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IMPACT OF BIOPHYSICAL CONDITIONS ON THE YIELD OF LEGUMES AND VARIETAL RESPONSE TO INPUT OF GROUNDNUT VARIETY (SAMNUT 24) IN AJINGI AND GAYA SAVANNA ZONE OF NIGERIA

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Abstract

Field experiments were conducted at Ajingi and Gaya operational areas of N2Africa both in Kano State, Nigeria for the impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety (samnut 24) in Ajingi and Gaya savanna zone of Nigeria. The experiment comprised six (6) treatments, groundnut seeds Samnut 24 have been planted in each plot. Four (4) of the plots had received P fertilizer at the rate of 30kg P_2^05/ha (Single Super Phosphate SSP), three (3) plots had received K in form of MOP at the rate of 20kg K_20/ha while two (2) plots each had received micronutrients and organic manure. The remaining one plot had serve as control no input. The treatments were laid out in a Randomized Complete Block Design (RCBD) with five replications. Application of all rates and combination of different of fertilizer produced statistically similar treatments effect per plot at both locations and combined. However, the study indicated that, application of combination of PK-MN-OM and PK-MN alone were statistically superior in Plant height, Number of branches, Canopy spread, Number of plant established and Days to maturity. There were statistically significant higher positive correlations between growth and yield components at both locations. Conclusively, the results of the study showed that, application of PK-MN-OM and PK-MN respectively were statistically superior to PK, P, OM and the control treatment. It is hereby recommended that, application of PK-MN-OM and PK-MN should be adopted and phosphorus fertilizer at the rate of 30kg/ha, potassium 20kg/ha and 40kg/ha of organic manure.

Keywords: Biophysical condition; Varietal response to input; Groundnut; Yield; Samnut 24

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) of the family leguminasea, is an annual legume which bears many names including peanut, earthnut, monkey-nut and goobers. It originated from Latin America and the Portuguese introduced it into African continent from Brazil in the 16th century (Adinya *et al.., 2010;* Hamidu *el al.,* 2007). The crop is mainly grown for oilseed, food and animal feed (Pande *et al...* 2003; Upadhyaya *et al..*, 2006). It is the world 13th most important food crop, 4th most important source of edible oil and 3th most important vegetable protein (Taru *et al.,* 2010). Groundnut seeds known as kernels contain 40-50% fats, 20-50% protein and 10-20%

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carbohydrates (Sorrensen *et al.*, 2004). They are a nutritional source of vitamin E and other minerals for human health including niacin, falacin, calcium, phosphorus magnesium, zinc, iron, riboflavin, thiamine and potassium. Groundnut is useful in the treatment of hemophilia, and can cure stomatitis, prevent diarrhea and is beneficial for growing children and for both pregnant and nursing mothers (Akobundu, 1998). Kernels are consumed directly as raw, roasted or boiled nuts and vines are used as fodder for cattle (Pompeu, 1980; Hong *et al.*, 1994). The crop is used as industrial materials for producing oil cakes and fertilizer, extracted oil from kernel is used as culinary oil and other crop extracts are used as animal feeds (Nigan, and Lenne, 1996). Almost each part of the crop is used in some ways. These multiple uses of groundnuts plant make it important for both food and cash crop for the available domestic, or worldwide external markets in several developing and developed countries. Globally, 50% of the crop is used for oil extraction, 37% for confectionary use and 12% seeds purpose (Teru *et al.*, 2010). Groundnuts are grown in nearly 100 countries worldwide. China, India, Nigeria, USA, Indonesia Senegal and Sudan are major producers growing an estimated total area of 21.8 million ha (Taru *et al.*, 2010). In Nigeria, the crop is presently grown throughout the country with the exception of the riverine and swampy areas. Groundnut is either cultivated sole or in mixture with other crops like Mize, Sorghum, Millet or Cassava. Fifty percent of the groundnuts produced in Nigeria are in mixtures (Anonymous, 2004). Developing countries accounts for 96% of the global production. Asia accounts for 58% of the global groundnuts area and 67% of the groundnuts production with annuals growth rate of 1.28% for area, 2% for production 0.71% of productivity. Twenty five countries in Asia produce 71.7% of the crop while, 46 countries in Africa produce 18.6% of the total produce. North-Central America produces 7.5% from a small area of 3.7% of the overall estimated global area of producers. Groundnut is a crop which can be grown in the tropics and warm temperate region between 40^0N and 40^0S latitude (Roman, 2001). The crop has some specific environmental and management requirements which must to be met the closet possible in order to achieve a good crop yield. Some of the climatic requirements for groundnut crop production include rainfall of between 450mm – 1250 per annum which should be well distributed and on an altitude of no more than 1500m (Busolo *et al.*, 2002) or an irrigation application of about 500mm – 600mm per its production season, a temperature range of 20^0 C – 35^0 C, lots of sunshine and optimum relative humidity up to its maturity are among the requirements.

MATERIALS AND METHODS

Experimental Sites

The study was conducted during 2015 wet season in two locations operational areas of N2Africa. Location 1: Gaya (Latitude 11^0. 762238N and longitude 008^0. 95753E; Alt. 432mabove sea level). Location 2: Ajingi (Latitude 11^0. 97570N and Longitude 009^0. 04805E; Alt. 417m above sea level). Both sites are located in the Sudan Savanna agro-ecological zone.

Collection and Analysis of Soil Sample

Soil sample were taken at random from each of the two sites before planting at 0-25cm depth using soil auger. Composite soil sample were made for each site and were air-dried, sieve using 2mm mesh and analyzed for physical and chemical properties using standard procedures. The pH was determined by glass electrode pH Meter; particles size; Organic carbon by oxidation; Available phosphorus; Total Nitrogen content; Exchangeable Bases (Ca, Mg, K, and Na); Cation Exchange Capacity. (Bremner and Mulvaney, 1982)

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Treatment and Experimental Design

In each site the experiment comprised of six treatments in the field layout, groundnut seed Samnut 24 have been planted in each plot. Four 4 plots received phosphorus P fertilizer at the recommended rate of 30kg $p_2{}^0 5$/ha (Single Super Phosphate SSP). Three 3 plots received potassium K in form of MOP at the recommended rate of 20kg K_20/ha. Two 2 plots received micronutrient 33 grams of agrolyzer and dissolve in 10litre of water which had been applied to 10x10m plot. Organic manure application 4 tons that is 40kg per plot of 100^2, one plot saved as control. All the treatments were laid out in randomized complete block design (RCBD) with five replications.

Land preparation

The land was cleared and ridged by using ox-plough and it was ridged against slope, the plot of 10x10m was established appropriately. Alley of 0.5m spacing between rows/ridge is 75cm

Sowing

Groundnut seed was sown at the rate Of 2 seeds per hole without thinning, spacing between plant stand 10cm and 75cm intra raw spacing.

Fertilizer application

In each plot, four plots of 10mx10m were fertilized by applying 0.3kg $P_2{}^0 5$ which is equal to 2kg SSP/plot of $100m^2$. Phosphorus fertilizer (SSP) were applied at planting by dibbled the fertilizer and covered. Potassium K was applied to three plots of 10mx10m at the rate of K_20 in form of MOP which is translated into 0.33kg K_20/plot of 100^2m. Recommended rate of organic manure 40kg/ha were applied to plot of100^2m, 33 grams of micronutrients agrolyzer were applied to two plots of 10mx10m.

Harvesting

Harvesting was done when the foliage slightly turned yellow and the pods attained physiological maturity. The plant was then cut below the level of the pods in the soil with hoe.

Data collection

Plant height: five pant per plot were randomly selected and tagged from the sampling rows, their height were measured from the base of the plant to the end of the terminal bud using meter ruler at 3, 6, 9, and 12 WAS, and average mean was recorded.

Number of branches:

The numbers of branches per plants at 3, 6, 9, and 12 WAS, and average mean was recorded.

Canopy spread:

five plants per plot were randomly selected and tagged from the sampling rows, their spread were measured by the use of meter ruler at 3, 6, 9, and 12 WAS and begin from the base of the plant to the end of terminal bug spread, and average spread was computed and recorded.

Number of plant established:

The number of plant established was assessed by counting the stand in each of the plot and recorded.

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Days to maturity:

The number of days where 80% of the plants in each plots reach maturity was 90-110 days after sowing were recorded.

Data Analysis

The data was analyzed using SAS latest version (2010), the data collected was subjected to Analysis of Variance (ANOVA), as described by Snedecor and Cochran (1976) and treatment means were compared using Duncan Multiple Range Test (DMRT) Duncan, 1955.

RESULT AND DISCUSSION

Physiochemical Properties of the Soil at Experimental Sites:

The characteristics of the soil at experimental sites are presented in Table 1. The soil at Ajingi was sandy loam while that of Gaya was loamy sandy in texture. The pH value for Ajingi was 6.68 and that of Gaya was 5.83 which indicate there are different reactions. Soil had medium organic carbon 0.392gkg-^{1} for Ajingi and Gaya 0.757 gkg-^{1} respectively, the total Nitrogen content for Ajingi 0.22 gkg^{-1} and 0.42 gkg^{-1} for Gaya which was very low, the available phosphorus content of Ajingi was high 11.25 (mgKg^{-1}). The exchangeable cations (Ca, Mg) at Ajingi Ca was 3.86 and that of Gaya was 2.91, Mg at Ajingi was 2.30, Gaya was at 1.50K potassium was medium at both location range between 0.18 – 0.12, Na content of both locations was moderate. The CEC of the soil analysis from both locations were medium and ranged between 5.89 cmo1^{+}Kgha^{-1} for Ajingi and 4.21 cmo1^{+}Kgha^{-1} for Gaya soil.

Table 1: Soil characteristics of the experimental sites at Ajingi and Gaya (0-25cm depth)

Soil Properties	Ajingi	Gaya
Particle size (%)		
Sandy	89.9	80
Clay	3	4
Silt	7.1	10
Texture Class	Sandy loam	Loam sandy
Chemical Properties		
pH in water (1:2:5)	6.68	5.83
Organic carbon (gkg^{-1})	0.392	0.757
Total Nitrogen (gkg^{-1})	0.22	0.42
Available P (mg/kg^{-1})	11.25	3.92
Exchangeable base (cmo/kg)		
Ca	3.86	2.91
Mg	2.30	1.50
K	0.18	0.12
Na	0.54	0.22
CEC	5.89	4.21

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Plant Height

Impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety on plant height is presented in table 2. Application of all rates and combination of different of fertilizer produced statistically ($P \leq 0.05$) similar plant height per plant, irrespective of locations and various sampling period, except at 6 WAS and at Ajingi site where by application of combination of PK-MN-OM produced statistically similar plant height compared with application of PK and P alone, though it was statistically similar at par with OM, PK_mn and the control treatment.

Table 2: Impact Of biophysical condition on the yield of legumes and varietal response to input of Groundnut Variety on Plant Height at 3, 6, 9 and 12 WAS at Ajingi and Gaya.

Treatment	Ajingi			WAS			Gaya	
	3	6	9	12	3	6	9	12
PK-MN-OM	6.00	20.31ab	41.56	57.16	8.36	30.97	49.06	60.56
OM	5.10	18.43b	41.33	56.80	7.46	29.52	44.76	57.80
PK	6.18	19.7ab	40.15	56.56	7.37	27.39	47.65	60.56
P	6.14	21.44a	39.67	56.52	7.27	25.77	40.60	55.97
PK-MN	5.94	17.91b	41.97	57.05	7.59	28.67	44.07	57.80
CONTROL	6.24	17.54b	38.14	57.73	7.35	26.43	46.28	59.06
SE±	0.37	0.85	1.64	0.59	0.39	1.84	2.41	1.57
Significance	NS	*	NS	NS	NS	NS	NS	NS
Interaction								
T x E	NS	NS	NS	NS	NS	NS	NS	NS

Keyword: Means within a column followed by same letter(s) are statistically similar ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT); NS = Not Significance; PK-MN = Phosphorus + Potassium + Micronutrient; OM = Organic Manure; PK-MN-OM = Phosphorus + Potassium + Micronutrient + Organic Manure; PK = Phosphorus + Potassium; CONTROL = No input; P= Phosphorus only; T = Treatment; E = Experiment; **= significant at 1% Probability; WAS= Weeks After Sowing.

Number of Branches

Impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety on number of branches is presented in table 3. Application of all rates combination of different of fertilizer produced statistically ($P \leq 0.05$) similar number of branches per plot, irrespective of locations and the various sampling period except at 9 WAS and at Ajingi site. At 9 WAS and at Ajingi site the various types of fertilizer applied produced statistically similar number of branches, except that the application of PK-MN-OM produced significantly more number of branches than plots fertilized with only OM.

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Table 3: Impact Of biophysical condition on the yield of legumes and varietal response to input of Groundnut Variety on Number of Branches at 3, 6, 9 and 12 WAS at Ajingi and Gaya.

Treatment	Ajingi			WAS	Gaya			
	3	6	9	12	3	6	9	12
PK-MN-OM	4.60	5.96	9.92a	9.96	4.80	6.00	9.24a	9.24
OM	4.36	5.64	8.92b	9.56	4.68	6.04	8.48a	8.48
PK	4.32	5.92	9.08ab	9.08	4.60	6.32	9.04a	9.06
P	4.48	6.00	9.28ab	9.28	4.76	5.88	8.76a	8.84
PK-MN	4.68	5.92	9.36ab	9.36	4.72	5.88	8.56a	8.56
CONTROL	4.72	5.96	9.04ab	9.08	4.72	5.88	9.02a	9.00
SE±								
Significance	NS	NS	*	NS	NS	NS	NS	NS
Interaction								
T x E	NS	NS	NS	NS	NS	NS	NS	NS

Keyword: Means within a column followed by same letter(s) are statistically similar (P≤0.05) using Duncan Multiple Range Test (DMRT); NS = Not Significance; PK-MN = Phosphorus + Potassium + Micronutrient; OM = Organic Manure; PK-MN-OM = Phosphorus + Potassium + Micronutrient + Organic Manure; PK = Phosphorus + Potassium; CONTROL = No input; P= Phosphorus only; T = Treatment; E = Experiment; **= significant at 1% Probability; WAS= Weeks After Sowing.

Canopy Spread

Impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety on canopy spread is presented in table 4. Application of all rates and combination of different of fertilizer produced statistically (P≤0.05) similar canopy spread per plot, irrespective of locations and the sampling period, except 3 and 6 WAS under Gaya locations respectively. Application of various types of fertilizer produced statistically (P≤0.01) similar canopy spread per plot and the control treatment, though application of PK-MN-OM as well as application of OM alone were statistically superior compared to the application of PK alone. At 6 WAS under same Ajingi site, application of PK-MN-OM produced significant more canopy spread than all other fertilizer combinations, which were statistically at par with each other. At 3 WAS under Gaya location, similar trend to Ajingi 6 WAS recorded was observed, though application of PK-MN-OM, OM alone and PK were statistically at par.

Table 4: Impact Of biophysical condition on the yield of legumes and varietal response to input of Groundnut Variety on Canopy spread at 3, 6, 9 and 12 WAS at Ajingi and Gaya.

Treatment	Ajingi			WAS	Gaya			
	3	6	9	12	3	6	9	12
PK-MN-OM	224.22a	774.53a	3064.8	2989.0	330.53a	1260.4	2335.6	3434.9
OM	215.91a	637.19b	3981.1	3054.9	290.43ab	1293.5	2180.7	3189.6
PK	170.5b	654.86b	2984.7	3105.5	302.69ab	1125.2	2300.9	3480.2
P	205.40ab	558.18b	2795.4	2987.2	243.44b	1207.5	2277.7	3246.4

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PK-MN	200.72ab	566.92b	2504.7	2887.8	262.92b	1204.4	2243.4	3298.0
CONTROL	202.04ab	624.17b	3001.2	2881.5	266.64b	1008.3	2420.1	3311.9
SE±	11.88	38.8	476.3	166.9	19.9	105.9	103.4	102.9
Significance	*	**	NS	NS	*	NS	NS	NS
Interaction								
T x E	NS	NS	NS	NS	NS	NS	NS	NS

Keyword: Means within a column followed by same letter(s) are statistically similar (P≤0.05) using Duncan Multiple Range Test (DMRT); NS = Not Significance; PK-MN = Phosphorus + Potassium + Micronutrient; OM = Organic Manure; PK-MN-OM = Phosphorus + Potassium + Micronutrient + Organic Manure; PK = Phosphorus + Potassium; CONTROL = No input; P= Phosphorus only; T = Treatment; E = Experiment; **= significant at 1% Probability; WAS= Weeks After Sowing.

Number of Plants Established

Impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety on number of plant established is presented in table 5. Application of all rates and combination of different of fertilizer produced statistically (P≤0.01) similar number of plants established per plot, irrespective of locations and the combined analysis. However, the various types of fertilizer applied produced significantly higher number of established plants per plot than the control treatment in all locations and in the combined analysis. Application of OM or PK and P or PK-MN alone produced statistically similar but the least number of established plants compared to the application of PK-MN-OM which were statistically at par but statistically superior to the application of OM or PK and P or PK-MN alone and control treatment that produced less number of plants established. There was statistically significant treatments effect recorded at both locations and combined analysis.

Table 5: Impact Of biophysical condition on the yield of legumes and varietal response to input of Groundnut Variety on Number of plants established at Ajingi and Gaya and combined.

Treatment	Ajingi	Gaya	Combined
PK-MN-OM	1570.8a	1285.0a	1427.9a
OM	1432.6a	1241.0a	1336.5a
PK	1414.6a	1221.0a	1317.8a
P	1388.6a	1252.4a	1320.5a
PK-MN	1373.2a	1296.2a	1334.7a
CONTROL	865.2b	940.4b	902.8b
SE±	101.7	42.31	76.15
Significance	**	**	**
Interaction			
T x E	NS	NS	NS

Keyword: Means within a column followed by same letter(s) are statistically similar (P≤0.05) using Duncan Multiple Range Test (DMRT); NS = Not Significance; PK-MN = Phosphorus + Potassium + Micronutrient; OM = Organic Manure; PK-MN-OM = Phosphorus + Potassium + Micronutrient + Organic Manure; PK = Phosphorus +

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Potassium; CONTROL = No input; P= Phosphorus only; T = Treatment; E = Experiment; **= significant at 1% Probability; WAS= Weeks After Sowing.

Days to Maturity

Impact of biophysical conditions on the yield of legumes and varietal response to input of groundnut variety on days to maturity is presented in table 6. At Ajingi and the combined analysis all treatments under study produced statistically ($P \leq 0.01$) similar number of days to maturity. However, at Gaya site, application of PK-MN-OM, PK-MN, OM, PK, P and the control produced statistically similar number of days to maturity, though the control and application of PK were statistically superior only to the application of PK-MN. In the combined analysis, all indicating no statistical difference among all treatments tested.

Table 6: Impact Of biophysical condition on the yield of legumes and varietal response to input of Groundnut Variety on Days to Maturity at Ajingi and Gaya and combined.

Treatment	Ajingi	Gaya	Combined
PK-MN-OM	92.2	89.8ab	91
OM	91.8	89.8abc	90.8
PK	95.2	91.6a	93.4
P	95.2	91.0ab	93.1
PK-MN	94.4	90.2bc	92.3
CONTROL	93.4	92.0a	92.7
SE±	1.39	0.36	1.61
Significance	NS	**	NS
Interaction			
T x E	NS	NS	NS

Keyword: Means within a column followed by same letter(s) are statistically similar ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT); NS = Not Significance; PK-MN = Phosphorus + Potassium + Micronutrient; OM = Organic Manure; PK-MN-OM = Phosphorus + Potassium + Micronutrient + Organic Manure; PK = Phosphorus + Potassium; CONTROL = No input; P= Phosphorus only; T = Treatment; E = Experiment; **= significant at 1% Probability; WAS= Weeks After Sowing.

Conclusion

Conclusively, the results of this study shown that, application of combination of PK-MN-OM and PK-MN were statistically superior only to the application of PK, P, OM and the control treatment.

Recommendation

From the finding of this study: it is hereby recommended that: -

- Application of PK-MN-OM and PK-MN should be adopted
- Organic manure at the rate of 40kg/ha should be use and combine with phosphorus fertilizer at the rate 30kg/ha which produced high yield
- Groundnut variety Samnut 24 is recommended

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