

EFFECT OF VARIETY AND FIVE DIFFERENT RATES OF COW DUNG ON GROWTH CHARACTERS OF GROUNDNUT IN ABRAKA, NIGERIA

Abstract

A study was carried out in Teaching and Research Farm of Delta State, Abraka in 2022 and repeated in 2023 farming seasons to assess the effects of variety and five different rates of cow dung on growth characters of groundnut in Abraka, Nigeria. It was a 2 x 5 factorial experiment in randomized complete block design with three replications. Seven parameters were investigated to achieve the objectives of the study, including initial physico-chemical properties of the experimental site, percentage emergence, plant height, number of branches per stand, number of leaves per stand, leaf area and chemical properties of the cow dung used for the study. The results of the study showed that Samnut-21 was superior in all the parameters assessed, while manure application rate of 20 tha^{-1} was outstanding in performance of the growth characters. It was therefore recommended that farmers in the study area adopt Samnut-21 and 20 tha^{-1} of cow dung for groundnut production in Abraka, Delta State, Nigeria.

Comment [WU1]: This portion should be rewritten elaborately

Keywords: Groundnut variety, growth characters, rates of cow dung, Abraka, Nigeria.

Introduction

Groundnut (*Arachis hypogaea* L.) is a leafy annual legume crop that produces its pods inside the soil (Ajeigbe, *et al*; 2014). As an industrial cash and food crop, it plays a significant role in the Nigerian economy employing about 70% of the rural and urban population (Hakeem *et al*; 2015). Groundnut is second to soybean among the food legume crops. It contains 40% - 50% edible fat, 20-50% protein, 10 - 20% carbohydrates and other essential vitamins and minerals (Briend, 2001). Groundnut is used for human consumption, animal/livestock feed, paint, polish, explosive and soap. Amoke (2019) posited that it is used as a carrier for drugs like penicillin and adrenaline and that the oil is used medically as a laxative and emollient. The researcher further indicated that groundnut production is influenced by differences in agro-ecological factors such as rainfall, temperature and soil condition. Groundnut performs best in sandy loam soil rich in calcium and phosphorus for pod formation in addition to adequate sunshine and well-distributed rainfall (Hakeem *et al*; 2015). Cultivation of groundnut in Nigeria occurs in five major producing states, including Kano, Kaduna, Katsina, Borno and Sokoto (Hakeem *et al*; 2016). In Nigeria, production of groundnut is intense but yields are low due to inability to identify the variety best suited for each agro-ecological zone, declining soil fertility, poor agronomic practices and irregular/inadequate rainfall, Ibrahim *et al*. (2000) indicated that growth characters of crops varied because of the differences in their genetic makeup. Odeleye and Odeleye (2001) suggested that since crop varieties differ in leaf area and other growth characters, breeders must select most promising combinations of good traits in their breeding programmes with a view to enhancing growth and eventual yield. Enujeke (2013) traced the differences in growth characters and yield of crops to leaf arrangement, chlorophyll content, light distribution and photosynthetic enzymes that interplay to affect growth, maturity period and yield. Thakur *et al*. (2002), indicated that crop varieties yield differently in different ecological zones, and some varieties can only express their full genetic potential when offered adequate management resources such as choosing the right site, providing

timely and appropriate establishment, opportunity offering adequate nutrition, disease and pest control, timely harvesting to proper harvesting, and produced disposal and/or storage. Odeleye and Odeleye (2001) posited that improved crop varieties are superior in transferring assimilates to the ear sink, hence they yield higher than local varieties.

The numerous uses of groundnut in Nigerian economy notwithstanding, there has been a decrease in its production over the years because of inability to identify the variety best suited for each agro-ecological zone, (Audi *et al.*, 2013). Also, information with respect to the suitable variety of groundnut for large scale cultivation in the Abraka area of Delta State is lacking. The objective of this study therefore was to determine the best rate of cow dung for the most suitable variety of groundnut in the study area.

Materials and Methods

Site description

The research was carried out at the Teaching and Research Farm of Delta State University, Abraka, Delta State. Abraka lies between Latitude $6^{\circ} 4^{\circ} \text{E}$ and Latitude $5^{\circ} 54^{\circ} \text{N}$. Rainy season starts in April and ends in October, while dry season is from November to March. Temperature ranges from 25° – 31°C , while annual rainfall is between 2000 mm to 3000 mm annually (Efe and Aruegodor, 2003).

Soil analysis and analytical procedure

Soil samples were collected randomly at a depth of 0–15 cm using a soil auger. The samples were air-dried, crushed and sieved with a 2 mm sieve mesh before analyzing for physico-chemical properties. Particle size distribution was ascertained by hydrometer method (Gee and Bauder, 1986). The pH was known using a Pyeunican model MK 2 pH meter in a 1:2:5 soil water suspension ratio. Organic carbon was measured by Walkley-Black wet oxidation method (Nelson and Sommer, 1982). Total nitrogen was determined by micro-kjedahl distillation technique as described by Bremiuer and Mulvancy (1982). Available phosphorus was assessed using Bray No. 1 method (IITA, 1979). Exchangeable potassium was measured by flame photometer, while cation exchange capacity (CEC) was known by ammonium acetate saturation method (Roades, 1982). The cow dung used for the study was analyzed as indicated by IITA manuals (1979).

Field work: A land measuring 132 m^2 (12 m x 11 m) was cleared using cutlass and tilled using hoe. Three replicates made up of five plots each measuring 3 m x 2 m and separated from one another with a space of 0.5 m marked out. Alley pathways of 1 m separated one replicate from the other. The total number of plots laid out in the entire experiment was thirty. Two groundnut seeds were planted per hole at 5 cm depth, using a spacing of 60 cm by 40 cm, but later thinned to one plant per stand. Regular weeding was done using hoe. Eight middle stands were used as sample population for data collection. Data collected were initial physico-chemical properties, percentage emergence, nutrient contents of cow dung use for the study, plant height, number of leaves, number of branches, and leaf area. Data collected were subjected to analysis of variance (ANOVA) and differences between means were separated with Duncan Multiple Range Test (DMRT) using SAS 2005.

Results and Discussion

Initial physico-chemical properties of experimental site

The initial physico-chemical properties of the soil used for the study is shown in Table 1. Particle size distribution shows that the soil was sandy loam that is not fertile as indicated by the low organic matter content (12.4 g kg^{-1}) and total nitrogen of 0.62 g kg^{-1} . Available phosphorus was 5.2 g kg^{-1} , while water soluble potassium (K) was $0.12 \text{ cmol kg}^{-1}$ which

were low based on FMANR (1996) ratings for Abiraka environment. The cation exchange capacity was 9.2 cmol kg^{-1} . These low fertility values of the study area are typical of humid environments where heavy rainfall erodes, leaches and weathers low activity clay minerals resulting in high soil acidity.

The sandy loam texture of the experimental site may be attributed to the parent material (PM) from which the soil was formed and the climate of the area. The soil might be formed from sandstone and quartz parent materials. This is consistent with the report of Brady and Weil (1999) who indicated that high sand content of soil could be attributed to high content of quartz in the parent material. The acidic nature of the soil, low available phosphorus and soluble potassium may be traced to heavy rainfall which causes erosion and leaching of low activity clay minerals in the area as reported by Esu (2001), Enujike (2013). The low organic matter status of the experimental site could be attributed to rapid decomposition of organic residues due to high solar radiation and moisture which favour optimum microbial activities in the soil. It could also be attributed to the annual bush burning which tends to deplete organic matter accumulation in the soil (Landor, 1991; Enujike, 2013). The low levels of total nitrogen could be attributed to leaching of nitrate by torrential rainfall prevalent in the environment (Esu (2001); Enujike, 2013).

Table 1: Soil physico-chemical properties of experimental site

Soil property	Value
Particle size fractions (%)	
Coarse sand	35.0
Fine sand	45.0
Silt	13.0
Clay	7.0
Textural class	Sandy loam
pH _{H₂O}	5.2
Organic matter (g kg^{-1})	12.4
Total Nitrogen (g kg^{-1})	0.62
Available P (mg kg^{-1})	5.2
Exchangeable K (cmol kg^{-1})	0.12
Cation exchange capacity (cmol kg^{-1})	9.20

Chemical properties of the cow dung used for the study: The analytical values of the cow dung used for the study are shown in Table 2

The result showed that the quantities of macro and micronutrients in the cow dung were adequate to enhance increased growth and yield of crops, including groundnut.

Table 2: Chemical properties of the cow dung used for the study

Nutrient elements	Values obtained
N (%)	1.40
P (%)	1.0
K (%)	0.42
Ca (%)	3.30
Mg (%)	0.32
Fe (mgkg ⁻¹)	1584
Mn (mgkg ⁻¹)	474
Zn (mgkg ⁻¹)	592
Cu (mgkg ⁻¹)	480

Effect of variety and rates of cow dung on percentage emergence of groundnut in 2022 and 2023

The response of percentage emergence of groundnut to variety and rates of cow dung in 2022 and 2023 is shown in Table 3. In 2022, significant differences were observed in percentage emergence of the two groundnut varieties investigated. Samnut - 21 had higher percentage emergence (91.2%) than Samnut - 22 which had 86.2%. Similar trend was observed in 2023 where Samnut - 21 had higher percentage emergence (92.4%) than Samnut - 22 which had 87.4% emergence.

With respect to rate of application of cow dung, plants that received 20 tha⁻¹ of manure had the highest percentage emergence (96%) in 2022, while plants that did not receive manure (control plot or 0tha⁻¹) had the lowest percentage emergence of 88%. The trend did not change in 2023, where groundnut plants that received 20tha⁻¹ of cow dung had the highest percentage emergence (98%) while plants that received 0tha⁻¹ had the lowest percentage emergence (88%).

The interaction effects (Tables 8 and 9) indicated that variety, rate, and variety x rate were significantly ($p < 0.05$) different in both years of evaluation.

Table 3: Effects of variety and rates of cow dung on percentage (%) emergence of groundnut in 2022 and 2023.

	Percentage emergence		
	2022	2023	Mean
Variety			
Samnut -21	91.2 _a	92.4 _a	91.8
Samnut -22	86.2	87.4	86.8
Rates of application of cow dung (tha ⁻¹)			
0	88 _{dd}	88 _{de}	88
5	89 _C	89 _d	89
10	90 _C	92 _C	91

15	93 _b	95 _b	94
20	96 _a	98 _a	97

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Effects of variety and rates of cow dung on plant height of groundnut in 2022 and 2023.

Table 4 shows the effects of variety and rates of cow dung on plant height of groundnut in 2022 and 2023. There were significant differences in plant height in both years of evaluation. In 2022, Samnut – 21 had higher plant height (8.5cm) than Samnut – 22 which had height of 6.1cm at 30 days after planting. Similar trend was observed in 2023 where Samnut – 21 was 8.8cm higher than Samnut – 22 which was 6.5cm at 30DAP.

At 60DAP, Samnut – 21 had superior plant height (12.4cm) than Samnut – 22 which had plant height of 10cm in 2022. The trend was the same in 2023 when Samnut – 21 plants were superior in height (12.8cm) than Samnut – 22 plants with value of 10.4cm.

At 90DAP, Samnut – 21 also had higher of 16.2cm while Samnut – 22 had lower height of 12.4cm in 2022. In 2023, similar trend was observed. Samnut – 21 had plant height of 16.6cm while Samnut – 22 had plant height of 12.4cm.

With respect to rates of cow dung applied, plants that received manure application rate of 20tha⁻¹ were outstanding at 30DAP, 60DAP and 90DAP with values of 13.6cm in 2022, 13.8cm in 2023, 15.8cm in 2022 and 16.0cm in 2023, 16.6cm in 2022 and 16.8cm in 2023, respectively. Plants that received 0tha⁻¹ of manure (control) had lowest plant height at 30DAP, 60DAP and 90DAP with values of 8.5cm in 2022, 8.7cm in 2023, 10.0cm in 2022 and 10.2cm in 2023, 11.4cm in 2022 and 11.6cm in 2023, respectively.

Interaction effects (Tables 8 and 9) showed that in both years of evaluation, variety, rate, variety x rate all significantly ($p < 0.05$) different.

Table 4 Effects of variety and rates of cow dung on plant height (cm) of groundnut in 2022 and 2023.

	Days after planting								
	Plant height (cm)								
	30			60			90		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Variety									
Samnut -21	8.5 _a	8.8 _a	8.65	12.4 _a	12.8 _a	12.6	16.2 _a	16.6 _a	16.4
Samnut -22	6.1 _b	6.5 _b	6.30	10.0 _b	10.4 _b	10.2	12.4 _b	12.6 _b	12.5
Rates of application of cow dung (tha⁻¹)									
0	8.5 _C	8.7 _C	8.6	10.0 _C	10.2 _C	10.1	11.4 _C	11.6 _C	11.5
5	8.8 _C	9.0 _C	8.9	10.4 _C	10.6 _C	10.5	11.6 _C	11.8 _C	11.7
10	9.0 _C	9.2 _C	9.1	11.1 _C	11.3 _C	11.2	12.0 _C	12.2 _C	12.1
15	11.1 _b	11.5 _b	11.3	13.6 _b	13.2 _b	13.4	14.2 _b	14.4 _b	14.3
20	13.6 _a	13.8 _a	13.7	15.8 _a	16.0 _a	15.9	16.6 _a	16.8 _a	16.7

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Effects of variety and rates of cow dung on number of branches/plant of groundnut in 2022 and 2023.

The response of number of branches/plant of groundnut to variety and rates of cow dung in 2022 and 2023 is shown in Table 5. At 30 DAP of 2022 Samnut – 21 variety had higher number of

branches/plant (4.4) than Samnut – 22 which had 4.2 branches/plant. There were no significant differences in number of branches/plant between the two varieties. With respect to manure application rates, both plants that received 15tha⁻¹ and 20tha⁻¹ of cow dung had highest but equal number of branches/plant (4.2 branches) which plants that received other manure application rates (0tha⁻¹, 5tha⁻¹ and 10tha⁻¹) had 4.1 braches/plant. Significant differences were not also observed. Similar trend was observed in 2023. Samnut – 21 variety had 4.4 branches/plant, while Samnut – 22 had 4.2 branches/plant. There were no significant differences in number of branches/plant of the two varieties investigated. Plants that received 20tha⁻¹ of cow dung were superior to plants that received other manure application rates with value of 4.6 branches/plant while plants that received 0tha⁻¹, 5tha⁻¹ and 10tha⁻¹ had 4.1 branches/plant.

At 60DAP of 2022 and 2023, Samnut – 21 was superior to Samnut – 22 with respect to higher number of branches/plant of 5.5 and 5.9, respectively, while Samnut – 22 had lower number of branches/plant of 5.2 and 5.2, respectively. Plants that received 20tha⁻¹ of cow dung were also superior in number of branches/plant with values of 5.8 in 2022 and 6.4 in 2023, respectively while plants that did not receive cow dung had lowest number of branches/plant of 5.3 in 2022 and 5.5 in 2023, respectively. Significant differences were only observed in number of branches/plant of the varieties and manure application rates in 2023 at 60DAP.

At 90DAP in 2022 and 2023, significant differences were observed in number of branches/plant of both varieties tested and rates of application of cow dung/. Samnut – 21 had higher number of branches/plants than Samnut – 22 with values of 6.5 in 2022 and 6.7 sin 2023, respectively while Samnut – 22 had lower number of branches/plant with values of 6.2 in 2022 and 6.4 in 2023. With respect to manure application rates, plants that received 20tha⁻¹ had highest number of branches/plant with 6.2 in 2022 and 6.8 in 2023, respectively while plants that received 0tha⁻¹ of cow dung had lowest number of branches/plant with values of 5.4 in 2022 and 5.6 in 2023, respectively.

The interaction effects (Tables 8 and 9) showed that variety, rate of application of cow dung were only significantly ($p < 0.05$) different at 60DAP of 2023, and at 90DAP of 2022 and 2023.

Table 5 Effects of variety and rates of cow dung on number of branches/plant of groundnut in 2022 and 2023.

	← Days after planting →								
	← Number of branches/plant →								
	30			60			90		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Variety									
Samnut -21	4.4 _a	4.4 _a	4.4	5.5 _a	5.9 _a	5.7	6.5 _a	6.7 _a	6.6
Samnut -22	4.2 _b	4.2 _a	4.2	5.2 _a	5.2 _b	5.2	6.2 _b	6.4 _b	6.3
Rates of application of cow dung (tha⁻¹)									
0	4.1 _a	4.1 _a	4.1	5.3 _a	5.5 _b	5.4	5.4 _b	5.6 _b	5.5 _b
5	4.1 _a	4.1 _a	4.1	5.4 _a	5.6 _b	5.5	5.4 _b	5.6 _b	5.5
10	4.1 _a	4.1 _a	4.1	5.5 _a	5.7 _b	5.6	5.6 _b	5.6 _b	5.6
15	4.2 _a	4.2 _b	4.2	5.5 _a	5.7 _b	5.6	5.6 _b	6.0 _b	5.8
20	4.2 _a	4.6 _a	4.4	5.8 _a	6.4 _a	5.7	6.2 _a	6.8 _a	6.5

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Effects of variety and rates of cow dung on number of leaves/plant of groundnut in 2022 and 2023.

The effects of variety and rates of cow dung on number of leaves/plant of groundnut in 2022 and 2023 is shown in Table 6 At 30DAP of 2022 and 2023, Samnut – 21 had higher number of leaves/plant with values of 36.2 in 2022 and 38.4, respectively while Samnut – 22 had lower number of leaves/plant with values of 29.5 in 2022 and 32.3, respectively.

Based on rates of application of cow dung, plants that received 20tha⁻¹ were outstanding in number of leaves/plant with values of 36.6 in 2022 and 38.0 in 2023. Significant differences were observed between the varieties investigated and rates of manure applied in both years of evaluation.

At 60DAP, similar trend was observed. Samnut – 21 had higher number of leaves/plant with values of 42.4 in 2022 and 43.2 in 2023, while Samnut – 22 had lower number of leaves/plant with values of 38.2 in 2022 and 40.0 in 2023. Manure application rates indicated that plants which received 20tha⁻¹ were superior to other rates of application with values of 42.6 leaves/plant in 2022 and 43.0 leaves/plant in 2023. Plants in the control plots which received 0tha⁻¹ of cow dung had the lowest number of leaves/plant with values of 30.2 in 2022 and 32.6 in 2023. There were significant differences in number of leaves/plant between the varieties and rates of manure investigated in the two years of assessment.

At 90DAP, Samnut – 21 was also superior in number of leaves/plant with values of 49.4 in 2022 and 50.2 in 2023, while Samnut – 22 had lower number of leaves/plant with values of 45.2 in 2022 and 47.2 in 2023. Based on manure application rates, plants that received 20tha⁻¹ had highest number of leaves/plant with values of 48.8 in 2022 and 50.8 in 2023, while plants that did not receive cow dung had lowest number of leaves/plant with values of 34.0 in 2022 and 38.2 in 2023, respectively. Significant differences were generally observed in number of leaves/plant between the varieties tested and manure application rates in the two years of evaluation.

The interaction effects (Tables 8 and 9) indicated that variety, rate of application of cow dung were significantly ($p < 0.05$) different in both years of evaluation.

Table 6. Effects of variety and rates of cow dung on number of leaves/plant of groundnut in 2022 and 2023.

	Days after planting								
	Number of leaves/plant								
	30			60			90		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Variety									
Samnut -21	36.2 _a	38.4 _a	37.3	42.4 _a	43.2 _a	42.8	49.4 _a	50.2 _a	49.8
Samnut -22	29.5 _b	32.3 _b	30.9	38.2 _b	40.0 _b	39.1	45.2 _b	47.2 _b	46.2
Rates of application of cow dung (tha⁻¹)									
0	23.6 _e	26.2 _e	24.9	30.2 _e	32.6 _e	31.4	34.0 _e	38.2 _e	36.1
5	26.2 _d	31.2 _d	28.7	33.4 _d	35.2 _d	34.3	38.2 _d	41.4 _d	39.8
10	28.4 _c	33.6 _c	31.0	36.2 _c	38.4 _c	37.3	43.4 _c	45.2 _c	44.3
15	33.4 _b	35.4 _b	34.4	40.1 _b	40.9 _b	40.5	46.2 _b	47.2 _b	46.7
20	36.6 _a	38.0 _a	37.3	42.6 _a	43.0 _a	42.8	48.8 _a	50.8 _a	49.8

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Effects of variety and rates of cow dung on leaf area of groundnut in 2022 and 2023.

The response of leaf area of groundnut to variety and rates of cow dung in 2022 and 2023 is shown in Table 7 At 30DAP of 2022 and 2023, Samnut – 21 had higher leaf area (298cm² in 2022 and 306cm² in 2023) than Samnut – 22 which had leaf area of 264cm² in 2022 and 270cm² in 2023. Manure application rates indicated that plants that received 20tha⁻¹ were outstanding in leaf area with values of 300cm² in 2022 and 304cm² in 2023, while plant that received 0tha⁻¹ had the lowest leaf area with values of 252cm² in 2022 and 260cm² in 2023. The trend did not change at 60DAP. Samnut – 21 had higher leaf area (1420cm² in 2022 and 1430cm² in 2023) than Samnut – 22 which had leaf area of 1240cm² in 2022 and 1252cm² in 2023. Based on rate of cow dung applied, plants that received 20tha⁻¹ had highest leaf area of 1420cm² in 2022 and 1430cm² in 2023, while plant which did not receive cow dung had lowest leaf area (1372cm²) in 2022 and 1382cm² in 2023.

At 90DAP, Samnut – 21 had higher leaf area of 1510cm² in 2022 and 1522cm² in 2023, than Samnut – 22 which had 1424cm² in 2022 and 1434cm² in 2023. Manure application rates showed that plant that received 20tha⁻¹ had the highest leaf area of 1510cm² in 2022 and 1522cm² in 2023 while plants that did not receive cow dung had the lowest leaf area of 1442cm² in 2022 and 1452cm² in 2023. Significant differences were generally observed in leaf area of between the varieties of groundnut assessed and the rates of manure applied in 2022 and 2023.

The interaction effects (Tables 8 and 9) showed that variety, rate of cow dung were significantly ($p < 0.05$) different in both years of the investigation.

Table 7 Effects of variety and rates of cow dung on leaf area of groundnut in 2022 and 2023.

	Days after planting								
	Leaf area (cm ²)								
	30			60			90		
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean
Variety									
Samnut -21	298 _a	306 _a	302	1420 _a	1430 _a	1425	1510 _a	1522 _a	1516
Samnut -22	264 _b	270 _b	267	1240 _b	1252 _b	1246	1424 _b	1434 _b	1429
Rates of application of cow dung (tha⁻¹)									
0	252 _e	260 _e	256	1372 _e	1382 _e	1377	1442 _e	1452 _e	1447
5	278 _d	282 _d	280	1308 _d	1384 _d	1382	1468 _d	1474 _d	1471
10	284 _c	288 _c	286	1392 _c	1404 _c	1398	1480 _c	1488 _c	1484
15	296 _b	300 _b	298	1400 _b	1420 _b	1410	1492 _b	1498 _b	1495
20	300 _a	304 _a	302	1420 _a	1430 _a	1425	1510 _a	1522 _a	1516

Means with the same letter(s) under same column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT).

Table 8: Effects of interaction of variety and rates of cow dung on growth characters of groundnut in 2022.

	Days after planting												
	Rate of cow dung (tha ⁻¹)	Plant height (cm)	30				60				90		
No. of Branches			No. of Leaves	Leaf area (cm ²)	Plant height (cm)	No. of Branches	No. of Leaves	Leaf area (cm ²)	Plant height (cm)	No. of Branches	No. of Leaves	Leaf area (cm ²)	
Variety													
Samnut - 21	0	8.5	4.1	23.6	252	10.0	5.3	30.2	1372	11.4	6.4	34.0	1442
	5	8.8	4.2	26.2	278	10.4	5.4	33.4	1380	11.6	6.4	38.2	1468
	10	9.0	4.4	29.4	284	11.1	5.5	37.2	1392	12.0	6.6	43.4	1490
	15	11.1	4.6	35.2	298	13.6	5.5	42.1	1440	14.2	6.6	47.3	1542
	20	13.6	4.8	38.6	320	15.8	5.8	44.6	1480	16.6	6.8	50.8	1590
	Mean	10.2	4.4	30.6	286.4	12.1	5.5	37.5	1413	13.2	6.6	42.7	1506.4
Samnut - 22	0	6.10	4.0	21.4	186	8.2	4.2	27.6	1040	9.0	4.4	32.0	1320
	5	7.2	4.1	23.0	208	8.6	4.4	30.0	1010	9.8	4.6	36.2	1360
	10	8.0	4.2	25.0	220	9.4	5.1	33.0	1160	10.2	5.2	40.1	1380
	15	9.0	4.3	27.2	242	10.2	5.3	36.2	1240	11.0	5.4	42.2	1410
	20	10.0	4.4	29.8	276	11.4	5.4	38.6	1280	13.2	5.6	45.5	1440
	Mean	8.1	4.2	25.3	226.4	9.6	4.9	33.1	1146	10.6	5.04	39.2	1382
Variety		*	ns	*	*	*	*	*	*	*	*	*	*
Rate		*	ns	*	*	*	*	*	*	*	*	*	*
Variety x Rate		*	ns	*	*	*	*	*	*	*	*	*	*

Legend * = significant at 0.05 level of probability, ns = not significant

Table 9: Effects of interaction of variety and rates of cow dung on growth characters of groundnut in 2023.

Variety	Rate of cow dung (tha ⁻¹)	Plant height (cm)	Days after planting														
			30					60					90				
			No. of branches	No. of leaves	Leaf area (cm ²)	Plant height (cm)	No. of branches	No. of leaves	Leaf area (cm ²)	Plant height (cm)	No. of branches	No. of leaves	Leaf area (cm ²)				
Samnut - 21	0	8.7	4.1	26.2	260	10.2	5.5	32.6	1382	11.6	5.6	38.2	1452				
	5	9.0	4.1	31.2	282	10.6	5.6	35.2	1384	11.8	5.6	41.4	1474				
	10	9.2	4.1	33.6	288	11.3	5.7	38.4	1404	12.2	5.6	45.2	1488				
	15	11.5	4.2	35.4	300	13.2	5.7	40.9	1420	14.4	6.0	47.2	1498				
	20	13.8	4.6	37.3	304	16.0	6.4	43.0	1430	16.8	6.8	50.8	1522				
	Mean	10.4	4.2	32.7	287	12.3	5.8	38.0	1404								
Samnut - 22	0	6.2	4.0	22.8	196	8.0	5.1	30.2	1202	10.2	5.2	34.6	1320				
	5	6.8	4.0	24.0	206	8.6	5.1	32.0	1220	10.5	5.2	38.2	1360				
	10	7.2	4.1	26.0	220	9.2	5.2	34.1	1260	10.8	5.3	40.7	1380				
	15	9.0	4.2	28.1	242	10.4	5.3	36.3	1310	12.0	5.4	43.2	1418				
	20	11.2	4.5	39.6	268	12.2	5.6	38.8	1340	14.0	5.8	45.8	1460				
	Mean	8.1	4.2	26.3	226	9.7	5.3	34.3	1266	11.6	5.4	40.5	1388				
Variety		*	ns	*	*	*	*	*	*	*	*	*	*				
Rate		*	ns	*	*	*	*	*	*	*	*	*	*				
Variety x Rate		*	ns	*	*	*	ns	*	*	*	ns	*	*				

Legend * = significant at 0.05 level of probability, ns = not significant

Effects of variety and rates of cow dung on growth characters of groundnut

Growth parameters of groundnut including percentage emergence, plant height, number of leaves and leaf area, increased as cow dung application rate increased. This may be adduced to increased supply of nutrients, better utilization of carbon and synthesis of assimilates which as reported by Eifediya and Remison (2010) on growth characters of cucumber. It could also be attributed to mineralization of ammonia present in cow dung, leading to the release of nitrogen for enhancement of crop, vegetable growth. This is similar to the findings of Mehedi *et al* (2012) and Enujeke *et al.* (2022) who traced the increase in vine length, number of leaves and branches of watermelon to possible release of nitrogen from mineralized ammonia present in cow dung. It is consistent with the findings of Thakure *et al.* (2002), Stevens *et al.* (2018) and Tilley (2012) which reported increased vegetative growth of vegetables due to addition of nitrogen released from organic fertilizers.

Summary, conclusion and recommendation

The study was carried out to determine the best rate of cow dung for the most suitable variety of groundnut in Abraka, Delta State. It was a 2 x 5 factorial experiment in randomized complete block design with three replications. Seven parameters were investigated to achieve the objectives of the study, including initial physico-chemical properties of the experimental site, percentage emergence, plant height, number of branches per stand, number of leaves per stand, leaf area and chemical properties of the cow dung used for the study the results of the study showed that Samnut-21 was superior in all the parameters assessed, while manure application rate of 20 tha^{-1} was outstanding in performance of the growth characters. It was therefore recommended that farmers in the study area adopt Samnut-21 and 20 tha^{-1} of cow dung for groundnut production in Abraka, Delta State, Nigeria.

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Comment [WU2]: New mentioned references should be included and all the reference style should be same.

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