.05$). Shoot biomass (g plant^{-1}) was also significantly affected ($P < 0.05$) by pedons but not by fertilizer treatment. Pedon 2 however produced the heaviest plants (6.08 g plant^{-1}) followed by pedon 3, 4 and 1. There was however no significant difference between the shoot weight of the plants of pedon 2 and 3 and also between the shoot weight of plants at pedon 1 and 4. Leaf number per plant was significantly affected ($P < 0.05$) by fertilizer treatment but not by pedon. A combination of 25 kg N ha^{-1} and 60 kg P N ha^{-1} produced more leaves compared with the control and with sole N and P application. 25 kg N ha^{-1} application gave a leaf number of 128 while 60 kg P N ha^{-1} produced a leaf number of 114. Nodule number (plant^{-1}) was significantly affected ($P < 0.05$) by pedons but not significantly affected by fertilizer treatments. The highest nodule number of 87 was however produced plants supplied with a combination of 25 kg N ha^{-1} and 60 kg P N ha^{-1}. The least nodule number was produced by control plants. Pedon 3 produced the highest nodule number of 107 followed by pedon 2, 1 and 4 in their sequence. Nodule weight (g plant^{-1}) was not significantly affected by fertilizer treatment or pedon ($P > 0.05$). However, plants supplied with 25 kg N ha^{-1} produced the heaviest nodules of 0.13 g followed by receiving a combination of 25 kg N ha^{-1} and 60 kg P N ha^{-1}with 0.1 g plant^{-1}. The control plants and plants receiving 60 kg P N ha^{-1} produced the lightest nodules (0.08 and 0.07 g plant^{-1} respectively). Pedon 3 plants produced the heaviest nodule weight (0.14 g plant^{-1}), followed by pedon 2, 1 and 4 in that order. There was a significant difference between the nodule weights of plants grown on Pedons 3 and 4.

Plant height and shoot biomass plant^{-1} was not significantly affected by fertilizer treatments suggesting that the inherent soil fertility status were probably sufficient. This is similar to the finding of Ahmed *et al.*, 2007 which observed that groundnut is adaptable to environment to low fertility status. It also suggests that SAMNUT 22 is nutrient efficient and may not need an exogenous supply of N and P fertilizers. Applying a combination of 25 kg N ha^{-1}and 60 kg P ha^{-1} depressed the height of plant compared with the control. Although the sole applications of 25 kg N ha^{-1}and 60 kg P N ha^{-1} respectively produced the taller and heavier plants, the difference compared with the control was not statistical ($P > 0.05$). Leaf number of plants followed a similar trend except that it was significantly affected by fertilizer treatments ($P < 0.05$) suggesting that nutrient supply determine the number of leaves produced by SAMNUT 22. It will however be needless to supply a combination of 25 kg N ha^{-1}and 60 kg ha^{-1} when sole application can give leaf number that are statistically as high as those produced when N and P are combined.

Table 1: Physico-chemical properties of the soils of each pedon collected from the Teaching and Research Farm

Parameter	Pedon 1	2	3	4
Sand (g kg?^{1})	675	665	685	705
Silt (g kg?^{1})	103	133	113	93
Clay (g kg?^{1})	222	202	202	202
Texture class		Sandy clay loam		
pH in $CaCl_2$	4.61	4.52	4.57	4.47
pH in H_2O (1:2.5)	6.27	5.47	5.15	5.80
Available P (mg kg?^{1})	16.00	12.00	21.00	17.00
Total Nitrogen (g kg?^{1})	0.62	0.71	0.40	0.60
Organic Carbon (g kg?^{1})	4.60	5.90	4.10	4.50
Exchangeable Cations (cmol kg?^{1})				
Mg^{2}?	1.12	1.12	0.80	0.56
Ca^{2}?	1.28	2.24	1.60	1.68
K?	0.13	0.23	0.11	0.20
Na?	0.15	0.22	0.12	0.15
Exchangeable Acidity (cmol kg?^{1})				
Al^{3}? + H?	2.5	2.5	2.5	2.5
ECEC	5.18	6.31	5.13	5.09

Table 2 Growth and nodulation characteristics of groundnut as affected by fertilizer treatment under four pedons

Treatment	Plant height (cm)	Leaf number (plant $^{-1}$)	Shoot biomass	Nodule number g plant^{-1}	Nodule weight
Fertilizer (F)					
Control	15.17	91.00	4.39	74.00	0.08
25 kg N ha^{-1}	15.58	128.00	4.91	78.00	0.13
60 k g Pha^{-1}	16.33	114.00	5.46	76.00	0.07
25 kg N ha^{-1} + 60 k g Pha^{-1}	15.00	133.00	5.41	87.00	0.10
LSD ($p<0.05$)	NS	32.18	NS	NS	NS
SE±	1.74	22.34	1.11	18.88	0.04
Pedon (P)					
1	15.67	118.00	3.10	77.00	0.08
2	15.33	118.00	6.08	79.00	0.09
3	17.17	128.00	5.74	107.00	0.14
4	13.92	101.00	3.25	53.75	0.06
LSD ($p < 0.05$)	2.51	NS	1.60	27.19	0.06
SE±	1.74	22.34	1.11	18.88	0.04
F*P	NS	NS	NS	NS	NS

Researches conducted in the Southern Guinea Savanna have shown that phosphorus is very important in shoot biomass production because it affects dry matter production and accumulation. Nitrogen has also been demonstrated to increase carbohydrate and protein synthesis (Yusuf *et al.*, 2003). These explained that plants supplied with 25 kg N ha^{-1} were taller, heavier and vigorous in growth compared with the control (Table 2). Pedons affected plant height and shoot biomass plant^{-1} significantly ($P < 0.05$) and not leaf number. Pedon 3 averagely produced the highest values of growths parameter observed, followed by Pedon 2, 1 and 4 in that sequence. Averagely Pedon 3 soils are the poorest in nutrient status (Table 1) and support the fact that SAMNUT 22 is nutrient efficient and very adaptable to poor soils of the pedon. Nodulation characteristics assessed as nodule number and weight plant^{-1} was significantly affected by ($P < 0.05$) pedon but not by fertilizer treatments. The highest nodule number of 87 plants was produced by plants supplied with combination of N and P while sole N and P produced 78 and 76 nodule per plant respectively. These values were higher than that produced by the control but the difference was not statistical ($P < 0.05$) suggest the fertilizer application may not be necessary. A similar trend was observed for nodule weight except that 60 kg P ha^{-1} surprisingly depressed nodule weight compared with the control. Pedon 3 produced the highest values of nodule number and weight, followed by pedon 2, 1 and 4 in that sequence. The reason might be that SAMNUT 22 is nutrient efficient and very adaptable to the poor soils of the pedons of the Teaching and Research Farm.

CONCLUSION

This study revealed that growing groundnut (SAMNUT 22) in pedon 3 of the Teaching and Research Farm Federal University of Technology support good growth and nodulation, although application of fertilizer treatments 25 kg N ha^{-1} + 60 kg P ha^{-1} and 25 kg N ha^{-1} increased leaf number in the area. No significant interaction between fertilizer and pedons suggest that planting groundnut (SAMNUT 22) without fertilizer treatment can still be encouraged in the study area.

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