



Effects of type and rate of organic and mineral fertilizer application on the performance of *Sesame indicum* L. on an Alfisol soil in the southern Guinea Savanna of Nigeria

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ABSTRACT

Poor soil fertility is among the major production problems responsible for poor growth and low yield of sesame in Nigeria. A field experiment was conducted at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomosho, Nigeria to determine the effect of application of organic and mineral fertilizers on growth and yield of sesame plants and rates of Nitrogen fertilizer application on the performance of sesame var E8. There were 12 factorial treatment combinations of three types of fertilizers namely; tithonia compost, maize compost, and urea and four rates of Nitrogen; 0, 60, 80, and 100 kg N/ha. Progressive increment in growth and seed yield parameters was observed as fertilizer rates increased up to 80 kg N/ha and decreased at 100 kg N/ha. Application of 80 kg N/ha produced the highest growth and yield of sesame. Application of 60, 80, and 100kg N/ha fertilizer resulted in 140, 350 and 170 % over the control. Tithonia compost produced the highest yield of sesame compared with maize compost and urea fertilizer. Generally, inorganic fertilizer (urea) resulted in lower yields compared to organic fertilizer (tithonia compost) in the production of sesame. Soil nutrient status was also enhanced as residual N increased slightly in all the treatment. However, phosphorus accumulation was highest with the application of tithonia compost at 80kg /ha. From the results of these experiments, it is indicative that application of tithonia compost at the rate of 80 kg N/ha is most suitable for the production of sesame and have the potential of improving the soils in the southern Guinea Savanna of Ogbomosho, Nigeria.

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Introduction

Sesame (*Sesamum indicum*) is an annual flowering plant with the genus *Sesamum* and family Pedaliaceae. It is an erect plant which grows between 50cm to 250cm tall depending on the variety, soil and environmental conditions (Sharma, 2005). It is an important oilseed crop with great commercial attributes by virtue of its oil having an edible quality and medicinal value. It yields 50-60% oil and the oil is highly stable against rancidity due to the presence of the natural antioxidants sesamin and sesamol (Weiss, 2000 and Sabah El-Khier *et al.*, 2008). It is potentially capable of producing large quantities of seeds per unit area but the yield is low ha⁻¹ (Ahmad *et al.*, 2001) due to lack of improved varieties and improper fertilization (Rao *et al.*, 1994). In Nigeria, it is cultivated in the derived, northern and southern guinea, Sudan and Sahel savanna zones. (Alegbejo *et al.*, 2003).

The use of fertilizers is considered one of the most important factors to increase crop yields on per unit basis. The base element of all biological cells starts with Nitrogen and its role cannot be substituted in crop production. Nitrogen is a component of protein and nucleic acids and an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. It also mediates the utilization of phosphorus, potassium and other elements in plants Brady 1984 good seed and dry matter yield. Its availability in sufficient quantity throughout the growing season is essential for optimum growth and when Nitrogen is

sub-optimal, growth is reduced (Haque, Hamid and N.I. Bhuiyan, 2001, Chen, 2006). Therefore, nitrogen deficiency or excess can result in reduced yield.

The use of mineral fertilizers has not been helpful as it is associated with increased soil acidity and nutrient imbalance (Kang and Juo, 1980). Farming regions that emphasize heavy chemical application have led to adverse environmental, agricultural and health consequences (Shehata and El-khawas, 2003). One of the possible options to reduce the use of chemical fertilizers could be use of organic fertilizers (Azam *et al.*, 2011). Organic manures can be used as an alternative for the inorganic fertilizers. They release nutrients rather slowly and steadily over a longer period and also improve the soil fertility status by activating the soil microbial biomass (Ayuso *et al.*, 1996; Belay *et al.*, 2001). Organic manure application sustains cropping system through better nutrient recycling and improvement of the soil physical attributes (El-Shakweer *et al.*, 1998). Several organic materials have been reported as suitable soil amendments for increasing crop production [1, 2, 3, 4]. Nutrition studies in the tropics have shown that sesame perform well with the applications of organic or inorganic fertilizers (Olowe & Busari, 2000; Okpara *et al.*, 2007; Haruna *et al.*, 2011).

The objective of this study was to determine the growth and yield of sesame plant as influenced by the application of organic and mineral fertilizers.

Materials and Methods

Field Experiments were conducted during the rainy seasons of 2011 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria in the derived southern Guinea savannah agro-ecological zone of Nigeria 8° 10'N and 40° 10'E. Ogbomoso area has a minimum temperature of 28°C and a maximum of 33°C. The humidity of the area is high (74%) all year round except in January when the dry wind from the north flows in. The annual rainfall is between 1150 mm-1250 mm. The experimental sites had been under cultivation of arable crops for several years before the experiment was set up. The site was under cassava and maize cultivation (mixed-cropped) and harvested before the experiment was set up. Ten core samples were randomly taken using 5mm soil auger at 0 -30 cm depth before planting. They were bulked, air-dried and sieved with 2 mm mesh sieve for analysis. The particle size analysis was done by pipette method (Gee and Bauders, 1986); soil pH in water was determined using soil: water ratio of 1:2 by a pH meter with a glass electrode. Total N in the soil was determined by Kjeldahl digestion and N determined colourimetrically (Bremner, 1996). Ca and Mg in the extract were read by atomic absorption spectrophotometer (AAS). Na and K were analyzed by using flame photometry. Available phosphorous was determined by Bray-1 extraction and determined colourimetrically by the molybdenum blue procedure (Bray and Kurtz, 1945). The pre-cropping soil sample used at the experimental location is sandy loam, well drained and has a slightly acidic pH 6.4 organic carbon (4.4%) available phosphorus (4.3) and nitrogen (0.42%) (Table 1).

The experiment consisted of factorial combinations of four levels of fertilizer (0, 60, 80 and 100 N kg/ha) and three fertilizer types (tithonia, Maize compost and urea). The twelve (12) treatment combinations were laid out in a randomized complete block design and replicated three times. The experimental plot was manually cleared and raised beds measured 3 m by 3 m in sizes were made. There were 12 beds in a replicate, giving a total of 36 beds for the three replicates used. The plots were separated by 1.0m unplanted boarder while replications were separated by 2.0 m unplanted boarder. The organic fertilizers were incorporated two weeks before sowing. The planting material used was E-8; it is white in colour, early maturity: 90 days (Iwo *et al.*, 2001). Sesame was planted on the 26th of July 2011. Four to six seeds of sesame were sown at 10cm intra-row spacing and spaced 60cm apart and was later thinned to one plant per stand at three weeks after planting. Hoe weeding was done at 3, 6, and 9 WAP to keep the experimental plots weed-free.

Data collection

Data collection commenced at 4WAP and continued on fortnight basis until maturity. Data were collected on growth and yield parameters. The growth parameters measured were plant height using measuring tape placed at the base of the main stem to the tip of the plant and the stem girth was measured by using vernier caliper at a height of 5cm above ground level. Data collection on number of branches commenced at 7WAP by direct counting of all developed branches per plant. Data collection on the number of pod per plant was by direct counting. The crop was harvested when lower leaves, pods and stem turned to lemon yellow colour. During harvest, 4 m² net plot was harvested separately by cutting the plants from ground level and these were bundled. Bundles of harvested plants were dried in sunshine. Later stalked bundles were inverted down and tapped with stick to separate the seeds. The seeds was dried,

winnowed, cleaned and weights of seeds obtained from each net plot were recorded.

Data Analysis

All data were subjected to analysis of variance (ANOVA). The differences between treatment means were evaluated using Duncan's Multiple Range Test at 0.05 probability level.

Results

Table 1 shows the physico-chemical properties of the soil before planting. The soil of the experimental site is sandy loam, well drained characterized by moderate pH 6.4, low in organic carbon (4.4), available phosphorus (4.3 g/kg) and nitrogen (0.42 g/kg) and exchangeable Ca (Akinrinde and Obigbesan, 2000) and below critical levels of some nutrients (Ibude *et al.*, 1988).. This is in agreement with earlier observations that soils in south-west Nigeria were deficient in nutrients (Ojeniyi and Akanni, 2008; Agbede *et al.*, 2008).

Table 1: pre-cropping physical and chemical properties of the soil samples used for the experiment

Parameter	Value	Critical level*
pH (H ₂ O)	6.40	
Organic carbon (g kg ⁻¹)	4.40	11.60
Total N (g kg ⁻¹)	0.42	1.50
Available P (mg kg ⁻¹)	4.30	8.50
Exchangeable K (cmol kg ⁻¹)	1.32	0.16
Exchangeable Ca (cmol kg ⁻¹)	1.35	1.50
Exchangeable Mg (cmol kg ⁻¹)	2.29	0.28
Exchangeable Na (cmol kg ⁻¹)	0.22	
Silt (%)	8	
Clay (%)	10	
Textural class:	sandy Loam	

*Ibude *et al* (1988).

Table 2: Effect of fertilizer types on sesame plant height (cm)

	Plant height (cm)					
	WAP					
	2	4	6	8	10	12
NO	15.51b	20.28b	35.73b	73.15b	113.88a	127.38b
N1	14.71b	18.82b	32.43b	77.28b	115.2a	128.04b
N2	18.97a	24.36a	40.52a	88.67a	117.53a	144.06a
N3	15.7b	20.8b	36.73b	78.16b	105.47a	126.3b

Means with the same letter are not significantly different using Duncan's Multiple Range Test (DMRT) at 5% level of probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

Table 3: Effect of fertilizer types on sesame stem girth (cm)

	Stem girth (cm)					
	WAP					
	2	4	6	8	10	12
NO	2.03a	2.48a	2.77b	3.32b	4.23b	4.28b
N1	1.96a	2.33a	3.02ab	3.77ab	4.47ab	4.54ab
N2	2.27a	2.64a	3.81a	4.57a	5.34a	5.38a
N3	2.03a	2.18a	2.58b	3.64b	4.22b	4.33b

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

probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

Table 4: Effect of nitrogen rates on sesame number of branches/plant number of pod/plant and seed yield(kg/ha)

Treatment	No of branches/plant	No of pod/plant	seed yield(kg/ha)
Fertilizer level (kg N/ha)			
N0	6b	33b	63.83b
N1	6ab	43b	89.50b
N2	8a	80a	223.38a
N3	7b	40b	108.33b

Means with the same letter are not significantly different using Duncan's Multiple Range Test (DMRT) at 5% level of probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

Effect of nitrogen rates on growth and yield attributes of sesame

Results indicated significant differences in growth parameters amongst treatments. Plant height exhibited a significant ($P < 0.05$) difference in all the Nitrogen rates applied at all sampling period except at 10 WAP (Table 2). From 8 to 12 WAP increase in nitrogen rate increased plant height up to N2 (80 kg N/ha) but the rate of increase decreased from 80 kg N/ha to 100 kg N/ha. At 12WAP, nitrogen rate increase, increased plant height up to N2 (80 kg N/ha) but the rate of increase decreased from 113 % at 80 kg N/ha to 99 % at 100 kg N/ha over the control.

N rates significantly affected the stem girth of sesame through out the period of sampling except at 2 and 4 WAP (Table 3). Maximum stem girth (125.11 cm) was recorded in N₂ (80 kg N/ha) treatment, which, was statistically similar to N₁ (60 kg N/ha) nitrogen rate (Figure 2). Minimum stem girth (4.28 cm) was noted in the N₀ (control) treatment. From 6 to 12 WAP stem girth increased linearly with increase in nitrogen rate to N2 (80 kg N/ha). At 12WAP, nitrogen rate increase, increased stem girth up to N2 (80 kg N/ha) but the rate of increase decreased from 123 % at 80 kg N/ha to 101 % at 100 kg N/ha over the control.

Number of branches per plant, number of pod per plant and seed yield (kg/ha) exhibited a significant ($P < 0.05$) difference in all the Nitrogen rates. Maximum values were recorded was recorded in N₂ (80 kg N/ha) treatment, which, was significantly higher than the other nitrogen rates (Table 4). Number of branches per plant, number of pod per plant and seed yield (kg/ha) increased linearly with increase in nitrogen rate to N2 (80 kg N/ha). The rate of increase of number of branches pr plant decreased from 125 % at 80 kg N/ha to 101 % at 100 kg N/ha over the control. The number of pod per plant and seed yield were 129, 242, 119 and 140, 350, 170 % over the control at 60, 80, and 100kg N/ha

Table 5: Effect of fertilizer types on sesame plant height

Treatment	plant height (cm)				
	WAP				
Fertilizer Type	4	6	8	10	12
Maize	21.02a	36.99a	82.4a	115.5a	129.59a
Tithonia	21.02a	37.11a	82.4a	115.9a	134.4a
Urea	20.8a	34.55a	76.9a	107.6b	130.4a

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

Table 6: Effect of fertilizer types on sesame stem girth

Treatment	Stem girth (cm)				
	WAP				
Fertilizer Type	4	6	8	10	12
Maize	2.41a	3.01a	4a	4.59a	4.71a
Tithonia	2.47a	3.13a	3.9a	4.64a	4.79a
Urea	2.35a	2.98a	3.53b	4.27b	4.41b

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

Table 7: Effect of fertilizer types on sesame plant height, stem girth, number of branches/plant number of pod/plant and seed yield(kg/ha).

Treatment	No of branches/	No of pod/	seed yield
Fertilizer Type	plant	plant	(kg/ha)
Maize compost	7 a	56a	126.50a
Urea	7a	36b	84.83b
Tithonia compost	7a	55b	129.19a

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

Relative Effect of Different Source of Nitrogen fertilizer on Growth of sesame

Fertilizer types had significant effect on plant height and stem (Table 5 and 6 respectively). Tithonia fertilizer recorded the highest values in plant height (134.4 cm), stem girth (4.79 cm) while the least value was observed in urea. Significant differences were observed in number of pod/plant and seed yield except the number of branches (Table 7). The highest values were observed in tithonia fertilizer treatment while and the least values were observed in urea fertilizer treatment for number of pod/plant and seed yield.

Discussion

From the results obtained, it was observed that growth, yield and yield attributes of sesame were significantly increased by the application of tithonia, maize and urea fertilizers. This could be attributed to the low nutrient status of the soil which was grossly low and in nutrients inadequate for crop production and therefore required artificial supply of nutrients or application of fertilizer materials to meet sesame requirements for improved growth and yield of sesame as experimented. These results are in agreement with other earlier researchers (Babajide *et al.*, 2008; Olabode *et al.*, 2007 ; Akanbi, 2002; Dare, 2008 ; Makinde *et al.*, 2007), who reported that the soils at the study areas are grossly inadequate in nutrients to support successful completion of the vegetative and reproductive stages of most tropical crops. The fertilizers have the ability to supply nutrients contained in them gradually to support crop growth which later translated to high growth and yield attributes (Aliyu, 2003 & Anon., 2007, Haruna and Abimiku, 2012). Growth, and yield attributes of sesame were optimized at 80 kg N/ha application This is not surprising as sesame plants grown with 80 kg N/ha compost have more nutrient for uptake, and biosynthesis and accumulation of photosynthates. This invariably led to the production of plants with higher plant height and stem girth. According to Togun and Akanbi (2003), Akanbi *et al.*, (2009), better plant performances are associated with plants that received adequate amount of fertilizer. This made available adequate amount of nutrients required for plants to successfully complete its vegetative and reproductive phases. This might be the reason for the observed poor performance of plants that were not fertilized.

In this study number of pod per plant and seed yield of sesame grown with organic fertilizers showed better growth and resulted in a higher number of pods and yield than those grown with chemical fertilizer. Similar results were obtained with vegetables, Xu *et al.*, 2005 ; lettuces, Michael *et al.*, 2010 .This is also inline with the work of Owen (2003), who reported that industrial fertilizers do not possess good characteristics of aggregating the soil particles, as a result, the plants produced by inorganic fertilizers showed relatively lower yield compared to organic materials. Studies by Rao (1991) indicated that the soil could be enriched with the application of organic material which tends to decompose and release relatively large amounts of nitrogen into the soil before planting each fresh crop to boost yield.

Conclusion

It can be concluded from this research that application of 80 N kg/ha produced the highest growth and yield of sesame. Tithonia compost produced the highest yield of sesame compared with maize compost and urea fertilizer. Inorganic fertilizer (urea) resulted in lower yields compared to organic fertilizer (tithonia or maize compost) in the production of sesame.

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