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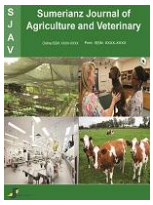

Original Article Open Access

Comparison of Nutrient Combinations for Enhanced Groundnut (*Arachis Hypogaea* L.) Productivity in a Dryland Ecology

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Abstract

Farmers in the savannas of Nigeria usually do not apply any form of mineral fertilizers to groundnut crops due to high cost, inadequacy of the fertilizers or due to the long-held belief that groundnuts do not require external application of fertilizers. Trials were conducted during the 2015 rainy season on farmers' fields in 15 villages across 3 Local Government Areas (LGAs) of Kano State to study the effects of various nutrient applications and combinations on groundnut productivity. The treatments were P only, P + K, P + K + Micronutrients (Mc), P + K + Mc + Organic manure (OM), OM only and no fertilizer treatment (Control). The treatments were laid out in a Randomized Complete Block Design with farmers as replicates. The results showed that nutrient applications whether singly or in combinations had positive influences on yield and yield attributes of groundnut across the LGAs. Plant height was the only variable affected by the nutrient combinations where P+K+Mc+OM produced the tallest plants, while the Control produced the shortest plants. Days to flowering were statistically similar in Ajingi and Gezawa but longer in Gaya. Significantly higher number of pods, pod and haulm yields, shelling %, and 100 kernel weights were recorded in Gezawa. Lowest number of pods, pod and haulm yields, were recorded in Gaya. Significant interactions between the treatments and LGAs were recorded for pod and haulm yields.

Keywords: Dryland ecology; Groundnut productivity; Nutrient combinations.

1. Introduction

Groundnut (*Arachis hypogaea* L.) is an important food and oilseed crop grown by small-scale, resource poor farmers under diverse agro-climatic environments of West Africa [1]. According to Food and Agricultural Organization (FAO), in the year 2017 Asia contributes 65.3 % of worlds groundnut production, followed by Africa with 26.3 % while Americans were third with 8.4 % of worlds production. China was the main producer with almost 13.9 million metric tons, followed by India with 7.1 million metric tons and Nigeria with 2.9 million metric tons. Nigeria is the largest groundnut producing country in Africa, accounting for 39% of production in the region [2].

Crop production in Sub-Saharan Africa is hindered by several factors such as drought, low soil fertility as well as restricted access to mineral fertilizers [3]. Groundnut removes fairly large quantities of nutrients from the soil. It depletes the soil nutrients rapidly unless the soil is adequately fertilized [4]. Mineral nutrient deficiencies due to inadequate and imbalanced use of nutrients, is one of the major factors responsible for low groundnut yield [5]. Groundnut farmers, in most parts of the semi-arid region use less nutrient fertilizer and sometimes only one or two nutrients resulting in severe mineral nutrient deficiencies due to inadequate and imbalance use of nutrients. This is one of the major factors responsible for low yield in groundnut [4].

Nutrients exported from the soil through harvested biomass or loss from soil by gaseous loss, leaching, or erosion must be replaced with nutrients from external sources. The judicious use of chemical fertilizer is also essential to maintain soil fertility [6]. Optimization of mineral fertilization is the key for improving groundnut production, as it has very high nutrient requirements [5]. No single source can meet the increasing nutrient demands for agriculture. To achieve sustainability in production, there is a need to integrate both organic and inorganic sources of nutrients. Such an integration of nutrient sources will enhance the nutritional use efficiencies [7].

Phosphorus (P) is the second major essential nutrient element for crop growth and good quality yield with the most obvious effect on the plant root system [5]. The requirement of P in nodulating legumes like groundnut is higher compared to non-nodulating crops as it plays significant roles in nodule formation and fixation of atmospheric nitrogen [8]. Due to the vital role that potassium plays in plant growth and metabolism, potassium-deficient plants show a characteristic reduced growth, photosynthesis and impaired osmoregulation and transpiration [9]. It therefore follows that for sustainable groundnut production, phosphorus and potassium application is necessary. Available

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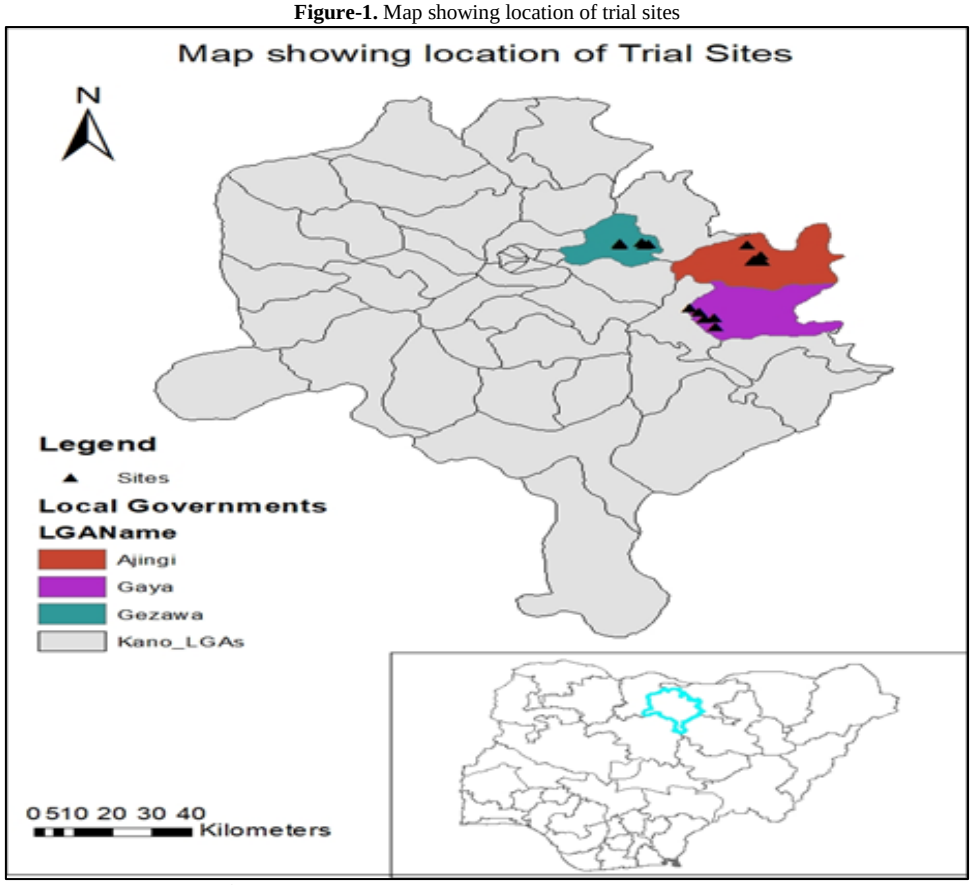
information showed that there are generally low to deficient levels of B, Cu, Mo and Zn in Nigerian Savanna soils [10]. Responses of crops to added micronutrients have been reported to increase yield over 100% above the control with optimum rate of micronutrients application [10]. Organic materials improve soil physical and chemical properties, in turn increasing crop yields. The benefit of organic materials in increasing groundnut yields has been extensively reviewed [4]. Laxminarayanan [11], reported that integrated application of organic and inorganic manures showed higher uptake of N, P and K compared to sole application of organic manure due to increased nutrient availability. The objective of this research therefore, is to study the effect of integrated use of organic manure (cow dung) and inorganic sources of nutrients on groundnut productivity across different locations in the Sudan Savannah of Nigeria.

2. Materials and Methods

2.1. Experimental Sites

Trials were conducted on farmers' fields in three Local Government Areas (LGAs) of Kano State viz; Ajingi, Gaya and Gezawa. In each LGA, five sites were used for the experiment. The sites were selected on the basis of adaptability of groundnut to the agro ecology and prevailing climatic conditions. The locations of trial sites in the various LGAs were presented in Figure 1.

Figure-1. Map showing location of trial sites



Source: and description of variety

The variety used for the research was Samnut 24, which was obtained from International Institute for Tropical Agriculture (IITA) Kano. It is an early-maturing variety (80-90 days) with good haulm yield (2.5-3 t ha^{-1}), vigorous plant growth, good yield (2-2.5 t ha^{-1}) and high oil content (53%). It is however susceptible to late leaf spot disease [2].

2.2. Treatments and Experimental Design

The following treatments were assigned at random to each experimental plot;

1 = Phosphorous (P) only at the rate of 30 kg/ha of (18%) P_2O_5, dibbled at planting.

2 = 30 kg/ha P_2O_5 + Potassium (K) at the rate 25 kg/ha K_2O.

3 = 30 kg/ha P_2O_5 + 25 kg/ha K + Micronutrients (Mc) at the rate of 42.5 g/ha.

4 = 30 kg/ha P_2O_5 + 25 kg/ha K + Mc + Organic matter (OM) at the rate of 4 tons/ha.

5 = OM only (4 tons/ha)

6= Control (no fertilizer treatment)

The micronutrients were applied as foliar spray of Agrolyser Micronutrient Fertilizer (AMF), consisting of;

Na = 1.04%, Zn = 0.11%, Mg = 0.19%, Cu = 0.19%, S = 2.72%, Fe = Trace, Mn = Trace and Mo = Trace.

The treatments were laid out in a Randomized Complete Block Design (RCBD) with 5 replications (where each farmer serves as a replicate).

2.3. Data Collection and Analysis

Data on Plant Height (cm), Number of Branches Plant^{-1}, Days to Flowering, Days to Maturity, Number of Pods Plant^{-1}, Shelling Percentage, 100 Kernel Weight, Haulm Yield (kg/ha) and Pod Yield (kg/ha) were collected and subjected to analysis of variance (ANOVA) as prescribed by Snedecor and Cochran [12] using JMP Version 14 and significant means were separated using Tukey's test [13].

3. Results and Discussion

3.1. Results

3.1.1. Effects of Nutrient Combination on Growth Parameters of Groundnut

The combined results of nutrient combinations in LGAs on growth parameters of groundnut are presented in Table 1. Significant differences existed between the LGAs, where Gaya and Gezawa produced plants of similar heights that were significantly taller than those produced in Ajingi LGA. There were significant differences between the LGAs for days to 50% flowering. Plants from Gaya produced flowers significantly earlier than those from Ajingi and Gezawa, which were statistically similar. However, there were no significant differences among the LGAs on number of branches and days to maturity. Among the treatments, combination of organic and inorganic nutrients (P+K+Mc+OM) produced the tallest plants, which were statistically similar with those that received P, P+K and OM, and significantly taller than those fertilized with P+K+Mc which were in turn significantly taller than those supplied with no fertilizer (Control). The treatments were however not significantly different for number of branches/plant, days to 50% flowering and days to maturity. The interaction between LGA and treatments were not significant for all the measured variables.

Table-1. Effects of Nutrient Combinations on Growth Parameters of Groundnut in Three (3) Local Government Areas of Kano State

	Plant height (cm)	Number of branches plant^{-1}	Days to 50% flowering	Days to maturity
Local Government Areas (LGA)				
Gaya	51.7a	7.2	26.0b	91
Ajingi	43.4b	6.6	27.1a	93
Gezawa	54.4a	6.7	27.7a	91
SE±	1.32	0.2	0.32	0.7
Fertilizer Treatment (Trt)				
P	49.5b	7.3	26.6	92
P+K	49.5b	6.6	26.9	92
P+K+Mc	49.1b	6.5	27.1	92
P+K+Mc+OM	54.6a	6.9	26.6	90
OM	51.7ab	7.2	26.9	90
Control	44.4c	6.4	27.4	92
SE±	1.94	0.34	0.48	0.9
INTERACTION				
LGA x Trt	NS	NS	NS	NS

Means followed by same letter (s) in a column are not significantly different at 5% level of probability using Tukey test. NS = Not Significant, P= Phosphorus, K= Potassium, Mc= Micronutrient and OM= Organic Manure

3.1.2. Effects of Nutrient Combinations on Yield Parameters of Groundnut

Yield parameters of groundnut are presented in Table 2. There were significant differences among all the measured variables at LGA level. Highest number of pods were produced in Gezawa while Ajingi and Gaya produced plants with statistically similar number of pods/plant. Highest pod yields (1783 kg/ha) were produced in Gezawa while Gaya and Ajingi were statistically at par and produced 1086 kg/ha and 1143 kg/ha of pods, respectively. Higher haulm yields were produced in Ajingi than Gezawa, which in turn was significantly higher than Gaya. For 100 kernel weight, heavier kernels were recorded in Gezawa (38.26g), which was significantly higher than Ajingi (36.00g), which was in turn higher than Gaya (33.90g). Significant differences in shelling percentage existed across the LGAs, where Gaya and Gezawa were at par and produced pods with higher shelling percentages than Ajingi.

Although no significant differences were observed between the treatments in all the measured variables across the LGAs, OM produced numerically highest pod and haulms yield of 1443 kg/ha and 2415 kg/ha respectively. The interaction between LGA and treatments were significant (P= 0.0420) for haulm yield and highly significant (P= 0.00131) for pod yield.

Table-2. Effects of Nutrient Combination on Yield Components of Groundnut in Three (3) Local Government Areas of Kano State

	Number of pods plant^{-1}	Pod yield (Kg/ha)	Haulm yield (Kg/ha)	100 kernel Weight(g)	Shelling percentage (%)
LGA					
Gaya	18.1b	1086b	1751c	33.90c	72.93a
Ajingi	16.9b	1143b	2725a	36.00b	70.40b
Gezawa	25.0a	1783a	2349b	38.26a	74.43a

SE±	1.27	82.4	94.9	0.408	0.884
Fertilizer Treatment (Trt)					
P	18.7	1315	2368	35.87	73.19
P+K	18.6	1303	2286	36.39	72.16
P+K+Mc	20.8	1338	2207	36.19	73.11
P+K+Mc+OM	21.1	1411	2368	37.11	72.41
OM	20.1	1443	2415	35.59	73.12
Control	20.9	1214	2003	35.19	71.51
SE±	1.87	121.9	140.1	0.602	1.306
INTERACTION					
LGA x Trt	NS	**	*	NS	NS

Means followed by same letter in a column are not significantly different at 5% level of probability using Tukey Test. NS = Not significant, P= Phosphorus, K= Potassium, Mc= Micronutrient, OM= Organic Manure, ** = Highly significant and * = Significant

3.1.3. Interactions between Nutrient Combinations and LGA on Pod and Haulm Yields

The results for interaction between nutrient combination and LGA on pod and haulm yields are presented in Table 3. The highest pod yield (2004 kg/ha) was obtained with application of organic manure only at Gezawa, while the lowest pod yields were produced under control at Ajingi (968 kg/ha), which were at par with the application of P alone (973 kg/ha) and P+K (974 kg/ha), both at Gaya. Application of the nutrients did not yield any significant responses for all the treatments in Gaya and Ajingi. In fact the control plot in Gezawa out yielded plots that received P, P+K etc. both in Gaya and Ajingi.

In general, haulms were least produced in Gaya for all treatments compared to the other two LGAs. The highest haulm yields were obtained by application of organic manure in Ajingi (2904 kg/ha), P+K+Mc+OM in Ajingi (2893 kg/ha), P in Ajingi (2871 kg/ha) and P+K in Ajingi (2862 kg/ha). The mean lowest haulm yields were obtained in control plots of Gaya (1640 kg/ha).

Table-3. Interaction between Treatments and Local Government Areas on Pod and Haulm Yield of Groundnut

Local Government Areas				
	Gaya		Ajingi	Gezawa
Fertilizer Treatment		Pods yield		
P	973f		1123def	1851ab
P+K	974f		1244b-f	1692a-d
P+K+Mc	1096def		1090def	1826abc
P+K+Mc+OM	1306b-f		1234c-f	1693a-d
OM	1128def		1197def	2004a
Control	1040ef		968f	1634a-e
SE±	202.2			
		Haulms yield		
P	1729de		2871a	2504abc
P+K	1673e		2862a	2322a-e
P+K+Mc	1695de		2546ab	2380a-d
P+K+Mc+OM	1924b-e		2893a	2287a-e
OM	1842cde		2904a	2500abc
Control	1640e		2271a-e	2099b-e
SE±	232.4			

Means followed by same letter(s) are not significantly different at 5% level of probability using Turkey Test

4. Discussion

Fertilizers are sources of plant nutrients that can be added to soil to meet crops needs. They are intended to supply plant needs directly rather than indirectly through modification of such properties as soil pH and structure. Treating groundnut with P+K+Mc+OM produced significant increase in plant height, while all the other parameters show no response to the nutrients and nutrient combinations. This could be attributed to the complimentary role played by the nutrients in successful growth and development of groundnut. Varalakshmi, *et al.* [14] demonstrated that incorporation of farm yard manure along with inorganic phosphorus increases the availability of P to the plant and this was attributed to the reduction in fixation of water soluble P, increased mineralization of organic P due to microbial action and enhanced mobility of Lalfakzuala, *et al.* [15] described that the combined application of NPK and cow dung exhibited a beneficial effect on groundnut yield. This is in agreement with the findings of Premanandarajah and Shanika [16], who testified that highest pod yields of groundnut were obtained by integrating 25% organic manure with 75% chemical fertilizer, with a significant yield improvement over control.

Organic manure normally contains complex compounds and provide not only a variety of nutrients but also add to the most important constituent of the soil, humus which provides excellent substrate for plant growth. The higher

pod and haulm yields as a result of organic manure application on the crop could be attributed to the role of manure in promoting the soil physical and chemical properties which could have resulted into higher yields of the crop. The positive effect of organic manure on groundnut yield was reported by Subrahmaniyan, *et al.* [17]; Chandrasekaran, *et al.* [18]. This result is also in agreement with Ahlawat [19] who stated that, application of cow dung maximizes pod yield of peanut. Lokanath and Parameshwarappa [20], reported increase in shelling percentage and pod yield with the application of organic manure under rain fed situation. Mukhtar and Ajit [21], also conveyed a significant effect of cow dung application on number of pods plant^{-1}, shelling percentage, pod yield and kernel yield of groundnut.

5. Conclusion

In conclusion, the present study has indicated that among the three LGAs, Gezawa produced the highest pod yield (1783 kg/ha) while Gaya and Ajingi were at par and produced 1086 kg/ha and 1143 kg/ha, respectively. Ajingi produced significantly higher haulm yield than Gezawa which in turn is significantly higher than Gaya.

The study also discovered that, although the effects of nutrient combinations were not statistically significant on all the measured parameters in all the sites within each of the 3 LGAs, the combined application of P, K, Mc and OM numerically produced the greatest results within Gaya and Ajingi while OM produced the best result in Gezawa. The least results within all the 3 LGAs were recorded under control.

Recommendation

Based on the outcome of this research work, the following recommendations were made;

i. Since the various nutrients and their combination did not show any significant difference on yield and its attributes in the study area, similar research should be repeated in other locations in the same ecological zones so as to confirm the outcome of this work.
ii. Meanwhile for economic and environmental consideration, farmers should consider applying 4 t/ha of OM, since the pod and haulm yields from P+K+Mc+OM was not significantly higher than yields from 4 t/ha of OM.

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