Effects of *Terminalia Catappa* leaves with Poultry Manure compost, Mulching and Seedbed preparation on the Growth and Yield of okra (*Abelmoschus esculentus* l. Moench)

E.A. Aiyelari, A. Ogunsesi and O.O. AdeOluwa

Department of Agronomy, University of Ibadan, Ibadan, Nigeria

Abstract

Tillage and soil fertility amendment can greatly influence the performance of crops raised on such lands. An experiment was conducted to investigate the effects of Terminalia catappa leaves composted with poultry manure, mulching and seedbed preparation on the growth and yield of okra (Abelmoschus esculentus L. Moench) grown at the experimental field of the Department of Agronomy, University of Ibadan. Experimental treatments comprised three seedbed preparation methods (heap, bed and flat) and seven soil amendments (compost at 0, 5 and 10 t ha^{-1}, mulch 0, 5 and 10 t ha^{-1} and N.P.K 15 – 15 – 15 at 250 kg ha^{-1} in factorial combinations. The experiment was laid out in a randomized complete block design with three replications. Results showed that Terminalia catappa leaves applied as compost or mulch at 5 and 10 t ha^{-1} respectively did not produce any statistical significant ($P < 0.05$) difference in terms of morphological parameters, dry matter and pod yield of okra. However, yields from okra planted on heap and beds were significantly different from those planted on flat ($P \leq 0.05$). Fresh okra pod weights from heap and bed were greater than the values recorded from the flat by 35.8% and 34. 4%, respectively. Application of compost at 5 and 10 t ha^{-1} gave a significant increase in okra pod counts and weight and both were greater than the fresh pod weight obtained from NPK fertilizer by 12.6% and 27. 5%, respectively. Levels of mulch at 0, 5 and 10 t ha^{-1} did not show significant difference in fresh pod counts and weight. The combined effects of tillage and compost/mulch on the growth and yield of okra were not significant ($P<0.05$). However, fresh okra pod yield recorded from the combinations of either heap or bed tillage with compost rate of 5 and 10 t ha^{-1} were better than okra planted on heap or bed without compost. Application of 5 t ha^{-1} compost as fertilizer for okra production on either heap or bed is therefore considered economic and recommended for raising okra in similar environment.

***Keywords**: Seedbed preparation method, Mulching, Compost, Terminalia catappa leaves, Okra*

1. Introduction

Okra is an important local vegetable cultivated in the tropical regions mainly for its pod yield (Vincent *et al,* 2005). In Nigeria, okra is grown by small scale farmers while its economic important lies in the internal trade. As a result of low input system mostly adopted for okra production, green pod yield in most cases has been relatively modest. Even where high yielding cultivars are planted, the innately low fertility status of the tropical soils coupled with minimal application of fertilizer, remain the limiting factor to production.

Positive responses by okra green pod yield to application of mineral fertilizer have been reported in India, Nepal and Nigeria. A yield of 2 - 3 t ha^{-1} has often been reported (Vincent *et al.*, 2005). Mishra and Pandey (1987) reported a significant increase in okra pod yield per plant by the application of nitrogen fertilizer at the rate of 40 kg and 80 kg N ha^{-1} respectively. The problem is that chemical fertilizer is often scarce and too expensive beyond the reach of local farmers. The solution then lies in organic manures which are available and comparable to chemical fertilizers in yield improvement. Their use as a source of plant nutrients for growing vegetable crops could assume increasing importance (Vincent *et al.*, 2005). Therefore, the use of compost manure, mulch, animal manure, farm wastes and green manuring is widely known to be an alternative source of supplying nutrients to crops and maintaining soil fertility (Agboola et al, 1994).

Compost is an organic manure which can be used to speed up the rate of decomposition of lignifying organic products (such as almond leaves) to enhance mineralization. This is because easily mineralized manure releases nutrients, increases pH and crop yield (Rishirumuhirwa; 1997). It improves soil organic matter and fertility. Taiwo *et al.* (2002) and Vincent *et al.* (2005) reported an increase in okra pod yield by the application of organic manure at the rate of 6, 10 and 12 t ha^{-1}; although Taiwo *et al.* (2002) noted that some growth parameters were not significantly affected.

The rate of nitrogen mineralization of any agro forestry tree is determined by the physical and chemical nature of the residue. Low quality organic residues with high C/N ratio, lignin contents and polyphenol would release nutrients slowly due to their slow rate of decomposition (Fox *et al.*, 1990; Palm and Sanchez, 1991; Tian *et al.*, 1992). Thus it can be used as mulch to suppress weed, conserve moisture and release nutrient progressively.

Soil manipulation induces profound changes in fertility status and changes may be manifested by the performance of the crops (Ohiri and Ezumah, 1991). Recent trials on tillage combined with residues mulching, showed reduced run off and erosion risks, improved level of soil organic matter and structural stability (Lal, 1975; Boli *et al.*, 1993). The use of minimum tillage with compost/mulch cover seems more adapted to tropical conditions. *Terminalia catappa* leaves are abundant and could be better managed when used as mulch or compost. Burning of the leaves could be detrimental to human health and environment owing to the release of green house gases to the atmosphere which could also lead to global warming effects. The consequences of this phenomenon may result into chaotic weather changes, food insecurity, starvation and malnutrition (Preston and Leng, 1989). Thus the need for massive movements towards environmentally friendly practices that can minimize the production of CO_2 but maximize fixation of CO_2. Organic agriculture will eliminate the emissions of green house gases from the production and transportation of mineral fertilizers. Its use as manure to crop will help to improve the fertility status of the tropical soil for sustainable crop production. This calls for the research into effects of *Terminalia catappa* leaves composted with poultry manure and tillage on the growth and yield of okra. The objectives of the research were to evaluate:

- the effects of *Terminalia catappa* compost on the growth and yield of okra.
- the influence of *Terminalia catappa* leaves mulch on the growth and yield of okra, and
- the combined effects of tillage and mulching / compost on the yield of okra.

2. Materials and Methods

2.1 Experimental location

Field experiments were carried out at the experimental field of the Department of Agronomy, University of Ibadan, Ibadan. Ibadan is located in the South West of Nigeria at latitude 7^0 24^1 N and longitude 3^0 54^1 W. This area is subjected to marked wet and dry seasons with a bimodal rainfall in May-June-July, which is interrupted by a dry period of two weeks in August. This is followed by another period of heavy rainfall from September to October. Annual rainfall is between 1250 mm and 1500 mm; annual temperature is between 21.3^0C and 31.2^0C while the average annual humidity is 76 %. The soil of the area belongs to an Alfisol, locally classified under Egbeda soil series (Smyth and Montgomery, 1962). The land has been exhaustively cultivated with various crops ranging from maize, cassava and yam.

2.2 Compost production

Terminalia catappa dry leaves were mixed with dry poultry manure at a ratio 1:1 and composted using static pile method of composting (Yuh-Minghuang, 2005). The mixture were thoroughly wetted with suitable water content, and then piled up in a round heap. Turning of the compost pile was done fortnightly for six times to keep the moisture content at optimum level for biological activities. Finished compost was achieved at 12 weeks after composting.

2.3 Soil analysis

Soil samples were randomly taken from 0-15 cm depth at the site using soil auger before the start of the experiment. The samples were bulked, air dried under ambient temperature and analyzed for routine physico-chemical properties of the soil. The hydrometer method by Bouyoucous (1951) was used to determine particle size analysis. Organic carbon was determined by Walkley- Black dichromate digestion method (Nelson and Sommers, 1982) and Total Nitrogen was determined by Bremner and Mulvancy (1982). Available P was determined by Brays P1 method (Bray and Kurtz, 1945). Exchangeable K, Na, Ca and Mg were extracted, using neutral ammonium acetate (NH_4OAC) and K and Na concentrations were determined with flame photometer, while Mg and Ca were determined by Atomic Absorption Spectrophotometer. The exchangeable acidity was determined by extracting 2.5 g of soil with 25 mls of the extract with 0.01N NAOH using phenolphthalein indicator. The Effective Cation Exchange Capacity (E.C.E.C) was taken as the sum of the Exchangeable Acidity and Exchangeable Cation. The soil pH was determined using a 1:2 (soil: water) ratio with a glass electrode pH meter.

2.4 Land preparation and plot lay out

The experimental plot was cleared of vegetation manually. The plot size per treatment was 3× 2 m (6 m^2) and separated by 1 m. The land area was 23× 32 m (736 m^2). Beds and heaps were made using the native hoe.

2.5 Experimental design

The treatments were factorial combinations of three different methods of tillage (flat, bed and heap) and seven soil amendments (three levels of compost 0, 5 and 10 t ha^{-1} ; three levels of mulching 0, 5 and 10 t ha^{-1} and N.P.K 15-15-15 at 250 kg ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The compost manure used for the trial contained 5.1 g / kg N, 0.9 g/kg P and 7.3 g/kg K. Compost was applied using spot application method a week before planting to enhance mineralization, while mulching material and N.P.K were applied two weeks after planting. The N.P.K was applied by ring method.

2.6 Variety used

Okra variety Long- 45 Dwarf was sown at the rate of two seeds per hole and at a spacing of 90 × 30 cm to give a plant density of 37,037 plants ha^{-1}. The emerged seedlings were thinned to one. Weeding was manually carried out three times while Cypermethrin was used twice to control insects attack.

2.7 Growth and yield data

Sampling of the plants started at 6 weeks after planting (WAP) and was carried out weekly. Data on plant height, number of leaves and stem girth were taken using three selected plants per plot. Fresh mature pods were harvested at three days interval to determine the number and fresh weight of mature pods. Other parameters measured include fresh weight of okra leaves, stem and root. Dry weights were also determined in an oven set at 75^0C for 48 hrs.

2.8 Data analysis

The data collected were subjected to analysis of variance and means were separated using the Duncan's Multiple Range Test (DMRT).

3. Results and Discussion

3.1 Results

The result showed that the pH of the soil was moderately acidic (5.8) while the textural class revealed that the soil was loamy sand. Total carbon value of 6.0 g/kg was less than the critical level of 8.7 g/kg for the soil in Western Nigeria (Sobulo and Adepetu, 1987). The total N content of 1.3 g/kg was lower than the critical level of 1.5 g/kg (Enwenzor *et al*., 1979), while the available P of 7 mg/kg was below the critical level of 10 - 16 mg/kg (Adeoye and Agboola, 1985). The K status of the soil which was 0.1 c mol kg^{-1} also less than the critical level of 0.2 c mol kg^{-1} (Adeoye, 1986). Therefore, the soil was generally poor in major essential nutrients. (Table 1).

3.1.1 Effects of treatments on okra plant height, number of leaves and stem girth

3.1.1.1 Plant height

The result obtained indicated that at 6 WAP, there was no significant difference (P< 0.05) in plant height among all the treatments used. The 5 t ha^{-1}compost treatment resulted in significantly highest plant height (48.71 cm) at 8 WAP, which was followed by 250 kg ha^{-1} NPK (47.50 cm), 10 t ha^{-1} compost (44.21 cm) and 10 t ha^{-1} mulch (38.19 cm), respectively. Mulch levels at 0, 5 and 10 t ha^{-1} did not result into any significantly different plant height at 6, 7 and 8 WAP respectively (Table 2).

3.1.1.2 Number of leaves

At 6 and 7 WAP, number of leaves influenced by the application of 10 t ha^{-1} compost was found to be significantly better from that of control compost. However, mulch levels did not result into any significant difference. The highest number of leaves was produced under the mineral fertilizer at 8 WAP (13.22) which was significantly from other treatments. The control treatments gave the lowest values (Table 3).

3.1.1.3 Stem girth

Okra at 6, 7 and 8 W.A.P with levels of mulch at 0, 5 and 10 t ha^{-1} respectively were not significantly different. However, at 8 W.A.P, N.P.K had the highest stem girth value of 3.37 cm and this was significantly higher than mulch and compost treatments (Table 4).

3.2 Effects on yield components of okra

The 10 t ha^{-1} compost treatment resulted in highest number of pods per plant, fresh and dry weights of pod per (Table 5). Okra plants that received 10 t ha^{-1} compost gave the highest weight of fresh pod (742.22g). This was higher than the weight obtained under the control treatment (202.22g) and 5 t ha^{-1} (615.56 g) by 72.8% and 17% respectively. It was 27.5% higher than yield from NPK fertilizer (537.78g).

Okra plants with 10 t ha^{-1} level of mulch had the highest pod fresh weight but not significantly different from those at 0 and 5 t ha^{-1} mulch levels respectively.

3.3 Treatment effects on okra fresh and dry matter production

Fresh and dry matter production from the N.P.K treatment at 250 kg ha^{-1} resulted in highest values which were significantly ($P< 0.05$) different from value obtained from compost and mulch respectively (Table 6). The result also indicated that leaf fresh weight at the application rate of 5 t ha^{-1} (17.56g and 10 t ha^{-1} (17.01g) compost was significantly different from 0 t ha^{-1} (3.41g) rate of compost but not significantly different from mulch rate of 0 t ha^{-1} (14.92g), 5 t ha^{-1} (11.02g) and 10 tha^{-1} (8.78g) respectively. Observation on leaf dry weight follow same trend observed as in the fresh leaves (Table 6).

3.4 Effects of tillage practices on okra:

3.4.1 Plant height

At 8 WAP, heap produced the maximum value of height (44.70 cm) closely followed by bed (43.28 cm) and minimum height value of 32.46cm was obtained from flat. (Table 7)

3.4.2 Number of leaves

The result showed no significant tillage differences in number of leaves at 6, 7 and 8 WAP respectively. However heap gave highest value of number of leaves (8.52) which was not statistically different from bed (7.95) and flat (8.33) respectively (Table 7).

3.4.3 Stem girth

At 8 WAP, heap had the maximum value of stem girth of 2.79 cm which was not significantly different from bed (2.45 cm) and flat (2.28 cm) respectively (Table 7).

3.5 Effects of tillage on yield components of okra

Okra grown on heap produced the highest number of pod yield of (15.52) which was higher than values obtained from bed (14.90) and flat (12.38) by 3.99% and 20.2% respectively. The results also showed that the highest weight of pod was recorded from heap and this was higher than value obtained from bed and flat by 2% and 35.8% respectively. However, with respect to number of pod, fresh and dry weights of pod, heap and bed tillage were not statistically different (Table 8).

3.6 Effects of tillage interaction with compost on yield components of okra

The interaction of compost with flat, bet and heap were not significant in terms of number and weight of pods. However, the result indicated that the application rate of 10 t ha^{-1} compost-tillage resulted in the best performance in terms of number of pods, fresh and dry matter of okra pod. This was followed by 5 t ha^{-1} compost-tillage, while the 0 rate compost-tillage gave the lowest value. The best combination that led to optimum yield was from the heap and bed at the rate of 5 and 10 t ha^{-1} compost respectively while the flat-compost relationship was found to produce the lowest okra yield (Table 9).

3.7 Effects of tillage interaction with mulch on yield components of okra

Mulch tillage interaction did not produce any significant effect on the yield of okra. However, results of number of pods, control mulch-tillage performed better than 5 and 10 t ha^{-1} mulch-tillage. The result also indicated that the yield of okra (fresh weight of pod) planted on heap and bed with 5 and 10 t ha^{-1} mulch rates were higher than control rate of mulch (table 10).

4. Discussion

The experimental field had low soil fertility with respect to total nitrogen, phosphorus and potassium contents of the soil (Table 1). This was probably the reason why there were positive responses of okra to various soil amendments applied. On the average, compost rates at 5 and 10 t ha^{-1} were significantly ($p<0.05$) better in plant height, number of leaves and stem girth from the control rate of compost. On the contrary mulch rates of 0, 5 and 10 t ha^{-1} and tillage methods (heap, bed and flat) did not produce any significantly different morphological parameters assessed. In virtual every instance, there was no significant differences in growth parameters between the compost or mulch rates of 5 and 10 t ha^{-1} respectively. Oikeh and Asiegbu (1993) reported similar results for tomatoes, that organic manures did not produce any statistical difference in stem diameter, plant height and number of leaves per plant in Nigeria. The results showed that compost applied at the rates of 5 and 10 t ha^{-1} were significantly better than that of the control with respect to fresh and dry matter production of okra leaf and stem. The result however, contradicted the findings of Nwanguma (1997) on okra grown in South Western Nigeria, which reported that, the root and shoot growth of okra in poultry-amended soil were not different from the control. However, mulch rates at 0, 5 and 10 t ha^{-1} did not have any significant effect on okra leaf, stem and root. The result also showed that NPK fertilizer applied at the rate of 250 kg ha^{-1} recorded a significant higher fresh and dry matter yield of okra leaf, stem and root than mulch and compost treatments respectively. Okra with no mulch (control) was not significantly different from the mulched okra plants at the rate of 5 and 10 t ha^{-1} in terms of number of pods, fresh and dry weight of pods. This could be due to the some recalcitrant properties of the organic materials used in this study. This is in line with the report of Palm and Sanchez (1991) and Tian et *al (1992*) that organic residues with high lignin and polyphenol contents decompose slowly to release its nutrients to the soil. In this experiment, only small part was able to decompose and the nutrient released in this way could be easily leached out. The result is similar to observation of Boli et *al., (1993)* who reported that mulching with 6 t ha^{-1} of grass, only produced significant reduction in run off erosion on a sandy Alfisol, but the maize yield was not increased because of increasing leaching. The result showed that the number of pods and yield obtained from okra planted with compost (5 and 10 t ha^{-1}) were significantly different from the control compost; in many respects, this result is in consonance with those reported for pepper by Aliyu (2000). He reported that given four farmyard manure rates ranging from 0 - 30 t ha^{-1}, all the rates were statistically similar and were higher than the control. The best performance was recorded for compost and mulch at the rate of 10 t ha^{-1}. However, at the rate of 10 t ha^{-1} compost and mulch it would be very difficult for peasant farmers to break even under a low input system, such as the small scale cropping system in Nigeria. Therefore, the 5 t ha^{-1} rate, particularly in the context of a low input system, resulted in better returns for labour, a major limiting factor. In comparison, the pod yield produced by the compost manure rate was observed to perform better than the NPK. It can be speculated that assimilates produced by NPK fertilizer was concentrated on vegetative growth and biomass yield (leaf, stem and root) to the detriment of edible pod yield. Heap and bed tillage produced a significantly higher okra fresh pod yield than flat tillage. This suggests that for optimum green okra pod yield, heap and bed tillage methods are preferred to the flat, especially during the rainy season. Tillage combined with mulch or compost had no significant effect on okra pod yield even though their combination led to increase in green okra pod yield.

5. Conclusion

Field investigations were carried out at Parry Road, University of Ibadan to evaluate the effects of *Terminalia catappa* leaves composted with poultry manure, mulching and tillage on the growth and yield of okra. It was revealed that tillage combined with *Terminalia catappa* leaves compost can successfully increase okra production in Ibadan. The results showed that the effect of *Terminalia catappa* leaves mulch on the number of pod and fresh and dry weights of pod were though not significant with the levels of mulch. The optimum level of compost for okra production is 5 t ha^{-1}, which produced higher okra pod yield than N.P.K by 27.5% while the 5 t ha^{-1} also higher in yield than the N.P.K by 12.6%. For optimum performance of okra, under a low input system, an early application of compost manure of 5 t ha^{-1} on okra planted on heap or bed, depending on the quality of compost will be appropriate for sustainable production.

References

Adeoye, G.O. and A.A. Agboola (1985). Critical levels for soil pH, available P.K .Zn and maize ear leaf content of P, Cu and Mn in sedimentary soils of South Western Nigeria. *Fertilizer Research* , 6:65-71.

Adeoye, G.O. (1986). Comparative studies of some extractants for sedimentary soil of South Western Nigeria. Ph.D Thesis, University of Ibadan.

Agboola, A.A. and Ray, P.A. Unamma (1994). Maintenance of soil fertility under traditional farming systems in: Lombin *et al.* (eds) Organic fertilizer in the Nigerian Agriculture, present and future. Proceedings of a National Organic Fertilizer Seminar, Kaduna, Nigeria. March 26-27, 1991.

Aliyu, L. (2000). Effects of organic and mineral fertilizers on growth, yield and composition of pepper (*Capsicum annum* L.) Biology, Agriculture and Horticulture 18: 29-36.

Boli, Roose E, Ziem, B, Sanon, K. and Waechter, F. (1993). Effect des techniques culturales surle Ruisseller *et al.* La production deco ton et mais sur un sol Ferrugineux tropic Sableux. Recherché de systems deculture intensits et durable en region soudanienn due nord Cameron (Mbissiri, 1991-1992) cashier ORSTOM serie Pedlogie. 28 (2): 309-326

Bouyoucos, G. H. (1951). A rehabilitation of the hydrometer method for making mechanical analysis of soils. *Agronomy Journal* 43:434-438.

Bray, H. Y. and L.I. Kurtz (1945). Determination of total organic and available form of phosphorous in soils. *Soil Science*, 59: 39-45

Bremner, J.M. and Mulvancy, C.S. (1982). Total Nitrogen. In: Page, A.L *et al.* (Eds), Methods of soil analysis part 2, Agron Monogr. 9 (2nd edition)) ASA and SSSA, Madison, Wsc, pp 403-430

Enwenzor, W. O. Udo, E.J,, Usoroh, N.J., Ayotade, K.A, Adepetu, J.A., Chude, U.O. and Udegbe, C.J. (1979). Fertilizer use and management practices for crops in Nigeria (series No 21) produced by Fertilizer Procurement and Distribution Division of the Fed. Ministry of Agriculture, Water Res and Rural Dev., Lagos.

Fox, R.L., Myer, R.J.K. and Vallis, I. (1990). Nitrogen mineralization rate of legume residue in soil as influenced by their polyphenol, lignin and nitrogen content. *Plant and Soil* 129: 251-259

Lal, R. (1975). Role of mulching techniques in tropical soil and water management. I.I.T.A Technical Bulletin No 9, Ibadan, Nigeria.

Mishra, J.P. and Pandey, R.A, (1987). Effects of N.and K on the seed production in calcerous soil. *India Journal of Agronomy*. 32 :425 -427.

Nelson, D.W, and Sommers, L.E. (1973). Determination of total nitrogen in soil. *Agronomy Journal*. 65: 109- 112.

Nwanguma, E.L. (1997). Preliminary studies of the effect of organic manure in the control of root knot nematode (*Meloidogyne incognita*) and growth of okra and tomato in South Western Nigeria. In: Adejoro, M.A and Aiyelaagbe O.O. (eds) Horticultural Society of Nigeria Conference Proceedings, Ibadan, Nigeria 8-11 April (1997) pp 166-168.

Ohiri, A.C. and Ezumah, A.C. (1991). Tillage effects on cassava production and some soil properties. *Soil and Tillage Research* 17: 221 – 231.

Oikeh, S.O. and Asiegbu, J.T. (1993). Growth and yield responses of tomatoes to sources and rates of organic manure in ferralitic soils. *Bioresource Technol*. 45:21-25

Palm, C.A. and Souchez, P.A. (1991). Nitrogen release from the leaves of some tropical legumes as affected by their lignin and Polyphenol content soil, Biology and Biochemistry (Soil,Bio, Biochem) 23: 83-88.

Preston, T.R. and Leng, R.A. (1989). The greenhouse effect and its implication for world agriculture. The need for environmentally friendly development. *Livestock Research* for rural development Vo1. Pp,1 - 4.

Rishirumuhirwa, T. (1997). Role du bananier dans le fontionnement des exploitations agricoles sur les haut Plateaux de I’A frique orientale. Application a la region du kirimiro au Burundi. These Ecole polytechque federale lausanne

Smyth, A.J. and Montgomery, R.F. (eds) (1962). Soils and Land use in central Western Nigeria. The govt. of western Nig. Ibadan 50pp

Sobulo, R.A. and Adepetu, J.A, (1987). Soil testing and fertilizer formulation of crop production in Nigeria. In: proceedings of the national fertilizer seminar, portharcourt , Nigeria, 28-30 October, 1987, 93 -105.

Taiwo, L.B. Adeniran, J.A. Ashaye, O.F. and Odofin, A.J. (2002): Organic okra (*Abelmoschus esculentus*): Its growth, yield and organoleptic properties. *Journal of Food Science and Nutrition* 5:180-183

Tian, G., B.T. Kang, and L. Brussard (1992). Biological effects of plant residues with contrasting composition under humid tropical conditions-decomposition and nutrient release soil biology and biochemistry 24: 1051-1060.

Vincent, B.O. Micheals, T.M. and Stanley. M.M. (2005): Effect of cattle manure application on yield and yield indices of okra (*Abelmoschus esculentus* L. Moench). *Journal of Food Agriculture and Environment* 3:125-129

Yuh-minghuang (2005): Composting methods. *Food and Fertilizer Technology Center* for the Asian and Pacific Region.

Table 1: Physico-chemical analysis of the soil used

Soil properties	Value
pH (1:1 H_2O)	5.8
Organic carbon(g/kg)	6.0
Total N (g/kg)	1.3
Available P (mg/kg)	7
Exchangeable cations (c mol/kg)	0.1
Ca	0.1
Mg	0.2
K	0.1
Na	0.1
Exchangeable acidity (c mol/kg)	0.4
Effective C.E.C (c mol/kg)	0.9
Mechanical analysis (g/kg)	
Sand	879
Silt	720
Clay	480
Textural class	loamy sand

Table 2: Effects of treatments on plant height (cm) of okra

Treatment	Weeks after planting		
	*6	7	8
Compost (t / ha)			
0	18.99	20.99d	34.02d
5	27.26	28.37a	48.71a
10	23.04	25.04ba	44.21abc
Mulch (t/ ha)			
0	19.71	20.20d	33.04d
5	20.22	22.47bcd	35.37cd
10	20.06	22.06cd	38.19bcd
N.P.K (250 kg/ ha)	22.27	24.27bc	47.50ab

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.
* No significant difference ($p< 0.05$)

Table 3: Effects of treatments on number of leaves of okra

Treatment	Weeks after planting		
	6	7	8
Compost (t / ha)			
0	6.22bc	7.11b	7.11bc
5	7.11ab	8.11ab	8.33bc
10	7.66a	8.64a	9.22b
Mulch (t/ ha)			
0	6.00c	7.00b	6.11c
5	6.33bc	7.66ab	6.66c
10	6.55bc	7.55ab	7.22bc
N.P.K (250 kg/ ha)	6.77ab	7.77.ab	13.22a

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 4: Effects of treatments on stem girth of okra

Treatment	Weeks after planting		
	6	7	8
Compost (t / ha)			
0	0.98c	1.08bc	2.15cd
5	1.25bc	1.35bc	2.51bc
10	1.55ab	1.65ab	2.86b
Mulch (t/ ha)			
0	1.14bc	1.24bc	1.96cd
5	1.15bc	1.25bc	2.33cd
10	1.11bc	1.20bc	2.46cb
N.P.K (250 kg/ ha)	1.80a	1.90a	3.37a

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 5: Effects of treatments on yield component of okra

Treatment	Number of pods	fresh pod weight (g/plant	Dry pod weight (g/plant
Compost (t / ha)			
0	10.55c	202.22c	104.93c
5	18.22ab	615.56ab	319.73ab
10	19.77a	742.22a	379.04a
Mulch (t/ ha)			
0	11.88c	157.56c	83.09c
5	11.33c	233.89c	121.62c
10	12.00c	240.56c	124.71c
N.P.K (250 kg/ ha)	16.11.b	537.78b	267.20b

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 6: Effects of treatments on fresh and dry matter (g/plant) production of okra

Treatments	Leaf	g/plant Stem	Root
		Fresh weight	
Compost (t / ha)			
0	3.41b	8.90d	8.01cd
5	17.56ab	48.71b	22.95bc
10	17.01ab	41.11.bc	31.18b
Mulch (t/ ha)			
0	14.92b	21.08cd	5.13d
5	11.02b	17.91cd	10.25cd
10	8.78b	18.18cd	10.28cd
N.P.K (250 kg/ ha)	30.54a	97.00a	52.54a
		Dry weight g/plant	
Compost (t / ha)			
0	0.84b	2.61c	5.41cd
5	2.80ab	14.25b	9.43bc
10	2.73ab	12.03b	13.04b
Mulch (t/ ha)			
0	2.38b	6.17bc	2.10d
5	1.77b	5.50bc	4.22cd
10	1.40b	5.35bc	4.23cd
N.P.K (250 kg/ ha)	4.72a	23.40a	21.54a

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 7: Effects of tillage on morphological parameters of okra

Tillage system	Weeks after planting 6	7	8
Plant height (cm)			
Heap	21.91a	23.54a	44.70a
Bed	23.24a	25.24a	43.28a
Flat	26.21a	21.23a	32.46a
Number of leave per plant			
Heap	6.95a	7.95a	8.52a
Bed	6.61a	7.80a	7.95a
Flat	6.42a	7.33a	8.33a
Stem Girth cm			
Heap	1.31a	1.40a	2.79a
Bed	1.37a	1.49a	2.45a
Flat	1.17a	1.26a	2.28a

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 8: Effects of tillage on yield components of okra

Tillage system	Number of pods	Fresh wt of pod (g/plant)	Dry wt of pod (g/plant)
Heap	15.52a	446.1a	229.2a
Bed	14.90a	437.1a	224.2a
Flat	12.38b	286.5b	146.6b

Means followed by the same letter within the same column are not significantly different at the 5% probability level according to the Duncan's Multiple Range Test.

Table 9: Effects of tillage interaction with compost on yield components of okra

Tillage system	compost Level (t ha^{-1})	Number of edible	Fresh wt of pod (g/plant)	Dry wt of pod (g/plant)
Heap	0	11.3	213.3	110.9
	5	17.0	586.6	303.3
	10	20.3	886.6	440.3
Bed	0	13.6	263.3	136.2
	5	21.3	733.3	381.3
	10	21.0	800.0	416.0
Flat	0	6.6	130.0	67.6
	5	16.3	526.6	274.5
	10	18.0	540.0	280.8

Tillage X compost no significant at ($Pr \leq 0.05$)

Table 10: Effects of tillage interaction with mulch on yield component of okra

Tillage system	Compost level (t ha-1)	Number of edible	Fresh wt of pod (g/plant)	Dry wt of pod (g/plant)
Heap	0	13.6	206.6	110.9
	5	12.6	233.3	121.3
	10	15.6	380.0	197.3
Bed	0	9.0	181.6	94.4
	5	10.0	186.6	97.0
	10	11.6	218.3	112.6
Flat	0	13.0	84.3	43.8
	5	11.3	281.6	146.4
	10	8.6	123.3	64.1

Tillage X mulch no significant at ($Pr \leq 0.05$)