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COMBINED APPLICATION EFFECTS OF POULTRY MANURE AND OIL PALM BUNCH ASH ON GROWTH AND POD YIELD OF GROUNDNUT (*Arachishypogaea* L.) IN THE ULTISOLS OF UMUDIKE, SOUTHEASTERN, NIGERIA

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ABSTRACT

A field experiment on combined application effects of poultry manure and oil palm bunch ash on growth and pod yield of groundnut (Arachis hypogaea L) in the ultisols of Umudike, Nigeria, was carried out at the Eastern farm of Michael Okpara University of Agriculture, Umudike, during 2020 and 2021 cropping seasons. The experiment was a 2 x 3 x 4 factorial laid out in a randomized complete block design (RCBD) with three replications. Factor A comprised two groundnut varieties (v) (SAMNUT 21 and SAMNUT 24). Factor B comprised poultry manure (PM) rates (0, 10 and 15 tha^{-1}), while factor C comprised oil palm bunch ash (OPBA) rates of 0, 10, 15 and 20 tha^{-1}. The results of the experiment indicated that leaf area index (LA1) increased at 4 and 8 weeks after planting (WAP) and reduced at 12 WAP due to the process of senescence. SAMNUT 24 produced higher LA1 values of 0.40 (WAP); 1.12 (8WAP); 0.89 (12 WAP) and 0.40 (4 WAP); 1.44 (8WAP); 1.16 (12WAP), during 2020 and 2021 cropping seasons compared with SAMNUT 21 with lower LA1 values. Number of branches and dry matter content increased at 4, 8 and 12WAP with SAMNUT 21 producing more branches while SAMNUT 24 produced more dry matter content. This suggests that branching and dry matter will increase with the age of groundnut variety notwithstanding. Both varieties gave higher growth results at the combination rates of PM15 + OPBA 20 compared with PMO + OPBA0 (control). Similarly, SAMNUT 24 gave higher mean pod weight of 75.7g (2020) and 56.3g (2021) over SAMNUT 21. SAMNUT 21 however recorded higher mean number of pods per plant of 41.9 (2020) and 28.9 (2021) as well as harvest index of 0.61 and 0.39% over SAMNUT 24. SAMNUT 24 however yielded higher mean pod yield values of 4994.8 kgha^{-1} (2020) and 3717.6 Kgha^{-1} (2021) compared with SAMNUT 21, with the combination rates of PM15 + OPBA 20 producing highest values for all yield indices compared with the control PMO + OPBA0. Consequently, the combination rate of PM15 + OPBA20 and SAMNUT 24 are recommended for sole groundnut production in Umudike, agro-ecosystem.

Keywords: Growth, yield, poultry manure, palm bunch ash, groundnut

INTRODUCTION

Groundnut is a self-pollinated, annual, herbaceous, prostrate or erect crop with underground fruit formation characteristics (Reddy, 2012). The author further posited that the special feature of groundnut is that the fruit begins as a fertilized flower above ground, but pods and seed mature in the ground. Groundnut is grown on all soil types such as sandy and sandy loam, but it thrives best on sandy loams (Reddy, 2012). It is the most acid tolerant crop, with moderate sensitivity to soil salinity, with an ideal pH of 6.5 to 7.0 (Reddy, 2012). They grow well with rainfall of 750 mm to 12500mm during the growing period (Uguru (2011) although, Reddy (2012) had earlier reported that year to year variations in groundnut productivity are largely due to variations in rainfall distribution, especially during flowering and pegging stages of the crop. Vessey and Buss (2002), acknowledged the importance of groundnut in the world's economy, due to increasing demand of products such as oil for making margarine, cooking oil, soaps and many other domestic uses. It is a veritable source of protein for man and livestock (Weiss, 1983) and most useful in crops rotation as it has the ability to fix atmospheric nitrogen into the soil, hence enriching the fertility of the soil for greater benefit of subsequent crops in the farmland (Oranekwulu, 1995).

` Niagaraj *et al*. (2001), reported that high yields of groundnut can be obtained with better management of soil fertility, especially when grown organically. Malligaward *et al*. (2007) in their studies on the effect of organics on the productivity of large-seeded groundnut stressed the

increased attention on organic farming is gaining, due to its numerous benefits such as the maintenance of a dynamic soil nutrients status and provision of healthy food products. Odedina*et al*. (2003), reported that the attribute that makes organic manure superior to the mineral fertilizer is the slow release of nutrients during decomposition. This makes organic wastes residues of greater benefits, distributed over longer period than inorganic fertilizers (Awodun, *et al*., 2007).

From the afore-mentioned therefore, the experiment measured the combined application effects of poultry manure and oil palm bunch ash on growth and pod yield of groundnut (*Arachis hypogaea* L.) in the ultisol of Umudike, Southeastern, Nigeria.

MATERIALS AND METHODS

This experiment took place at the Eastern farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, during 2020 and 2021 cropping seasons. The location is on latitude 05°29' North, longitude 07°23' East, at an altitude of 122.0m above sea level.

The precipitation pattern is bimodal with the first rains starting from March with a dry period in August followed by the second period which occurs between September and November, following the commencement of dry season. Annual rainfall ranges from 2074.3mm to 2420.0mm, minimum and maximum temperature of 26°C to 31.4°C and relative humidity of 68.4 – 80% respectively (Asumugha *et al*., 2008).

The experiment was a 2 × 3 × 4 factorial laid out in a randomized complete block design (RCBD) with three replications. Factor A comprised two groundnut varieties (SAMNUT 21 and SAMNUT 24). Factor B comprised the poultry manure (PM) rates (0, 10 and 15 tha^{-1}) while Factor C comprised oil palm bunch ash (OPBA) rates (0, 10, 15 and 20 tha^{-1}). SAMNUT 21 possess prostate while SAMNUT 24 possess erect growth habits respectively and were sourced from the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria.

The experimental layout was 43.2 × 8 m (345.6m^2 or 0.035 ha), with each plot measuring 1.8m × 2.0m; 0.5m between plot and 1m between replications. Plant spacing was 50cm × 30cm giving a planting density of 66,660 plants per hectare. The experimental site was ploughed and harrowed before bed making, while planting was conducted in 15th April on bed. Two to three seeds were planted per hole, while thinning to one plant per stand was conducted at 14 days after sowing (DAS). Different rates of poultry manure and oil palm bunch ash were combined and subsequently incorporated into the soil. After organic fertilizer incorporation, the plots were left for two weeks before planting. This was to ensure adequate mineralization of the applied organic manures for prompt release of nutrients.

Poultry manure was sourced from the University poultry farm using a deep litter system of management. Empty oil palm bunches were sourced from local farms and oil mills, which were subsequently incinerated to obtain ash (Akpan and Eka, 2019).The experimental plots were weeded twice, while insect pests were controlled with *Tricel* insecticide at the rate of 43mls per 6.5 litres of water with the help of a knapsack sprayer (Akpan and Oladunmoye, 2019). Harvesting was done at the end of August, precisely, 4 months after planting.Data collection on growth parameter involving leaf area index, number of branches per plant and dry matter contents were taken at 4, 8 and 12 WAP while, that of the yield parameters were conducted at harvest. LAI was obtained from the formula:

$\frac{\text{LA}}{\text{plant spacing}}$ (Watson, 1947)Where: LA = leaf area

Plant spacing = 50cm × 30cm

Number of branches was determined by counting the branches of three uprooted stands and the total divided by three while shoot dry matter content was by the formula: $\frac{\text{dry weight}}{\text{fresh weight}} \times \frac{100}{1}$

Pod weight was determined by dividing the total weight of all pods obtained from three uprooted stands by three. Number of pods per plant was determined by dividing the total number of pods obtained from three uprooted stands by three, while harvest index (H.I) was obtained by the formula: $\text{HI} = \frac{\text{Economic yield}}{\text{Biological yield}} \times \frac{100}{1}$

Pod yield (kg ha^{-1}) was determined from the formula: $\frac{\text{pod yield per plot} \times 10{,}000\text{m}^2}{\text{plot size}}$

Prior to the commencement of the experiment, soil samples from the experimental site were randomly collected at the depth of 0 – 20 cm with the help of a soil auger for the determination of physico-chemical properties. Equally, both poultry and oil palm bunch ash manures were analyzed to determine their nutrient status. All vegetative and reproductive data from the experiment were subjected to analysis of variance (ANOVA) method (Gomez and Gomez, 1984), while Fishers Least significantly different (F-LSD) at ($p < 0.05$) probability level was adopted to compare significant means.

RESULTS AND DISCUSSION

Physico-chemical and meteorological properties of the experimental site

The physico-chemical properties of the research site (Table 1), revealed that the textural class was a sandy loam with a sand fraction of <80%.

Table 1: Soil physicochemical properties of experiment sites during 2020 and2021 cropping seasons

Soil properties	2020	2021	Poultry manure	Oil palm bunch ash
Sand (%)	76.5	74.2	-	-
Silt (%)	9.7	10.6	-	-
Clay (%)	13.8	15.2	-	-
Texture	Sandy loam	Sandy loam		-
pH	4.5	4.8	8.43	11.10
Available phosphorus (mg/kg)	14.1	14.9	0.30	0.35
Nitrogen (%)	0.189	0.102	2.17	0.28
Organic carbon (%)	0.99	1.12	31.60	5.83
Organic matter (%)	1.71	1.93	54.5	10.05
Calcium (Cmol/kg)	3.4	3.9	4.11	13.51
Magnesium (Cmol/kg)	1.0	1.3	0.61	4.77
Potassium (Cmol/kg)	0.093	0.116	0.83	11.28
Sodium (Cmol/kg)	0.098	0.119	-	-
Exchangeable acidity (Cmol/kg)	1.74	1.68	-	-
Effective cation exchange (Cmol/kg)	6.33	7.12	-	-
Base saturation (%)	72.51	76.4	-	-

The pH values of 4.5 and 4.8 and P values of 14.1 and 14.9 ($mgkg^{-1}$) showed that the site was acidic while P was low. The site contained moderate values of Nitrogen, Organic carbon, Organic matter and Potassium.Analysis of both poultry and oil palm bunch ash fertilizers showed that both PM, OPBA were high in pH, Organic carbon, Organic matter, Calcium and Magnesium (Table 1).The meteorological properties (Table 2) of the site, revealed that rainfall pattern was smaller in the dry months of Jan., Feb., March, April as well as Nov. and December during both cropping seasons. The temperature and relative humidity pattern equally fluctuated in line with the dictate of rainfall pattern (Table 2).

Combined effect of poultry manure oil palm bunch ash and variety on some growth parameters of groundnut

The leaf area index (Table 3) for variety and organic manure combination increased at 4 and 8 WAP and depreciated at 12 WAP for 2020 and 2021 cropping seasons. SAMNUT 24 (erect) gave higher mean LAI of 0.40 (4WAP), 1.12 (8WAP); 0.80 (12 WAP) and 0.40 (4WAP); 1.44 (8WAP) and 1.16 (12WAP) in 2020 and 2021 cropping seasons compared with SAMNUT 21 (spreading) with lower LAI values in both cropping seasons. Both varieties however produced higher LAI at 8WAP. The combination rates of PM15 + OPBA20 gave the highest LAI values compared with PMO + OPBAO which gave the least values for both varieties (Table 3). Variety × PM × OPBA interactions (Table 6) revealed that higher LAI of 1.32 and 1.59 for SAMNUT 21 and SAMNUT 24 were recorded at 12WAP at the combination rates of PM15 + OPBA20 during 2020 cropping season Number of branches per plant (Table 4) for variety and organic manure combinations increased at 4, 8 and 12 WAP with SAMNUT 21 (spreading) producing higher number of branches of 9.18 (4 WAP); 13.84 (8 WAP), 15.50 (12WAP) as well as 7.12 (4 WAP), 11.89 (8 WAP) 14.83 (12WAP) during 2020 and 2021 cropping seasons compared with SAMNUT 24 (erect) with lower number of branches.The combination rates of PM 15 + OPBA 20 recorded the highest number of branches compared with PM0 + OPBA 0 with the least values for both varieties during both cropping seasons (Table 4). Variety x PM x OPBA (interaction (Table 6) revealed that both varieties produced more branches of 19.88 and 19.56 at 8 WAP in 2020 as well as 11.1 and 10.6 at 4 WAP in 2021 at the combination rates of PM15 + OPBA 20 (Table 4).Dry matter contents (Table 5) increased at 4, 8 and 12 WAP, with SAMNUT 24 producing higher dry matter contents of 11.87% (4WAP), 23.38% (8 WAP), 35.57% (12WAP) and 12.62% (4 WAP) 21.76% (8 WAP) and 34.10% (12WAP) for 2020 and 2021 seasons respectively, compared with SAMNUT 21 with lower values in both cropping seasons.The combination rates of PM15 + OPBA 20 had highest dry matter content values at 4, 8 and 12 WAP compared with PM0 + OPBA0 with the lowest values during both cropping seasons. Variety x PM + OPBA (interaction)(Table 6) showed that SAMNUT 21 an SAMNUT 24 produced highest dry matter content of 32.6% and 23.9% at 8WAP, respectively, with the combination rates of PM 15 + OPBA 20 during 2021 cropping season..

Combined effect of poultry manure, oil palm bunch ash and variety on some reproductive parameters of groundnut

Reproductive parameters (Table 7) showed that SAMNUT 21 yielded higher mean number of pods per plant of 41.9 and 28.9 pods as well as higher harvest index of 0.61% and 0.39% compared with SAMNUT 24 with lower values of

number of pods per plant and harvest index respectively during both cropping seasons. SAMNUT 24 however recorded higher mean pod weight per plant of 75.7g and 96.3g as well as higher mean pod yield of 4994.8 kgha^{-1} and 3717.6 kgha^{-1} for both cropping seasons compared with SAMNUT 21 with lower values (Table 7).The combination rates of PM15 × OPBA 20 gave the highest reproductive values for both varieties during both cropping seasons. Variety ×PM × OPBA (interaction)(Table 8) showed that SAMNUT 21 and SAMNUT 24 produced highest number of pods of 60.8 and 48.0 pods respectively at combination rates of PM15 + OPBA 20 during 2020 cropping season.

Table 2:Meteorological properties of the experimental site during 2020 and 2021 cropping seasons

Months	2020				2021			
	Rainfall (mm)	Tempt (°c) min	Tempt (°c) max	Relative humidity (%)	Rainfall (mm)	Tempt (°c) min	Tempt (°c) max	Relative humidity (%)
Jan	74.8	23	33	74	5.0	23	35	72
Feb	76.4	24	34	79	41.7	24	35	73
March	42.4	24	34	78	132.8	24	34	77
April	91.4	23	33	78	87.8	24	34	76
May	450.1	23	33	80	332.7	24	32	84
June	242.4	23	31	83	264.2	24	30	87
July	320.5	22	30	87	133.4	23	30	86
August	232.1	33	29	88	438.5	23	29	88
Sept.	314	22	30	86	412.7	23	29	86
Oct.	162.4	23	31	82	165.2	23	30	86
Nov.	88.8	22	32	74	147.4	23	31	87
Dec.	80.4	22	34	78	00	22	33	75
Total	**2186.1 mm**				**2150.0mm**			

Table 3: Effect of PM and OPBA combination on leaf area index per plant of groundnut varieties at 4, 8 and 12 WAP during 2020 and 2021 cropping seasons

Variety	Treatments	Leaf area index (LAI)					
		2020			2021		
		4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
SAMNUT 21 (Spreading)	PM 0 + PBA0	0.12	0.59	0.44	0.17	0.64	0.54
	PM 0 + PBA 10	0.16	0.66	0.55	0.22	0.78	0.65
	PM 0 + PBA 15	0.18	0.77	0.70	0.25	0.96	0.85
	PM 0 + PBA 20	0.20	0.81	0.72	0.27	0.97	0.80
	PM 10 + PBA 0	0.24	0.96	0.83	0.32	1.27	0.94
	PM 10 + PBA 10	0.30	0.99	0.87	0.36	1.21	1.18
	PM 10 + PBA 15	0.34	1.06	0.94	0.37	1.10	0.91
	PM 10 + PBA 20	0.37	1.20	1.00	0.39	1.10	0.98
	PM 15 + PBA 0	0.39	1.37	1.10	0.35	1.22	0.99
	PM 15 + PBA 10	0.40	1.36	1.15	0.34	1.31	0.11
	PM 15 + PBA 15	0.43	1.61	1.28	0.43	1.38	1.16
	PM 15 + PBA 20	0.46	1.67	1.32	0.43	1.71	1.39
Variety mean		**0.30**	**1.09**	**0.91**	**0.33**	**1.14**	**0.96**
SAMNUT 24 (Erect)	PM 0 + PBA0	0.15	051	0.42	0.20	0.73	0.63
	PM 0 + PBA 10	0.20	0.63	0.52	0.33	1.17	1.08
	PM 0 + PBA 15	0.29	0.78	0.61	0.34	1.14	0.97
	PM 0 + PBA 20	0.31	1.15	0.64	0.34	1.25	1.01
	PM 10 + PBA 0	0.35	0.80	0.77	0.37	1.26	1.04
	PM 10 + PBA 10	0.38	0.89	0.83	0.45	1.40	1.04
	PM 10 + PBA 15	0.39	1.10	0.84	0.42	1.36	1.11
	PM 10 + PBA 20	0.46	1.19	1.02	0.42	1.45	1.22
	PM 15 + PBA 0	0.52	1.22	1.02	0.41	1.66	1.36
	PM 15 + PBA 10	0.54	1.29	1.11	0.47	1.78	1.30
	PM 15 + PBA 15	0.60	1.69	1.30	0.51	1.98	1.42
	PM 15 + PBA 20	0.63	2.13	1.59	0.54	2.05	1.69
Variety mean		**0.40**	**1.12**	**0.89**	**0.40**	**1.44**	**1.16**
Grand mean		**0.35**	**1.11**	**0.89**	**0.63**	**1.29**	**1.06**
LSD (P<0.05) variety		0.11*	NS	NS	NS	0.10*	0.21*
	PM x PBA	NS	NS	0.10*	NS	0.11*	0.21*
	Variety x PM x OPBA	NS	NS	0.23*	NS	NS	NS

Table 4: Effect of PM and OPBA combination on number of branches per plants of groundnut varieties at 4, 8 and 12 WAP during 2020 and 2021 cropping seasons

Variety	Treatments	Number of branches per plant					
		2020			2021		
		4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
SAMNUT 21 (Spreading)	PM 0 + PBA0	5.34	9.00	11.00	5.23	8.43	9.67
	PM 0 + PBA 10	7.77	10.36	12.23	6.90	9.23	13.33
	PM 0 + PBA 15	7.67	10.45	13.00	6.87	11.67	14.37
	PM 0 + PBA 20	8.43	13.34	13.37	6.97	11.57	13.43
	PM 10 + PBA 0	9.53	12.10	14.10	8.53	11.87	13.90
	PM 10 + PBA 10	8.53	13.24	14.01	7.90	11.77	14.53
	PM 10 + PBA 15	7.41	13.10	16.68	8.00	11.03	15.23
	PM 10 + PBA 20	8.67	14.80	17.67	8.23	11.77	14.43
	PM 15 + PBA 0	9.98	15.23	17.03	7.43	12.33	14.53
	PM 15 + PBA 10	11.11	15.67	17.77	6.90	13.00	15.01
	PM 15 + PBA 15	12.7	18.90	20.30	8.57	14.87	16.57
	PM 15 + PBA 20	13.3	19.88	20.90	11.10	15.23	18.20
Variety mean		**9.18**	**13.84**	**15.50**	**7.71**	**11.89**	**14.43**
SAMNUT 24 (Erect)	PM 0 + PBA0	5.38	9.20	10.23	4.67	7.73	10.47
	PM 0 + PBA 10	6.24	11.77	12.87	8.23	12.30	15.43
	PM 0 + PBA 15	6.47	13.24	14.00	8.33	11.67	13.00
	PM 0 + PBA 20	6.34	11.54	13.77	5.23	9.90	12.90
	PM 10 + PBA 0	7.79	14.02	16.00	10.67	13.67	14.57
	PM 10 + PBA 10	7.68	14.58	14.33	6.54	11.20	13.43
	PM 10 + PBA 15	9.27	11.44	12.67	5.90	10.77	14.80
	PM 10 + PBA 20	10.37	12.98	16.37	5.33	10.20	13.70
	PM 15 + PBA 0	9.58	14.47	17.63	5.57	11.10	14.10
	PM 15 + PBA 10	9.22	17.34	18.57	7.90	11.33	13.23
	PM 15 + PBA 15	10.79	17.79	18.37	9.37	12.90	15.67
	PM 15 + PBA 20	11.67	19.56	20.80	10.00	13.00	15.00
Variety mean		**8.40**	**13.99**	**15.47**	**7.31**	**11.31**	**13.87**
Grand mean		**8.79**	**13.92**	**15.49**	**7.52**	**11.60**	**14.15**
LSD (P<0.05) variety		NS	NS	NS	NS	NS	NS
	PM x PBA	NS	1.45*	1.78*	0.68*	1.65*	1.45*
	Variety x PM x OPBA	NS	NS	NS	0.95*	NS	NS

Physico-chemical and meteorological properties of the experimental site

The low sand fraction <80% and the sandy loam textural class of the experimental site showed that it can sustain the production of groundnut. The textural class conformed with the recommendations of Ibia and Udo (2009) and Remison (2012).

The high pH content of both PM and OPBA must have undoubtedly reduced the acidic status of the site by increasing the pH of soil. The pH values of 4.5 and 4.8 for 2020 and 2021 cropping seasons were lower and not in conformity with the pH ranges of 5.5 – 6.5 earlier recommended by Ibia and Udo (2009) and Remison (2012) for the production of groundnut.

Combined effect of poultry manure, palm bunch ash and variety on some growth parameters of groundnut

Leaf area index was not significantly ($p > 0.05$) affected by variety at 8 and 12 WAP in 2020 cropping season, and at 4WAP in 2021 cropping season. The parameter was significantly ($p < 0.05$) affected by variety at 4WAP in 2020 and at 8 and 12WAP in 2021 cropping season. PM × OPBA (interaction) significantly ($p < 0.05$) affected LAI at 12WAP in 2020 and at 8 and 12WAP in 2021 cropping season. LAI was significantly ($p< 0.05$) affected by variety × PM × OPBA (interaction) at 12WAP in 20920 cropping season. LAI for SAMNUT 21 and SAMNUT 24 increased at 4 and 8WAP and depreciated at 12WAP due to the process of senescence.The higher LAI by SAMNUT 24 showed that the variety has the genetic potentials of producing more leaves that are also larger in size compared with SAMNUT 21. This also explains the higher adaptability and yield potentials of SAMNUT 24 over SAMNUT 21. SAMNUT 24 by this result stands a better chance of accumulating higher photosynthates which will culminate into improved yield potentials compared with SAMNUT 21. Both Variety equally recorded higher LAI at 8WAP, suggesting that the growth and yield of groundnut depends on the environmental occurrences prior to 8WAP and shortly before the attainments of senescence at 12WAP. Leaf area index may vary with the variety and the growth duration. Varieties with longer growth duration will attend higher LAI compared with short duration varieties.Number of branches

was not significantly ($p<0.05$) influenced by variety in 2020 and 2021 cropping seasons. It was OPBA (interaction) at 8 and 12WAP in 2020 as well as at 4, 8 and 12WAP in 2021 cropping season respectively. The parameter varied significantly ($p<0.05$) with variety x PM × OPBA (interaction) at 8WAP and at 4WAP in 2020 and 2021 cropping season respectively. Number of branches for SAMNUT 21 and SAMNUT 24 increased at 4, 8 and 12WAP, showing that both varieties are likely to produce more branches with age. SAMNUT 21 produced higher number branches, suggesting that the variety being of spreading growth habit has the potentials of producing more branches irrespective of the rates of poultry manure and oil palm bunch ash. Branching in groundnut irrespective of the variety can be manipulated by combined application of poultry manure or oil palm bunch ash.

Shoot dry matter content was significantly ($p<0.05$) affected by variety at 8 and 12WAP in 2020 cropping season and 4WAP in 2021 cropping season. The parameter was significantly ($p<0.05$) affected by PM × OPBA (interaction) at 8WAP and 8WAP during both cropping seasons. Both varieties produced higher shoot dry matter content at 12WAP suggesting that dry matter contents will likely increase with the age of the crop. SAMNUT 24 recorded higher shoot dry matter content, suggesting that the variety produced more photosynthates, due to the possession of more leaves that were longer and larger than that of SAMNUT 21. The higher LAI at 8WAP with a depreciation at 12WAP was earlier reported by Akpan (2015) and Akpan and Mba (2016). Akpan and Eka (2019) in their research on groundnut reported increased number of branches and dry matter contents as groundnut increases in age. The results corroborates the findings of Malligawad*et al*. (2007) and Kelechukwu*et al*. (2007), who reported that plant morphology especially number of branches as dependent on the variety and soil nutrient status,. Awodun*et al*. (2007) upheld that in Southern Nigeria, oil palm bunch ash fertilizer is an effective fertilizer and liming material for increasing soil fertility, pH and nutrient uptake by crop. It was observed that both varieties recorded higher growth values with the combination of PM 15 + OPBA20, compared with PMO + OPBA0 with smallest values. This suggests that the combination rates provided ample nutrients to the soil for the sustenance of groundnut production.

however significantly ($p < 0.05$) affected by PM ×

Combined effect of poultry manure, oil palm bunch ash and variety on some reproductive parameters of groundnut

Pod weight per plant, harvest index as well as pod yield ($kgha^{-1}$) were significantly ($p<0.05$) influenced by variety during 2020 and 2021 cropping seasons while number of pods per plant varied non-significantly ($p >0.05$) with variety in 2021 cropping season. Poultry manure × OPBA (interaction) did not significantly ($p >0.05$) affect number of pods per plant in both cropping seasons. Pod weight per plant and pod yield were significantly ($p < 0.05$) affected by PM × OPBA (interaction) in 2021 cropping seasons, while harvest index was significantly affected ($p < 0.05$) during 2020 cropping season. Variety × PM × OPBA (interaction) significantly ($p < 0.05$) affected number of pods per plant during 2020 cropping seasons, while other reproductive parameters were not significantly ($p>0.05$) influenced.SAMNUT 24 produced heavier pods and higher cumulative pods yield values over SAMNUT 24, while SAMNUT 21 produced higher number of pods per plant and harvest index over SAMNUT 24. Both varieties produced higher yield values with the combined rates of PM 15 + OPBA 20, compared with the least values obtained from PM0 + OPBA0. The improved yield performance by SAMNUT 24 is traceable to possession of higher number of leaves, leaf area and LAI over SAMNUT 21. Yield parameters were equally observed to vary with the rates of organic fertilizers as well as the varieties. The result corroborates earlier reports by Akpan and Eka (2019) as well as Mbah and Akpan (2017) that increased in the rate of oil palm bunch ash and poultry manure could lead to increases in the reproductive values of groundnut. This was also confirmed by Niagaraj*et al*. (2001), that high yields of groundnut can be obtained with better management of soil fertility, especially when grown organically. The cumulative pod yield obtained with the combination rates of PM15 + OPBA20 was slightly higher than the pod yield of 3,000 – 4,500 $kgha^{-1}$ earlier reported by Remison (2012). The seeming similarities in both the growth and the reproductive values of the varieties could be attributed to similarities in weather and soil conditions as observed during both cropping season. The moderately acidic status of the study site in both cropping seasons calls for regular lime application to mitigate the acidity

Table 5: Effect of organic fertilizer combination on dry matter contents of groundnut varieties at 4, 8 and 12 WAP during 2020 and 2021 cropping seasons

Variety	Treatments	Dry matter contents (%)					
		2020			2021		
		4WAP	8WAP	12WAP	4WAP	8WAP	12WAP
SAMNUT 21 (Spreading)	PM 0 + PBA0	8.57	11.67	13.27	7.80	17.13	22.83
	PM 0 + PBA 10	11.83	15.20	16.50	9.07	19.83	23.67
	PM 0 + PBA 15	11.57	15.33	16.17	9.53	23.83	23.47
	PM 0 + PBA 20	12.17	16.10	19.17	10.53	22.70	26.20
	PM 10 + PBA 0	12.27	18.17	19.53	11.60	25.04	28.50
	PM 10 + PBA 10	12.13	19.10	20.60	11.43	24.10	30.93
	PM 10 + PBA 15	11.80	20.33	22.60	12.53	26.63	30.57
	PM 10 + PBA 20	11.73	20.70	25.43	12.01	28.87	33.40
	PM 15 + PBA 0	11.37	17.63	26.27	12.00	29.27	32.60
	PM 15 + PBA 10	11.93	22.10	26.60	12.43	30.77	34.13
	PM 15 + PBA 15	12.17	21.17	27.87	12.67	32.63	37.43
	PM 15 + PBA 20	12.37	22.33	28.83	12.83	22.60	40.40
Variety mean		**11.66**	**18.32**	**21.90**	**11.20**	**25.29**	**30.34**
SAMNUT 24 (Erect)	PM 0 + PBA0	9.77	17.45	27.92	10.82	19.80	17.30
	PM 0 + PBA 10	11.91	20.40	32.26	11.70	21.33	26.07
	PM 0 + PBA 15	11.15	20.64	33.62	12.29	20.67	26.63
	PM 0 + PBA 20	11.90	18.93	40.08	13.10	20.70	27.97
	PM 10 + PBA 0	11.57	20.17	33.80	13.33	21.00	32.57
	PM 10 + PBA 10	12.50	20.47	34.57	12.33	22.63	37.60
	PM 10 + PBA 15	11.87	25.23	36.23	12.50	21.00	36.57
	PM 10 + PBA 20	11.70	26.27	37.00	12.67	21.47	36.67
	PM 15 + PBA 0	12.37	26.17	37.83	13.00	22.47	34.87
	PM 15 + PBA 10	11.97	27.93	34.01	13.13	22.87	38.43
	PM 15 + PBA 15	12.80	27.86	38.82	13.53	23.23	42.30
	PM 15 + PBA 20	12.92	29.02	40.67	14.07	23.90	52.25
Variety mean		**11.87**	**23.38**	**35.57**	**12.62**	**21.76**	**34.10**
Grand mean		**11.76**	**20.85**	**28.74**	**11.91**	**23.52**	**32.34**
LSD (P<0.05) variety		NS	6.18*	2.98*	1.41*	NS	NS
	PM x PBA	1.07*	NS	NS	0.40*	2.67*	NS
	Variety x PM x OPBA	NS	4.78*	NS	NS	5.56*	NS

Table 6:Variety × poultry manure × oil palm bunch ash interaction effects on some growth indices of groundnut during 2020 and 2021 cropping seasons

Variety	Poultry manure	Oil palm bunch ash	LAI	Number of branches per plant		Dry matter content (%)
			2020 12WAP	2020 8WAP	2021 4WAP	2021 8WAP
SAMNUT 21 (spreading)	0	0	0.44	9.00	5.2	17.13
		10	0.56	10.34	6.9	19.83
		15	0.69	10.45	6.8	23.83
		20	0.72	13.34	6.9	22.7
	10	0	0.83	12.10	8.5	25.04
		10	0.87	13.24	7.9	24.11
		15	0.94	13.10	8.0	26.63
		20	1.00	14.80	8.2	28.7
	15	0	1.10	15.23	7.4	29.3
		10	1.15	15.67	6.9	30.8
		15	1.28	18.90	8.6	22.6
		20	**1.32**	19.88	11.1	32.6
SAMNUT 24 (erect)	0	0	0.42	9.20	4.7	19.8
		10	0.52	11.76	8.2	21.3
		15	0.61	13.24	8.3	20.7
		20	0.64	11.54	5.2	20.7
	10	0	0.78	14.02	9.7	21.0
		10	0.83	14.58	6.5	22.6
		15	0.84	11.44	5.9	21.0
		20	1.02	12.98	5.3	21.5
	15	0	1.02	14.47	5.5	22.5
		10	1.11	17.34	7.9	22.9
		15	1.30	17.79	10.0	23.2
		20	**1.59**	19.56	10.6	23.9
LSD (p<0.05) Variety × PM × OPBA			0.24	2.23	0.95	5.56

Table 7: Combined effect of poultry manure and oil palm bunch ash on some reproductive parameters of groundnut varieties during 2020 and 2021 cropping seasons

Variety	Treatments	Pod weight per plant (g)		No. of pods per plant		Harvest index (%)		Pod yield ($kgha^{-1}$)	
		2020	2021	2020	2021	2020	2021	2020	2021
SAMNUT 21 (spreading)	PM 0 + PBA 0	31.1	39.1	22.8	21.5	0.52	0.32	2053.3	2582.8
	PM 0 + PBA 10	41.6	46.5	30.2	20.5	0.58	0.37	2742.7	3071.2
	PM 0 + PBA 15	45.1	46.3	31.9	21.1	0.62	0.34	2976.6	3055.8
	PM 0 + PBA 20	46.1	44.4	32.7	19.9	0.63	0.34	3042.6	2928.2
	PM 10 + PBA 0	48.7	50.4	32.1	31.9	0.60	0.38	3212.0	3324.2
	PM 10 + PBA 10	51.5	47.6	37.9	32.1	0.60	0.36	3396.1	3139.4
	PM 10 + PBA 15	57.4	50.9	47.4	34.1	0.63	0.41	3786.2	3357.2
	PM 10 + PBA 20	63.2	50.6	44.2	34.1	0.59	0.40	4173.4	3338.3
	PM 15 + PBA 0	75.0	50.8	54.4	31.3	0.58	0.42	4950.7	3355.9
	PM 15 + PBA 10	73.9	51.2	53.3	31.7	0.63	0.42	4876.5	3379.6
	PM 15 + PBA 15	78.6	60.6	54.9	33.0	0.63	0.44	5184.7	3995.2
	PM 15 + PBA 20	82.2	64.6	60.8	35.3	0.65	0.49	5425.9	4261.4
Variety mean		57.9	50.2	41.9	28.9	0.61	0.39	3818.4	3316.7
SAMNUT 24 (erect)	PM 0 + PBA 0	47.8	44.0	20.7	17.1	0.35	0.35	3154.8	2904.0
	PM 0 + PBA 10	57.5	46.7	22.2	19.9	0.39	0.44	3797.2	3080.0
	PM 0 + PBA 15	63.2	52.0	21.9	20.2	0.44	0.46	4171.2	3432.0
	PM 0 + PBA 20	64.4	51.0	23.0	20.9	0.42	0.44	4253.3	3366.0
	PM 10 + PBA 0	67.0	55.7	22.9	26.3	0.49	0.43	4422.0	3674.0
	PM 10 + PBA 10	72.3	55.6	26.1	30.6	0.51	0.34	4774.0	3669.0
	PM 10 + PBA 15	79.1	56.2	28.9	32.5	0.49	0.42	5222.8	3718.0
	PM 10 + PBA 20	81.7	56.7	32.2	30.2	0.48	0.46	5394.4	3740.0
	PM 15 + PBA 0	88.5	52.7	36.1	31.1	0.49	0.49	5841.0	3476.0
	PM 15 + PBA 10	90.5	61.3	41.3	33.0	0.55	0.52	5970.8	4048.0
	PM 15 + PBA 15	95.1	69.3	46.1	33.1	0.54	0.57	6276.6	4576.0
	PM 15 + PBA 20	100.9	74.7	48.0	34.7	0.57	0.59	6659.4	4928.0
Variety mean		75.7	56.3	30.8	22.5	0.48	0.46	4994.8	3717.6
Grand mean		66.8	53.3	36.4	28.2	0.54	0.42	4406.6	3516.7
LSD ($p < 0.05$) variety		6.01*	4.61*	2.89*	NS	0.64*	0.09*	396.9*	304.7*
LSD ($p < 0.05$) PM × PBA		NS	3.97*	NS	NS	0.06*	NS	NS	262.1*
LSD ($p < 0.5$) variety ×PM × OPBA		NS	NS	6.26*	NS	NS	NS	NS	NS

CONCLUSION

The research has shown that poultry manure, oil palm bunch ash are of veritable influence on the productivity of groundnut irrespective of the variety planted. The improved growth and yield performance with the combination rates of PM15 + OPBA20, showed that more nutrientwere released for uptake by the crop, compared with other combination rates. The improved performances by SAMNUT 24 over SAMNUT 21 equally suggested that it was more adaptative than SAMNUT 21, consequently, SAMNUT 24 as well as the combination rates of PM 15 + OPBA 20 are recommended for the sole cultivation of groundnut in the agro-ecosystem.

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