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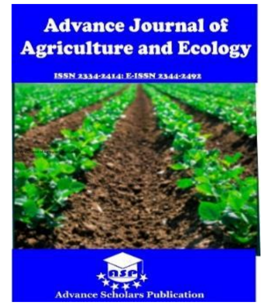

EFFECT OF APPLICATION OF MINERAL FERTILIZERS AND ORGANIC MANURE ON THE POD AND HAULM YIELDS OF GROUNDNUT (*ARACHIS HYPOGEA*. L.) IN THE SAVANNA OF BORNO STATE NORTH-EAST NIGERIA

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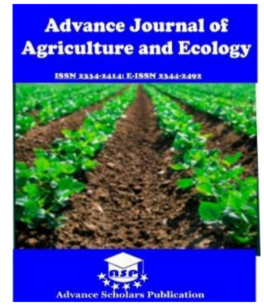
Key words: *Groundnut, SAMNUT 22, Mineral fertilizers, P, K, Micronutrients, Organic Manure, Savanna*

Abstract: *Declining land productivity is a major problem facing smallholder farmers in North-eastern Nigeria today. This decline primarily results from reduction in soil fertility caused by continuous cultivation without adequate addition of external nutrient input. Mineral fertilizers and organic manure and their combinations are necessary to increase nutrient use efficiency. Improved soil fertility management combining mineral fertilizers and organic manure can increase overall system's productivity. Trials were established on farmers' fields in Bayo, Kwaya Kusar and Hawul Local Government Areas (LGAs) in Borno State North-eastern Nigeria with the aim of testing the response of groundnut to mineral fertilizers and organic manure and their combinations. The combined application of P, K, micronutrients and organic manure (PKMNOM) produced the highest pod and haulm yields (kg ha-1) in both years across the three locations. Though the plots that received P alone consistently produced higher both pod and haulm yields (kg ha-1), organic manure application alone generally had greater influence across all the three LGAs.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is central to the financial and nutritional well-being of millions of farmers and consumers across North-east Nigeria (Hakeem *et al.* (2020), Viba *et al.*, (2019a). Groundnut is an important cash and food grain legume crop grown for its edible oil and protein rich kernels (Audu *et al.* 2017, Viba *et al.* 1019b, Ojo *et al.* 2023, Ahmed *et al.* 2020, Ajala *et al.*, 2021). Groundnut production in North-east Nigeria has been found to be a profitable enterprise (Lawal and Muhammad, 2018). Nigeria is the leading producer of groundnut in Africa with production mostly carried out by



resource poor farmers (Yusuf *et al.,* 2014). As a leguminous crop, it does not require high amounts of nitrogenous fertilizers, hence most farmers in North-east Nigeria prefer to grow groundnut on poor soils without fertilizers. Groundnut is also an easily marketed cash crop that increases farmer' income, and sometimes grown as sole crop or in rotation with cereals to reduce infestation of the parasitic weed, *Striga hermontheca*. Groundnut yield in most countries in Africa and some in Asia and South America are lower than the world average. The yields are low largely because the crop is grown under rainfed conditions in marginal and eroded soils with very little or no input (Mustapha *et al*., 2020, Viba *et al*., 2019a). Low organic matter and nitrogen and phosphorus are the main constraints to crop production including groundnut in North-eastern Nigeria (Kwari *et al*., 1999). Both mineral fertilizers and organic inputs are required to improve soil fertility (Vanlauwe *et al*., 2002). Soils in the savanna zone of Northern-eastern Nigeria are generally poor in nutrient status especially phosphorus, potassium, micronutrients and low organic matter content. The need for sustainable and productive agriculture necessitates prioritization of soil management (Sharu *et al*., 2013, Ado and Yusuf, 2008). Intensification of land use systems arising from increased population pressure combined with low fertilizer use has resulted in soil fertility depletion in North-east Nigeria (Rayar, 1988). Cattle manures are a source of nitrogen and other nutrients for plants (such as phosphorus, potassium, calcium, iron, zinc and copper) that can make valuable contributions to soil's organic matter, can improve soil physical fertility, and are a centre for biological activities (Khalid and Shafei, 2005; Najm *et al.,* 2012). Organic amendments can improve plant health beyond the nitrogen fertility value (Atiyeh *et al.,* 2002). In addition to improvement of soil fertility organic matter application promotes soil aggregation, improves moisture infiltration and increase the water holding capacity of the soil (Najm *et al.,* 2012)). They contribute to plant growth through their favourable effects on the physical, chemical and biological properties of soil.

Phosphorus (P) deficiency is the most frequent nutrient stress for growth and development of grain legumes including groundnut (Kamara *et al*., 2008) in the Nigerian savannas. As with other legumes, added phosphates may have beneficial effects on growth, nodulation, and nitrogen fixation of groundnut. Phosphorus is a crucial element in crop production which plays important role for many characteristics of plant growth such as sugar and starch utilization, photosynthesis use, cell division and organization, nodule formation, root development, flower initiation and seed and fruit development (Gangasuresh *et al*., 2010). Phosphorus is second only to nitrogen as an essential mineral fertilizer for crop production.

The role of K in agricultural production is intimately connected with photosynthesis (Atkin and Macherel, 2009). The need for K has been

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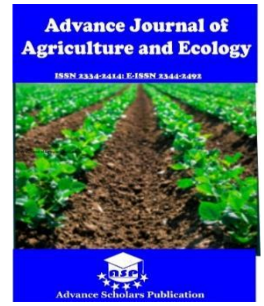

demonstrated for some *Rhizobia* strains (Vincent, 1977), who showed restricted growth of *R. trifolii* and *R. meliloti* when K was omitted from a defined medium. Potassium plays significant roles in enhancing crop quality. High levels of available K improve the physical quality, disease resistance, and shelf-life of fruits and vegetables used for human consumption and the feeding value of grain and forage crops. However, K has other important roles in major plant processes such as photosynthesis, respiration, osmoregulation, growth and yield of plants but however, does not enter the composition of any product unlike nitrogen and phosphorus (Khurana and Sharma, 2000).

Nutrient limitations to legume production result from deficiencies of not only major nutrients but also micronutrients (Bhuiyan *et al.*, 1999). However, as a general practice, optimal supply of macronutrients to crops is usually ensured while that of micronutrients are ignored.

Ashraf *et al.,* (2012) observed that the involvement of micronutrients in different physiological and biochemical activities of the legume plants is well documented because correlations between micronutrient supply and crop growth and productivity have often been observed. Problem soils such as acid, alkaline or sandy soils are often deficient in one or more micronutrient elements (Ashraf *et al.,* 2012). Thus, application of micronutrients as foliar or soil amendment is paramount to achieving optimum groundnut productivity from the soils of the northern Nigerian savannas.

Soils of the Nigerian savanna are low in available P, K, organic matter and micronutrient; therefore, application of these fertilizer has been recommended to increase productivity since legumes generally have a good response to these fertilizers (*Ogoke et al.*, 2003, Bationo *et al.*, 2015). Also, organic matter content of the soil is low, thus there is need to incorporate organic manure to raise soil fertility by improving soil physical, chemical and biological properties. Current fertilizer recommendations are based on single nutrients thereby necessitating the use of other nutrient sources. The beneficial effects of combined organic and inorganic sources on soil nutrients, crop yields, and maintenance of soil organic matter have been reported in field trials (Vanlauwe *et al.*, 2002, Kihari *et al.*, 2016). Owing to this fact, this practice is worth adopting in groundnut production to increase productivity while maintaining and improving soil organic matter content. There is the need to investigate the response of groundnut to P, K, organic manure and micronutrient especially in North-eastern savannas of Nigeria where groundnut is one of the major crops grown and such information is scanty.

MATERIALS AND METHODS

Experimental sites

Field experiments were conducted on 90 farmers' fields in Bayo Local Government Area (LGA), Kwaya Kusar LGA and Hawul LGA of Borno State North-eastern Nigeria (Fig. 1). Groundnut was not grown in the sites for the trials for the past two rainy seasons. Separate but adjacent plots within

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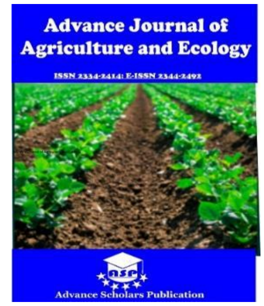

each site was used each year to avoid the residual effects of applied fertilizers. At the beginning of the trials, composite soil samples (0-20 cm) were collected from each experimental plot with a soil auger. Each composite sample contained three subsamples along three transect across the field and mixed together. Soil and cow dung samples were analysed according to the analytical procedures of IITA (1989) for the following soil properties: pH (H_2O), organic C, total N, plant available P (Olsen), CEC, cations (K, Ca, Mg) and soil particle size. Rainfall figures were obtained at weather stations close to the experimental sites.

Treatments and experimental design

The treatments consist of the control (C), organic manure (cow dung) (OM), Phosphorus (P), combination of Phosphorus and Potassium (PK), combination of Phosphorus, Potassium and Micronutrients (PKMN) and combination of Phosphorus, Potassium, micronutrient and organic manure (PKMNOM). The experimental design was Randomized Complete Block Design (RBCD) with 90 replicates (number of farmers).

Cultural practices

The experimental sites were cleared, tilled with disc harrow, and ridges were prepared using work-bulls mounted with mould-board ploughs. The groundnut variety SAMNUT 22 (a medium maturing Spanish type variety released in 2011) was used. At all locations two seeds of groundnut per hole was sown without thinning at 10 cm between hills and 75 cm between rows. Each plot measuring 10 m x 10 m is separated with alleys of 0.5 m apart. The organic manures as cow dung were uniformly
spread on the soil surface and then incorporated in the soil at the rate of four ton/ha at land preparation while Agrolizer micronutrients fertilizer was by foliar application at 5g of granules per two litres of water per plot. Three applications were carried out using a knapsack sprayer beginning from 3 weeks after planting at one-week interval. Phosphorus and K fertilizers in form of single super phosphate (SSP) and muriate of potash (MOP) were applied by banding at planting at the rate of 30 kg ha^{-1} P_2O_5 and 20 kg ha^{-1} K_2O. Manual hoe weeding was carried out to control the subsequent weeds throughout the crop growth periods. Plants were harvested at physiological maturity.

Data collection and statistical analysis

At harvest, all mature pods from plants were uprooted from the net plots on an area of 1.5 m^2 per plot (net plot), were left on the haulm to sun-dry to a constant weight in the field before they were picked and weighed. After picking the pods, all the hauls (stems and leaves) were collected and weighed. Pod and haulm yields were then converted to kg ha^{-1} as follows:

$$\text{Pod yield (kg ha}^{-1}\text{)} = \frac{\text{Pod yield per net plot x } 10{,}000\text{m}^2}{\text{Net plot area (m}^2\text{)}}$$

$$\text{Haulm yield (kg ha}^{-1}\text{)} = \frac{\text{Haulm weight per plot x } 10{,}000\text{m}^2}{\text{Net plot area (m}^2\text{)}}$$

The data were subjected to analysis of variance (ANOVA) using SAS (SAS Institute Inc. Cary, NC,

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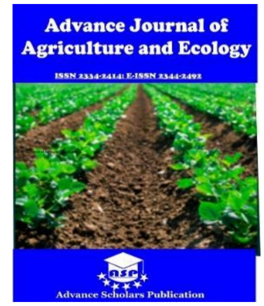

USA.) computer software. Duncan's Multiple Range Test (DMRT) was adopted for means separation.

RESULTS AND DISCUSSION

Details of the physical and chemical analytical results of the soils at the experimental sites taken before planting are presented in Table 1. The pH of the soils was slightly acidic to neutral at all sites while organic carbon was highest in Kwaya Kusar Local Government Area (LGA) (12.89 g kg^{-1}) and lowest in Bayo LGA (5.38 g kg^{-1}) (Table 1). Total N was almost similar in Kwaya Kusar LGA (1.27 g kg^{-1}) and Hawul LGA (1.28 g kg^{-1}) but lowest in Bayo LGA (0.46 g kg^{-1}). Available phosphorus was 6.93 Mg kg^{-1}, 3.86 Mg kg^{-1}, and 5.22 Mg kg^{-1} in Bayo, Kwaya Kuasar and Hawul LGAs, respectively while exchangeable K was highest in Hawul LGA (10.27 cmol kg^{-1}) and lowest in Bayo LGA (1.65 cmol kg^{-1}) (Table 1).

The properties of manure (cow dung) used for the are presented in Table 2. Average N and P contents of the manure are 0.35% and 2.3%, respectively (Table 2). The content of Ca is high with an average of 0.68% ranging from 0.43% to 0.93% while Mg and Ca averaged 0.21% and 0.45%, respectively. The amounts of Fe, Mn and Zn were comparatively high (Table 2) indicating that the manure used has high micronutrients.

The mean rainfall in the first and second years in Bayo, Kwaya Kusar and Hawul LGAs where the experiment was conducted are summarized in Figure 2. In Bayo LGA, total rainfall was higher in the second year (1013.5 mm) than in the first (648.0) (Figure 2). Also, in Kwaya Kusar LGA total rainfall was higher in year two (1003.0 mm) than in year one (953 mm) (Table 2). Similarly, in Hawul LGA total rainfall was higher in year two (1071.3 mm) than in the first (908.5) (Figure 2). Generally, at all the three locations, rainfall was poorly distributed in the first year than in the second year. The total rainfall in the two locations was optimal for groundnut growth.

Results of the effects of the application of mineral fertilizers and organic manure on pod and haulm yields of groundnut in Bayo LGA are shown in Table 3. The pod yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) of groundnut were significantly influenced by the application of mineral fertilizers and organic manure in both year one and year two cropping seasons (Table 3). The application of P gave pod yield (kg ha^{-1}) that was significantly higher than that of the control in Bayo LGA (27.7% in year one and 13.6% in year two (Table 3). This result is consistent with the findings of Kamara *et al.* (2011) who reported significant responses of grain yield and yield components of groundnut to P application in north east Nigeria confirming the importance of P for groundnut production in the Nigerian savannas. According to Kwari (2005), the soil P level in the trial sites were far below the critical values recommended for groundnut. In both 2015 and 2016, the combined application of P, K, micronutrients and organic manure (PKMNOM) gave the highest pod yield (kg ha^{-1}) followed by the combined application of P, K and micronutrients (PKMN). Also, in both years, the application of organic matter only produced pod yield (kg ha^{-1}) that was

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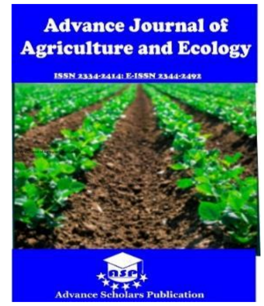

significantly higher than that of the control and when only P was applied. This agrees with the work of Stevenson, (1994) who documented the many benefits of organic manure. On average, the yield of groundnut was significantly higher in the second year (2439.2 kg ha^{-1}) than in the first year (2189.7 kg ha^{-1}) Table 3. This may be because rainfall was poorly distributed in the first year than in the second year.

The combined application of P, K, micronutrients and organic manure (PKMNOM) produced the highest haulm yield (kg ha^{-1}) in both years in Bayo LGA (Table 3). The application of OM alone produced haulm yield (kg ha^{-1}) that was significantly higher than the control and even with the application of P alone. In the first year, the application of OM alone produced haulm yield that was similar to that of combined application of P, K and micronutrients (PKMN). The general better performance in terms of both haulm and pod yields derived from this study reconfirmed the result obtained from the findings of Tejada and Gonzalez; 2003 who concluded that application of organic fertilizer which are made from animal excreta or other agricultural wastes contributed to the sustainability of agricultural system and is usually used to improve soil structure and stability in addition to enhancing the yield and quality of plants. In both years the haulm yield of groundnut was neither significantly influenced by year nor by year x variety interaction in Bayo LGA (Table 3).

Table 4 shows the pod yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) for both years in Kwaya Kusar LGA of Borno state northeast Nigeria. The results did not show significant difference in mean pod yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) among the five soil amendments and the control in the first year. In contrast, the results the in second year indicated significant differences in the pod yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) among the five soil amendments and the control. The combined application of P, K, micronutrients and organic manure (PKMNOM) produced the highest pod yield. The unfertilized plots (control plots) recorded the lowest pod yield (1,385.7 kg ha^{-1}) in the second year. Also, in the second year the application of P alone and combined application of P and K produced pod yield (kg ha^{-1}) that were statistically similar (Table 4). The results agreed with reports of Rayar, (1988) that intensification of land use systems arising from increased population pressure combined with low fertilizer use has resulted in soil fertility depletion in northeast Nigeria. Phosphorus (P) deficiency is the most frequent nutrient stress for growth and development of grain legumes including groundnut (Kamara et al., 2008) in the Nigerian savannas. As with other legumes, added phosphates may have beneficial effects on growth, nodulation, and nitrogen fixation of groundnut. Mean pod and haulm yields were not statistically different between years in Kwaya Kusar LGA (Table 4). Interactions between treatment and year were also not significantly different. The combined application of P, K, micronutrients and organic manure (PKMNOM) produced the highest haulm yield (kg ha^{-1}) in year two (3108.7

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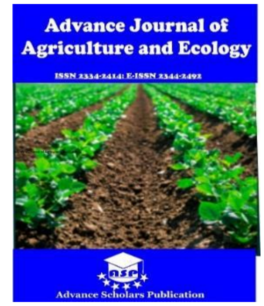

kg ha^{-1}). The combined application of P, K and micronutrients (PKMN) did not produce haulm yield that was statistically different from that of sole organic manure application (Table 4). This may be due to the fact that cattle manures are a source of N and other nutrients for plants (such as phosphorus, potassium, calcium, iron, zinc and copper). The manure can make valuable contributions to soil's organic matter, can improve soil physical fertility, and are a centre for biological activities (Khalid and Shafei, 2005; Najm et al., 2012). The unfertilized plots recorded the lowest haulm yield (kg ha^{-1}) in year two (Table 4). The influence of year and also treatment x year interaction were similar for both pod and haulm weight in Kwaya Kusar LGA location.

Table 5 presents the effects of the application of mineral fertilizers, organic manure and their combinations on grain and haulm yields of groundnut in Hawul LGA of Borno State northeast Nigeria. In the first year the unfertilized plots produced the lowest pod yield (kg ha^{-1}) while all the other soil amendments produced significantly similar pod yield (kg ha^{-1}). The application of mineral fertilizers and organic manure to groundnut significantly influenced grain and haulm yields of groundnut in Hawul LGA. The highest pod yield (kg ha^{-1}) were produced in plots applied with a combination of PKMNOM.

The combined application of P, K, micronutrients and organic manure (PKMNOM) produced the highest haulm yield in Hawul LGA in the combined mean for both years as shown in Table 5, though haulms yield in plots treated with PKMNOM, P, K and micronutrients PKMN, PK and organic manure (OM) alone were statistically similar. Mean pod yield was higher by 14.7% when P alone was applied and 19.1% with the combined application of P and K (PK) compared with unfertilized plots (Table 5). P is a limiting nutrient in the soils of the Nigeria savannas (Kwari *et al*.,). According to Gangasuresh *et al*., (2010), P is a crucial element in crop production which plays important role for many characteristics of plant growth such as sugar and starch utilization, photosynthesis use, cell division and organization, nodule formation, root development, flower initiation and seed and fruit development. Kamara *et al*., 20111 reported that pod yield increased linearly with increasing P rates in the savannas of northeast Nigeria with mean pod yield was higher by 49.3% at 20 kg and by 57.8% at 40 kg P ha-^{1} compared with unfertilized plots. Potassium is also important for groundnut production. The role of K in agricultural production is intimately connected with photosynthesis (Atkin and Macherel, 2009). The need for K has been demonstrated for some Rhizobia strains. Vincent, (1977), showed restricted growth of *R. trifolii* and *R. meliloti* when K was omitted from a defined medium. Mean pod yield (kg ha^{-1}) and mean haulm yield (kg ha^{-1}) were both statistically higher in both years (Table 5). This may be due to that fact that rainfall was poorly distributed in the first year than in the second year.

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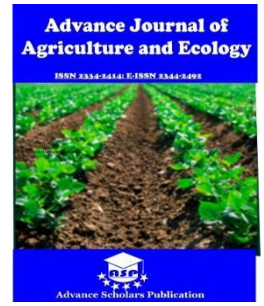

CONCLUSION

This study showed that there is the need for combined application of both mineral fertilizers and organic manure to close the yield gap of groundnut in northeast Nigeria. The combined application of P, K, micronutrients and organic manure (PKMNOM) consistently produced the highest pod and haulm yields in both years in all the three locations (LGAs). Though the plots that received P alone produced both pod and haulm yield of groundnut that were significantly higher those of the unfertilized plots, organic manure application alone generally had greater influence across all the three agroecological zones.

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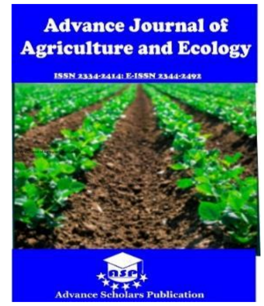

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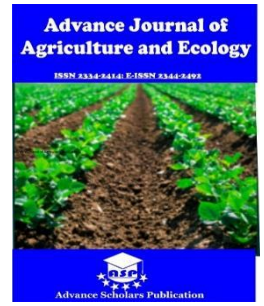

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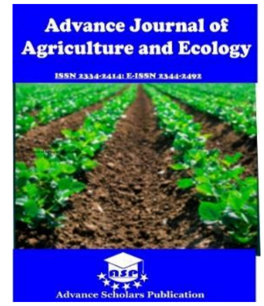

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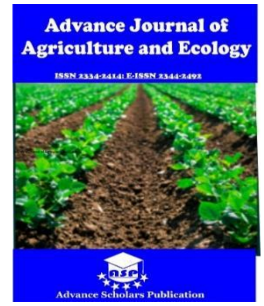

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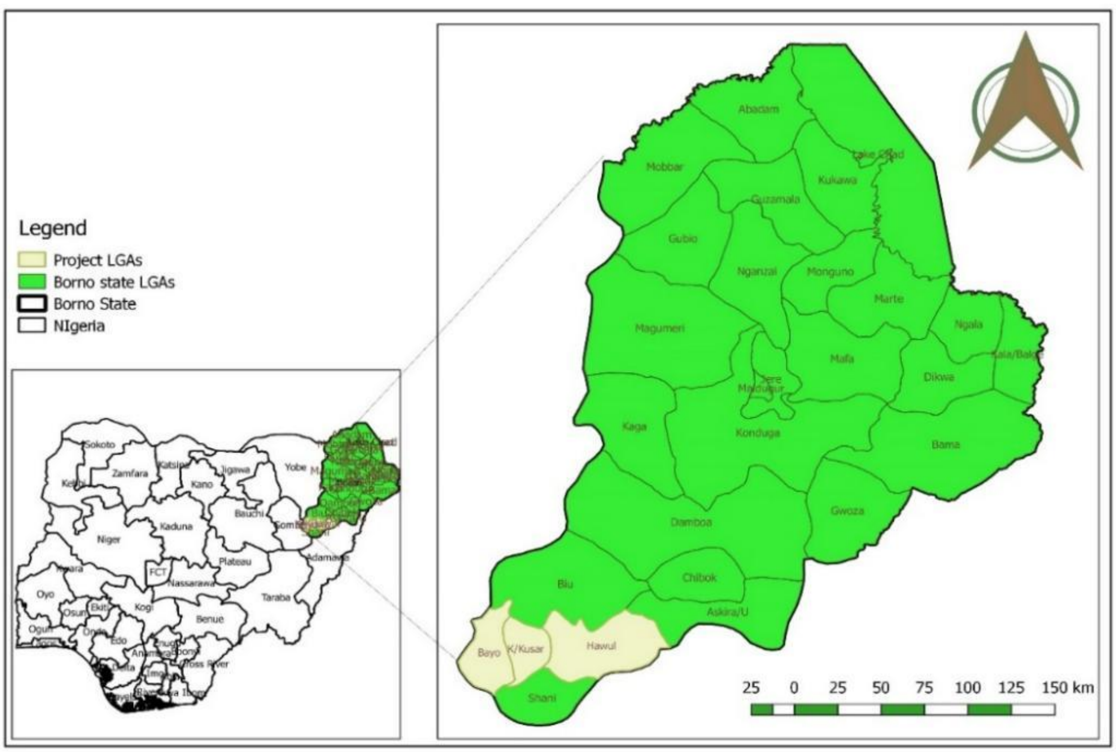

Fig.1: Map showing Bayo, Kwaya Kusar and Hawul Local Government Areas of Borno State, North-eastern Nigeria where the trials were conducted

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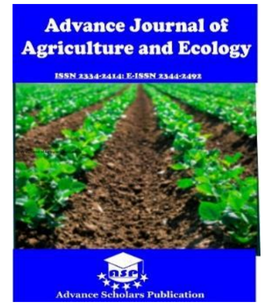

Table 1: Means of soil physical and chemical analytical results of the soils (0-20 cm) obtained from farmers' fields in Bayo, Kwaya Kusar and Hawul Local Government Areas of Borno State, North-eastern Nigeria

AEZ	Soil PH (H_2O)	OC g kg^{-1}	Total N g kg^{-1}	Avai. P (Bray 1) Mg kg^{-1}	Exch. K cmol kg^{-1}	Exch. Ca cmol kg^{-1}	Exch. Mg cmol kg^{-1}	Exch. Na cmol kg^{-1}	ECEC cmol kg^{-1}	Zn mg kg^{-1}	Mn mg kg^{-1}	Fe mg kg^{-1}		Sand %	Silt %	Clay %
SS	6.73	5.38	0.46	6.93	1.65	3.32	1.44	0.06	6.47	27.04	105.41	213.08		64.5	13.25	22.00
NGS	7.00	12.89	1.27	3.86	4.04	7.03	3.82	0.14	15.02	27.89	116.83	175.89		62.78	16.00	20.67
SGS	6.79	10.59	1.28	5.22	10.27	10.22	4.56	0.81	25.86	26.14	110.41	178.79		24.07	26.53	49.07
Mean	6.82	9.575	1.02	5.29	5.39	7.15	3.26	0.3	16.09	26.98	110.93	181.21		43.09	21.35	34.50

Table 2: Chemical composition of manure (cow dung)

Composition	Mean	Range
N (%)	0.35	0.14 – 0.56
P (%)	0.23	0.21 – 0.25
Ca (%)	0.68	0.42 – 0.93
Mg (%)	0.21	0.13 – 0.28
K (%)	0.54	0.18 – 0.89
Fe (mg kg^{-1})	1771.1	1057.0 – 2485.2
Mn (mg kg^{-1})	142.2	132.4 – 151.9
Zn (mg kg^{-1})	33.4	21.34 – 42.4

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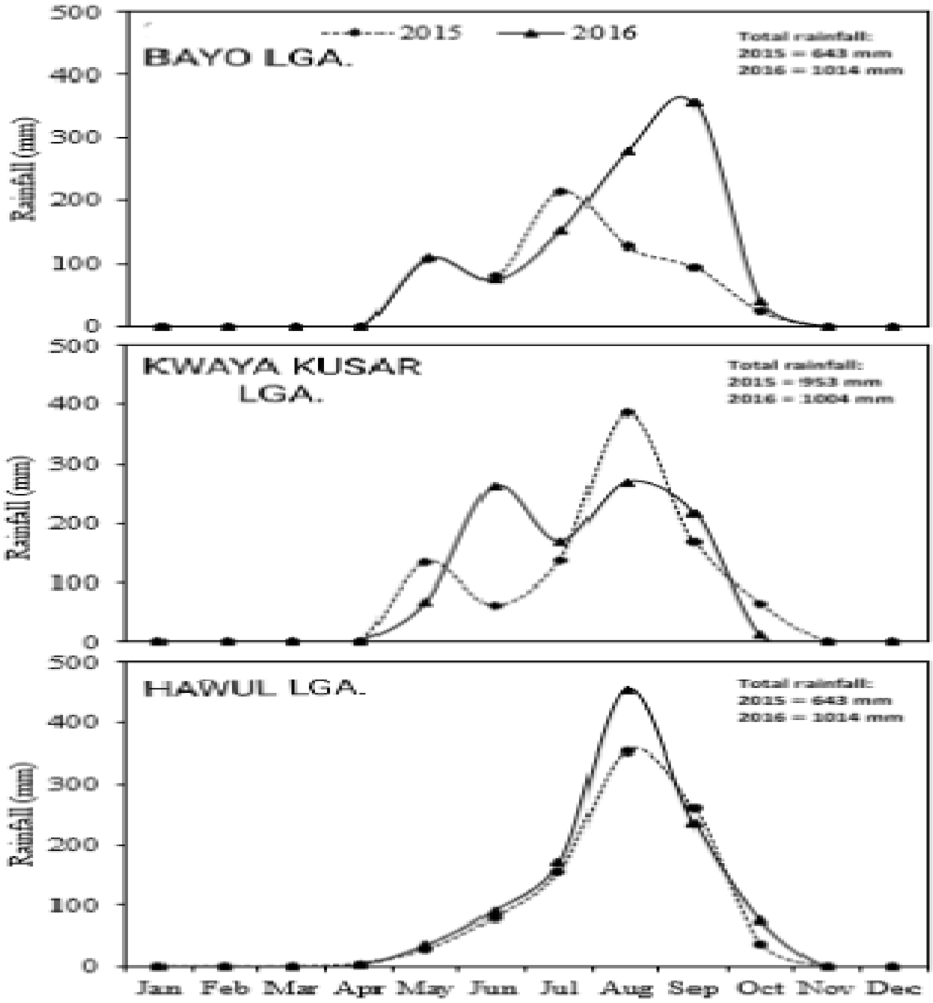

Figure 2: Mean monthly rainfall (mm) showing Bayo, Kwaya Kusar and Hawul Local Government Areas of Borno State, North-eastern Nigeria

Table 3: Effects of the application of mineral fertilizers and organic manure and their combination on grai and haulm yields of groundnut in Bayo LGA of Borno state, North-eastern Nigeria

	Pod yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
Treatments	Year 1	Year 2	Mean¹	Year 1	Year 2	Mean¹
Control	1499.0^{e2}	1743.3^{f}	1621.1^{f2}	1980.5^{c}	2047.1^{f}	2013.8^{e}
OM	2292.0^{c}	2563.0^{c}	2427.5^{c}	2802.7^{ab}	2774.1^{c}	2788.4^{bc}
P	2073.0^{d}	2017.0^{e}	2045.0^{e}	2469.0b^{c}	2292.5^{e}	2380.7^{d}

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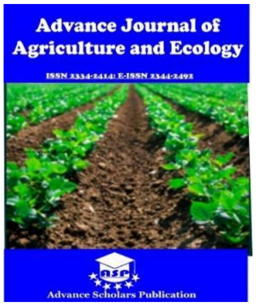

PK	2210.7^{c}	2378.6^{d}	2294.6^{d}	2625.5^{b}	2584.4^{d}	2604.9^{cd}
PKMN	2423.5^{b}	2797.9^{b}	2610.7^{b}	2976.5^{ab}	3060.4^{b}	3018.4^{b}
PKMNOM	2639.7^{a}	3134.9^{a}	2887.3^{a}	3255.7^{a}	3443.4^{a}	3349.6^{a}
Mean	2189.7^{b}	2439.2^{a}		2685.0^{a}	2700.3^{a}	
SE (±) T	44.11**	13.80**	23.11**	168.02**	16.85**	84.43**
SE (±) Y	13.34**			48.75^{ns}		
SE (±) T x Y	32.69**			119.41^{ns}		

NB: OM = organic manure (cow dung), P = Phosphorus, PK = combination of Phosphorus and Potassium, PKMN = combination Phosphorus, Potassium and Micronutrients and PKMNOM = combination of Phosphorus, Potassium, micronutrient and organic manure. 1 = Combined mean of Year 1 and Year 2 data. 2 =Means within a column followed by similar letter(s) are not significantly different (P=0.05) according to Duncan's Multiple Range Test (DMRT). **Significant at 1% level of probability according to DMRT. ns=not significant.

Table 4: Effects of the application of mineral fertilizers and organic manure and their combination on grai and haulm yields of groundnut in Kwaya Kusar LGA of Borno state, North-eastern Nigeria

	Pod yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
Treatments	Year 1	Year 2	Mean^{1}	Year 1	Year 2	Mean^{1}
Control	1676.2^{2}	1385.7^{e}	1531.0^{d}	2037.0	1652.0^{e}	1844.5^{d}
OM	2071.0	2194.0b^{c}	2132.5^{bc}	2862.5	2558.6^{bc}	2710.6^{abc}
P	1971.5	1689.6^{d}	1830.6^{cd}	2489.0	2012.3d	2250.7^{cd}
PK	1997.0	1973.5^{cd}	1985.2^{bc}	2533.5	2297.9^{cd}	2415.7^{bc}
PKMN	2174.0	2402.4^{b}	2288.2^{ab}	2910.7	2825.0a^{b}	2867.9^{ab}
PKMNOM	2307.5	2702.0^{a}	2504.8^{a}	3094.5	3108.7^{a}	3101.6^{a}
Mean	2032.9^{a}	2057.9a		2654.5^{a}	2409.1^{a}	
SE (±) T	213.45ns	96.06**	117.04**	326.93ns	115.15**	173.31**
SE (±) Y	67.57^{ns}			100.06^{ns}		
SE (±) T x Y	165.51^{ns}			245.91^{ns}		

NB: OM = organic manure (cow dung), P = Phosphorus, PK = combination of Phosphorus and Potassium, PKMN = combination Phosphorus, Potassium and Micronutrients and PKMNOM = combination of Phosphorus, Potassium, micronutrient and organic manure.

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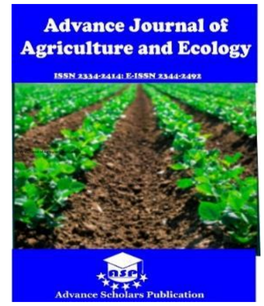

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Table 5: Effects of the application of mineral fertilize and organic manure and their combination on grain an haulm yields groundnut in Hawul LGA of Borno stat North-eastern Nigeria

	Pod yield (kg ha^{-1})			Haulm yield (kg ha^{-1})		
Treatments	Year 1	Year 2	Mean^1	Year 1	Year 2	Mean
Control	1151.0^{b2}	2409.2	1780.1^{c}	1602.5	2744.9	2173.7^{c}
OM	1590.0^{a}	3290.9	2440.4^{ab}	2126.0	3575.4	2850.7^{abc}
P	1535.0^{a}	2551.5	2043.3^{bc}	2033.0	2956.1	2494.6^{bc}
PK	1496.5^{a}	2994.2	2245.4^{abc}	1890.0	3288.0	2589.0^{abc}
PKMN	1649.5^{a}	3600.9	2625.2^{ab}	2137.0	3957.3	3047.1^{ab}
PKMNOM	1722.0^{a}	3924.9	2823.5^{a}	2403.0	4232.4	3317.7^{a}
Mean	1524.0^{b}	3128.6^{a}		2031.9^{b}	3459.0^{a}	
SE (±) T	102.61*	405.08^{ns}	208.94*	215.04^{ns}	520.90^{ns}	236.32*
SE (±) Y	120.63**			136.44**		
SE (±) T x Y	295.48^{ns}			334.21^{ns}		

NB: OM = organic manure (cow dung), P = Phosphorus, PK = combination of Phosphorus and Potassium, PKMN = combination Phosphorus, Potassium and Micronutrients and PKMNOM = combination of Phosphorus, Potassium, micronutrient and organic manure.

1 = Combined mean of Year 1 and Year 2 data. 2 =Means within a column followed by similar letter(s) are not significantly different (P=0.05) according to Duncan's Multiple Range Test (DMRT). **Significant at 1% level of probability according to DMRT. ns=not significant.