American-Eurasian Journal of Sustainable Agriculture, 4(1): 1-13, 2010
ISSN 1995-0748

ORIGINAL ARTICLES

Growth, Dry Matter and Fruit Yields Components of Okra under Organic and Inorganic Sources of Nutrients

[1]Akanbi, W.B, [2]Togun, A.O., [3]J.A. Adediran and [1]E.A.O. Ilupeju

[1]Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[2]Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria.
[3]Soil and Water Management Programme, OAU, Moor Plantation, Ibadan, Nigeria

Akanbi, W.B, Togun, A.O., J.A. Adediran and E.A.O. Ilupeju; Growth, Dry Matter and Fruit Yields Components of Okra under Organic and Inorganic Sources of Nutrients, *Am. Eurasian J. Sustain. Agric., 4(1): 1-13, 2010*

ABSTRACT

Pot and field experiments were conducted at Institute of Agricultural Research and Training, Ibadan, Nigeria between 2002 and 2004 to determine okra response to organic and inorganic sources of nitrogen (N) fertilizer. The experimental design was a factorial experiment fitted into randomized complete block with three replicates. In the pot experiment okra variety NHAe 47-4 was nourished with four N levels (0, 25, 50 and 75 kg N ha^{-1}) and five compost rates (0, 1.5, 3.0, 4.5 and 6.0 Mg ha^{-1}) while in the field experiment the same variety of okra was fertilized with three N levels (0, 25 and 75 kg N ha^{-1}) and four compost rates (0, 2, 3 and 4.0 Mg ha^{-1}). The experiment was laid out in a randomized complete block replicated thrice. Data were collected on growth parameters, dry matter production and partitioning and marketable fresh fruit yield. The analysis of variance was performed on the data following procedure of Gomez and Gomez and significant means will be compared using Duncan‘s Multiple range test ($P \leq 0.05$). All data collected were reported as average of 2002 and 2004 trials. Application of 75 kg N ha-^{1} gave the highest okra fruit yield of 11.46 Mg ha-^{1}. This is not significantly different from 11.41 and 11.44 Mg ha-^{1} fruit yield obtained when the crop was fertilized with either 50 kg N/ha or 4.0 Mg ha-^{1} compost. It is concluded that for optimum performance of okra, 4 Mg ha-^{1} compost that could be reduced if fortified with small amount of mineral fertilizer is adequate.

Key words:

Introduction

Okra (*Abelmoschus esculenta* L. Moench) belongs to the Malvaceae family, believed to have originated in tropical Africa (Purseglove, 1984). In Nigeria, it is widely grown, distributed and consumed either in fresh or in dried form (Fatokun and Chedda, 1983). Its fruits are used as vegetable boiled, sliced or fried. It is mainly grown by many farmers because of its tender texture which is highly mucilaginous and useful in soup thickening. The edible portion of the pod contains approximately water, 88; protein, 2.1; fat, 0.2; carbohydrate, 8.0; fibre, 1.7 and ash, 0.2 g per 100 g (Tindall, 1983). Okra is tolerant to a wide range of climatic conditions. In Nigeria, its cultivation areas spread right from the south to the far North. In the southwestern Nigeria it is taken as peri urban crops for it grows both as rain fed and dry season fruit vegetable crop to supply the teeming urban population.

Application of N has been reported to significantly increase growth and fruit yield of okra (Katung *et al* 1996). Significant higher flower and fruit production in okra has also been reported by Sharma *et al* (1996). This was attributed to the fact that sufficient supply of N will improve cell division and multiplication, foliage production and photosynthetic activity of the plant. All these improve dry matter accumulation and partitioning

Corresponding Author: Akanbi, W.B, Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
E-mail: akanbiwasiu2001@yahoo.com

into economic part of the plant. Despite the indispensability of N to okra growth and fruit production, its source could determine its availability to plant.

The source of N for crop production may affect the performance of the crop. There is therefore the need to synchronize crop N supply with crop demand (Pang and Letey, 2000). Nitrogen deficiencies limit crop growth, whereas N excesses are often lost to the environment. Poor arable and vegetable crop yields under organic cropping systems compare with those from conventional practices have been attributed to a mis-match between N supply and demand (Robert and Walker, 1989). Thus, in organic farming, the limited amounts of available N require more effective distribution among various crops to optimize crop outputs.

Optimizing of organic N management requires knowledge of the response of crop growth processes to N. Variation in dry matter yield in response to N source may arise from differences in the amount of intercepted photosynthetically active radiation (PAR) by the canopy, the light use efficiency (LUE), and harvest index (Charlfen 1981; Robert and Walker, 1989). Depletion and or shortage of N indicate that either the crop will not be able to maintain its leaf area expansion rate or cannot maintain its leaf and plant N concentration. Either of this will have effects on crop growth and production of economic products. Plant species differs in their degree of responses to N sources. Also crop varieties have been reported to respond differently to applied nutrients. In an experiment on response of wheat varieties to organic and conventional fertilizers, it was observed that crop demand for and the form of nutrient used by crop varies and this depend on nutrient sources, soil conditions, crop root biomass and its absorption rate (Lombin *et al*; 1991, Akanbi *et al* 2000).

Available information about response of okra varieties to organic and conventional source of N is scanty. And this information is require to fine tune the technology involved in the adoption of organic farming in Nigeria before it is introduced to the farmers who are the end users. The objective of the present work is to assess the growth, dry matter partitioning and accumulation, and fruit yield of okra grown with organic and inorganic source of nutrients

Materials and Methods

Between 2002 and 2004, okra was grown in pot and field experiment at the experimental site of Soil and Water management programme, IAR&T; Obafemi Awolowo University, Ibadan (7º33’N, 3º 56’E), Nigeria. The soil was alfisol and dominated sand loam soil. The area has bimodal rainfall with total annual rainfall ranges from 1250 mm and 1500 mm spanning eight months (March to October). In the year of the experiment the total rainfall was 1230 mm per. Analysis of soil sampled from the experimental land showed organic carbon, 3.2 g kg^{-1}; total N, 0.27 g kg^{-1} and available P, 5.23 mg kg^{-1}. This result shows that the essential nutrients are grossly inadequate for okra production (NIHORT, 1986).

Experimental materials

Compost used for the study was prepared from maize stover and well cured poultry manure. The Stover and poultry manure were sorted out of non biodegradable materials. The Stover was chopped into materials of particle size below 5 cm with chaff cutter. Concrete surface heap method of composting the organic materials was adopted. The walls were lined with black polythene sheet and the materials were laid out in ratio 3:1 maize Stover to poultry manure (on dry weight basis) (Abad *et al* 1997; Adediran *et al* 1999). The materials were laid out in layers, a layer consisted of 30 kg maize stover and 10 kg poultry manure. The compost heaps were monitored till maturity, turning and watering were done every fortnight, while pH, compost heap and ambient temperatures were taken every week. At maturity, the compost was evacuated from the heap, air dried, shredded, bagged and stored under shade at room temperature until use. Samples were taken for chemical analysis.

The mineral fertilizer use as source of nutrients was urea (45% N) as a source of N, single super phosphate (SSP) (18 % P_2O_5) for phosphorus and muriate of potash (MOP) (60 % K_2O) for potassium. The okra variety studied was NHAe 47 -4 representing early maturing one. The variety is adapted and well cultivated among farmers in the southwest Nigeria. The seeds of the test crop were collected from National Horticultural Research Institute (NIHORT), Ibadan.

Pot experiment

This was conducted in the glass house of Soil and Water Management Unit of IAR & T, Ibadan with the objective of monitoring the effect of different levels of compost and N on growth, dry matter accumulation and fresh fruit yield of okra at different growth stage. The soil used was a composite top soil that was collected from the plots that was later used for the filed experiment. Plastic pots of 5 litre capacity were used. They were perforated at the base and plugged with cotton wool to control drainage and facilitate aeration. A treatment had

3 pots per replicate. A pot contained 2 plant stands making a total of 6 plants per treatment per replicate. The pots were perforated at the bottom and plugged with cotton wool to control drainage and facilitate aeration. Each pot was filled with 4 kg air dried soil leaving about 5 cm to the brim of the pot to prevent soil wash during watering. The pots were arranged in a randomized complete block design with three replicates. The tested treatments on okra variety HNAe 47 -4 were four N levels (0, 25, 50 and 75 kg^{-1}) and five compost rates (0, 1.5, 3.0, 4.5 and 6.0 Mg ha^{-1}). Urea was used as N source and the equivalent amount applied per pot to give the corresponding levels of N ha^{-1} were 0.0, 0.11, 0.00 and 0.33 g. The compost rates used were chosen based on N content of the matured compost, N recommended rate for okra in southwest Nigeria and approximately mineralization rate of compost (Dalzell *et al*; 1981). The quantity of compost applied per pot to give the equivalent rates of compost /ha were 0,3, 6, 9 and 12 g. Uniform application of P as 300 mg SSP, and K as 67 g MOP per pot were done to those pots that were not treated with compost. This is equivalent to 30 kg P_2O_5 and 20 K_2O as recommended for the test crop (NIHORT, 1986).

Factorial combinations of the treatments gave 40 treatment combinations. They were laid out on glasshouse benches in a randomized complete block design with three replicates. At planting each treatment was applied by thoroughly mixing it with 4 kg soil and transferred into 5-litre plastic pot. The pots were watered to field capacity and a saucer pan placed under each to collect the leachates. Four seeds were sown in the pots on 26th January 2002. The seedlings on establishment were thinned to two per pot. The plants were allowed to grow for period of 6 weeks after which they were harvested by cutting from the soil surface. The roots were neatly sieved out and the pots were re-seeded and plants allowed growing for a further six-week period. At the end of each six weeks cropping cycle, plants were harvested from soil surface for each crop. The roots were neatly removed, washed under running tap water and air-dried to remove surface water. Thereafter, roots and shoots were oven dried at 80°C to a constant weight and the plant dry matter yield was determined.

The leaf area measurement was taken by measuring the length of median lobe of individual leaf on the plant and applying the following formula: (Asif, 1977; Olasantan 1999):

$Y = 115X - 1050$
Where: Y = Leaf area (cm^2)
X = length of median lobe (cm).
The area of all leaves on a plant were added up to give leaf area per plant

Field experiment

The field experiment was conducted on the field where soil used for pot experiment was collected. Prior to planting, the land was ploughed and harrowed once each. Soil samples were taken for laboratory analysis to know the nutrient contents. The treatments imposed on okra were three N levels (0, 50 and 75 kg N/ha) and four compost rates (0, 2, 3 and 4 Mg /ha). The treatments were chosen based on the results of pot experiment. There was uniform application of P as 113.4g SSP and K as 25.25g MOP to plots that did not receive compost. This is equivalent to 30 kg P_2O_5 and 20 kg K_2O /ha. The experiment was a 3 x 4 factorial laid out in a randomized complete block design. The plot measured 3.6 m x 2.1 m (7.56 m^2) and consisted of 7 rows of eight plants each, with 1m gap between plots and 2 m gap between replicates.

At planting three seeds were dropped per hole at a spacing of 0.6 m x 0.3 m giving a projected population of 55,555 plants /ha. Thinning was done to one plant per stand at 2 WAP. The compost treatments were uniformly applied and worked onto the soil by light hoeing a week before sowing. Nitrogen was split applied at 2 and 5 WAP while weed free plots were achieved by applying combination of gramozone and galex (Metobromuron + metolachlor) at the rate of 1.5 and 2.5 kg a.i. /ha a day after planting. This was supplemented by one light hoeing at 5 WAP. The plants were sprayed with karate 2ml /l water against flea beetles fortnightly, starting from 2 weeks after seedling emergence till on set of fruiting.

Data collection

Data collections commenced at 4 WAP and continued through 4 growth stages: active shoot elongation stage (4WAP), flowering (6WAP), peak of fruiting (8WAP), end fruiting (10 WAP) and at the point of plant senescence (12 WAP) (Fatokun, 1976). Data were collected on growth, dry matter, fruit yield components, seed yield attributes, tissue elemental composition and nutrient uptake.

a. Growth parameters:

Six (6) plants were randomly selected from each plot for the assessment of the following growth parameters:

stem height and girth, leaf area, leaf area index (LAI), crop growth rate (CGR) and net assimilate rate (NAR). The LAI was determined by dividing the leaf area per plant by the land area occupied by one plant. The crop growth rate (CGR) and net assimilation ratio (NAR) were calculated as follows:

$$Crop\ growth\ rate\ (C) = \frac{W_2 - W_1}{P\ (t_2 - t_1)}\ (Roderick, 1978)$$

$$Net\ assimilation\ ratio\ (NAR) : - \frac{W_2 - W_1}{(L_2 - L_1)} \frac{Log_e\ L_2 - Log_1}{(t_2 - t_1)} L_1\ (Roderick, 1978)$$

Where W_1 = Biomass yield at previous harvested date.
W_2 = Biomass yield at current harvested date
P = The area of the ground on where W_1 and W_2 have been realized
t_1 = Time of harvesting biomass yield W_1
t_2 = Time of harvesting biomass yield W_2
L_1 = Leaf area at previous harvest date
L_2 = Leaf area at current harvest date.

b. Dry matter yield

For determination of the dry matter accumulation and partitioning, another 3 plants per plot (destructive sampling) were uprooted at each sampling time. They were processed for dry matter yield as explained under pot experiment. For post flower sampling (i.e. 8, 10 and 12 WAP), partitioning of dry matter into shoot, root, flower and fruit was done.

Fruit yield

For determination of crop fresh fruit yield, four plants / plot were selected randomly among the competing plants. Harvesting of fruit commenced when the first set of fruits snapped easily and reached market size. Harvesting of fruit continue every four days until when the crop are no longer producing economic fruits. At each time of harvesting, the harvests are sorted into marketable and non marketable fruits, counted and weighed. The total fresh fruit yield recorded here constituted the cumulative marketable fruits and were obtained by converting the fresh fruit yield from kg / plot to Mg ha^{-1}.

Statistical analysis

The analysis of variance will be performed on the data following procedure of Gomez and Gomez (1991) and significant means will be compared using Duncan‘s Multiple range test ($P \leq 0.05$). All data collected were reported as average of 2002 and 2004 trials.

Results

Development of vegetative characters in pots and field grown okra

Pot experiment

Fig. 1 shows the effect of nitrogen on the vegetative development of pot grown okra. There was significant difference among N levels on mean plant height, stem girth and LA The control (0 kg /ha) had significantly lower stem height and girth compared to the other N levels. The same trend was observed for the leaf area. The highest LA per plant was obtained at 25 kg N /ha and is significantly higher than what was observed with plants nourished with 0 and 75 kg N /ha. The leaves of plant fertilized with 25 and 50 kg N/ha were statistically similar.

Compost application significantly increased only the mean stem height and LA development over the control. At harvest, plants from all the 4 compost rates had similar height, which is significantly better than the control plants. The LA increased with increasing level of applied compost up to 4.5 Mg /ha, there after, decreased. Plants that received 4.5 Mg /ha compost had the widest LA and this was 3.1, 5.36, 10.4 and 25.3% significantly higher than 3.0, 1.5, 6.0 and 0.0 Mg /ha compost rate respectively (Table 1).

Table 1: Effect of compost on Okra ve and getable development in pot experiment

Compost (Mg /ha)	Stem height (cm)	Stem girth (cm)	Leaf area /plant (cm^2)
0	25.65b	1.02a	350.59c
1.5	27.41a	1.04a	443.86b
3.0	27.86a	1.01a	454.32ab
4.5	26.86a	1.06a	469.02a
6.0	29.39a	1.08a	420.20b
Mean	27.43	1.04	427.60

Mean along the same column with the same alphabet are not significantly different at $P \leq 0.05$

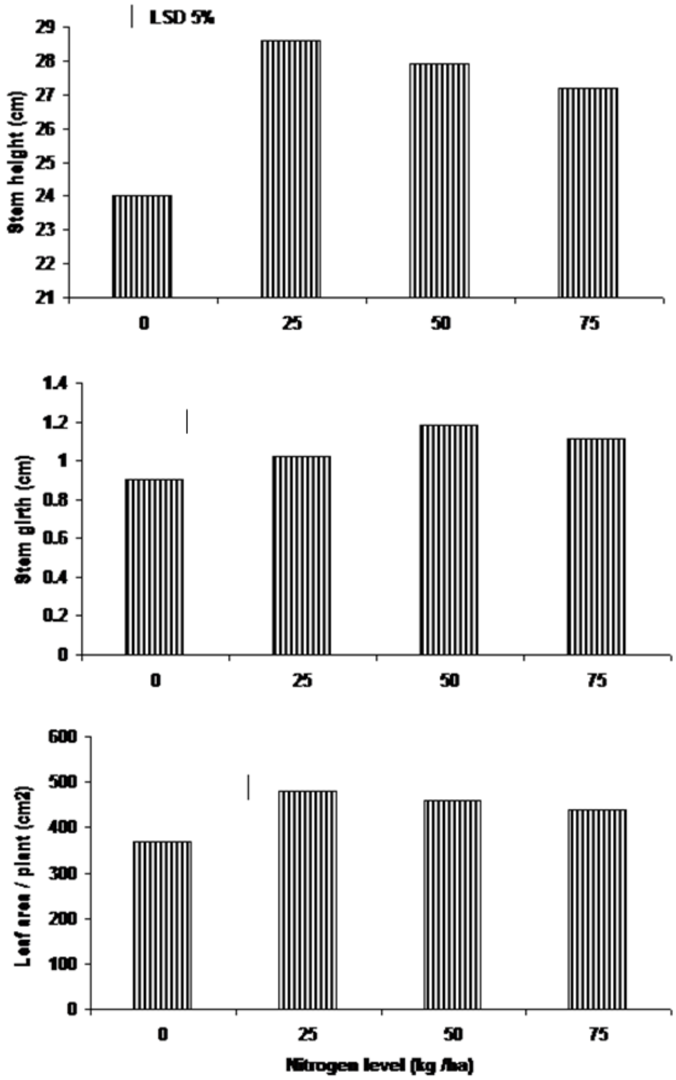

Fig. 1: Effect of Nitrogen on the stem height, stem girth and leaf area of pot grown okra

Field experiment

Significant effect of N levels was observed on stem height, stem girth and leaf area development for most of the sampling periods the exception are the stem height and leaf area both at 4 WAP. Plant height increased gradually with age up to 8WAP and thereafter remained unchanged. At most sampling periods, there were no significant difference between the height observed at 50 and 100 kg N/ha. The height at these levels were however significantly higher than the non-fertilized control plant. Similarly leaf area per plant increased up to 8 WAP, thereafter fell slightly. At this time of highest leaf area production, 50 kg N /ha level gave the best value, which is significantly higher than other N levels (Fig. 2).

Application of compost leads to significant increase in stem height, stem girth at 4WAP and LA at 10WAP. The control (0 Mg /ha compost) had significantly shorter stem height compared to other compost rates. There were however no significant differences between the rests of the compost rates. Stem girth significantly differed

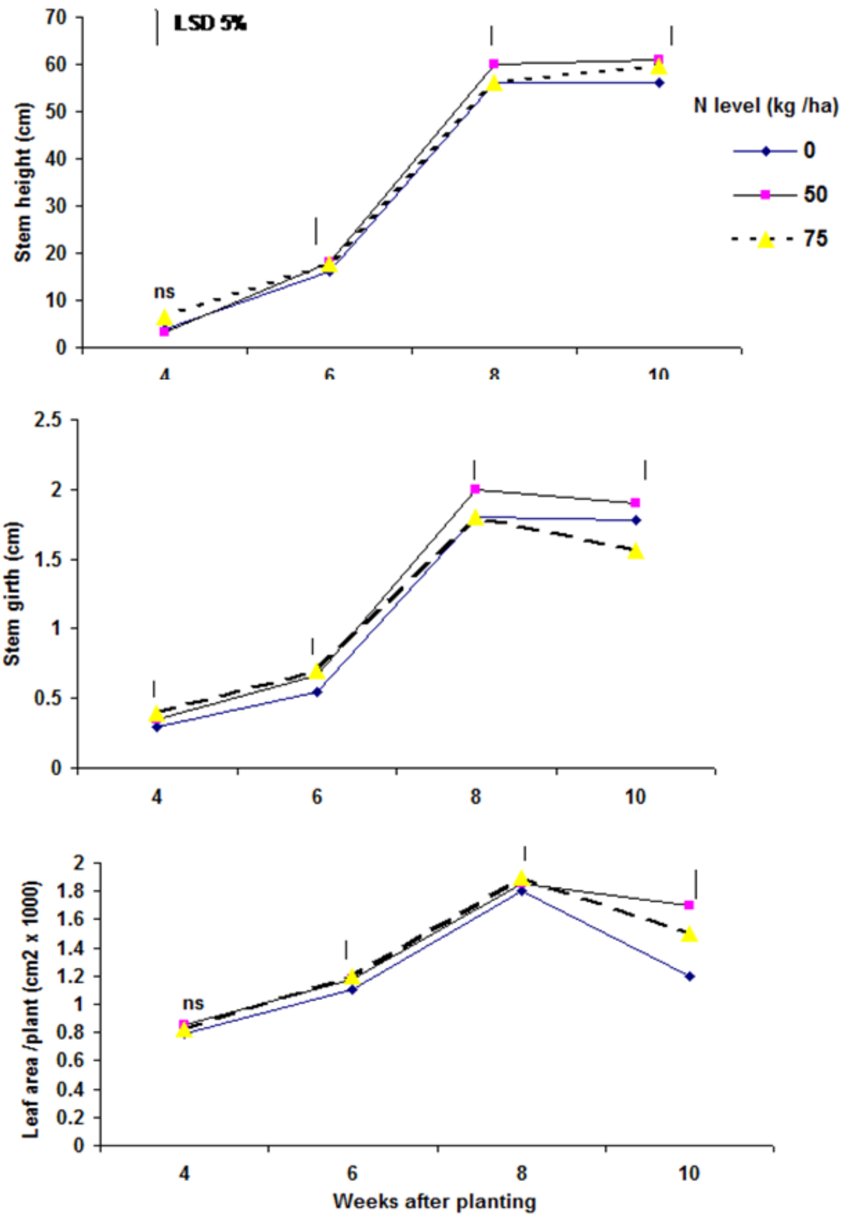

Fig. 2: Effect of Nitrogen on the stem height, stem girth and leaf area of field grown okra

between 0 Mg /ha and the other compost rates. The most robust crop stem was of 2.13cm was obtained from 2 Mg /ha rate compost at 10 WAP. Leaf area development increases with plant ages up to 8 WAP and, thereafter decreased. Significantly differences among the compost rates on leaf area development were observed only at 8 WAP. At this age, leaf area increased with increasing compost rate and reach the peak at 4 Mg /ha (Table 2). Again, at this age, the leaf production of 3 and 4 Mg / ha compost rates were similar.

Dry matter accumulation of pot and field grown okra

Pot grown plants

The mean amount of dry matter accumulated in okra plant at final harvest (6WAP) was highly significantly (P £ 0.01) affected by N or compost fertilizer and their interaction (Fig. 3). Increasing N from 0 to 25 and 75 kg /ha^{-1} respectively increased plant dry matter by 0.66 and 0.21 g /plant. Similarly, dry matter per plant increased with increasing level of applied compost up to 6 Mg /ha but there was no significant differences between value at 4.5 and 6 Mg /ha but there was no significant differences between values at 4.5 and 6.0 Mg /ha compost. The interactive effects of N and compost rate on plant dry matter were highly significant (P £ 0.01).

Table 2: Effect of compost rates on the vegetative characters of okra in the field experiment

Compost rate (Mg /ha)	Weeks after planting			
	4	6	8	10
		Stem height (cm plant^{-1})		
0	5.13c	18.66b	55.14b	56.19b
2	5.76a	17.70c	56.53b	57.53ab
3	5.84ab	18.92ab	57.57b	56.06b
4	6.17a	19.28a	58.94a	58.34a
Mean	5.77	18.64	57.04	57.03
		Stem girth (cm plant^{-1})		
0	0.78b	1.13a	1.74a	1.93b
2	0.82a	1.15a	1.99a	2.13a
3	0.90a	1.13a	1.98a	2.06b
4	0.77b	1.17a	1.98a	2.10a
Mean	0.82	1.15	1.92	2.05
		Leaf area (cm^2 plant^{-1})		
0	340.76a	680.68a	1747.90c	1338.28a
2	331.85a	622.61a	2001.71ab	1348.22a
3	361.54a	669.34a	2048.80a	1382.38a
4	370.69a	652.55a	1879.80b	1482.32a
Mean	351.21	656.29	1919.54	1387.80

Mean along the same column for each parameter with the same alphabet are not significantly difference at P $\leq$ 0.05

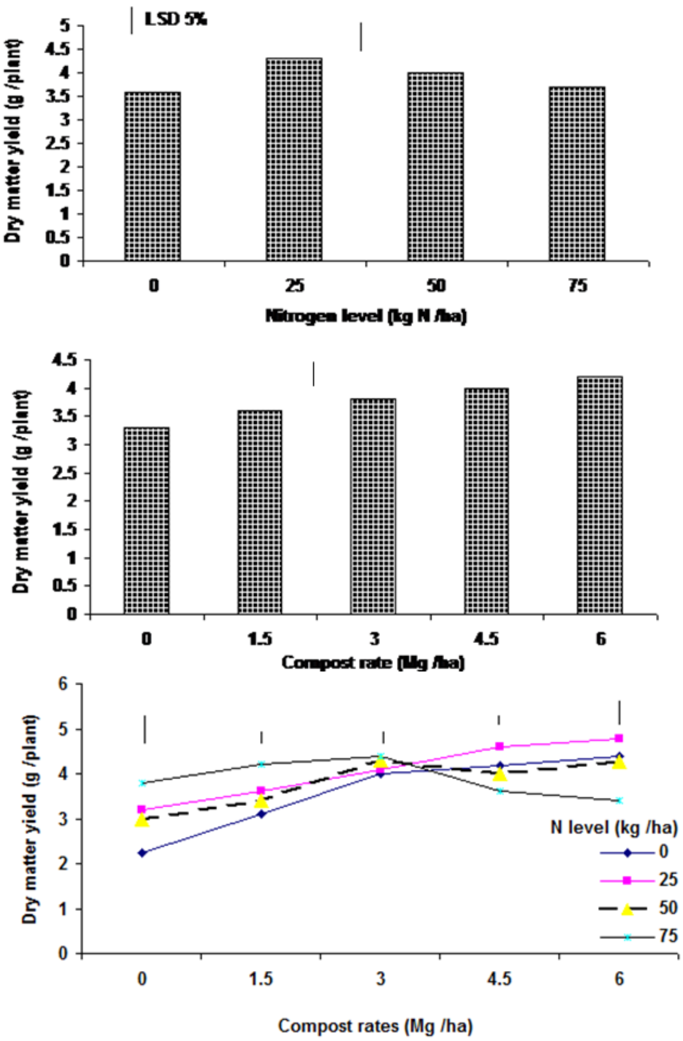

Fig. 3: Main effects of (a) Nitrogen level (b) Compost rate and (c) Interactive effects of N and compost on dry matter yield of pot grown okra plants

Generally, dry matter yield increased with increasing compost rate with peak at 6.0 Mg/ha for most N levels. Also for most of the N levels, the dry matter obtained at 4.5 and 6.0 Mg /ha compost rates were similar. The highest dry matter yield (4.77 g /plant) was obtained with combine application of 25 kg /ha N and 6.0 Mg /ha compost. This was closely followed by 4.49 and 4.55g per plant respectively produced by plants treated with 0 kg N x 6.0 Mg/ha compost and 25 kg N /ha x 4.5 Mg /ha compost (Fig. 3).

Field grown plants

Application of N fertilizer and compost had significant effect on okra dry matter partitioning for most of the growing period. Generally, dry matter accumulation increased with plant age up to 8WAP. Across the sampling period, plant accumulated of dry matter in the vegetative part (shoot and root) increased up to 10 WAP, thereafter declined while partitioning of dry matter in the flower and fruit increased up to 8 and 10WAP, respectively (Fig. 4).

Application of N led to significant enhancement of shoot, root, flower and fruit dry matter production over the control. Generally, the highest dry matter accumulation was recorded for shoot and root at 10WAP. At this growth period, the highest dry matter was obtained at 50 and 75 kg N/ha for shoot and root, respectively. At all sampling time, and irrespective of plant part, the dry matter yield obtained under 0 kg N /ha was significantly lower than what was obtained under other N levels (Fig. 4).

Application of 2, 3 and 4 Mg /ha compost resulted in significant increases over the control in the shoot, root, flower and fruit dry matter per plant over the control (Table 3). At 8 WAP, the 4 Mg /ha compost rate did not differ from the control for flower and fruit dry matter per plant. This is equally true for root dry matter at 12WAP. At each sampling period, there was a significant increased ($P < 0.01$) in shoot and root dry matter per plant with increase in applied compost rates but in most cases, the values obtained at 3 and 4 Mg /ha was similar. Partitioning of dry matter into flower and fruit at 8, 10 and 12 WAP increased with increasing compost rates with peaks at 4 Mg ha^{-1}. Over the sampling periods (8 – 12 WAP) partitioning of dry matter into flower and fruits increased steadily up to 8 and 10 WAP respectively, irrespective of compost levels.

The interactive effects of N fertilizer and compost rate were significant on dry matter partitioning of field grown okra. Irrespective of N and compost rate combination dry matter partitioning increased steady up to 10 WAP and there after decreased. At 10 WAP, and for most of the plant parts combine application of 50 kg N and 3.0 Mg/ha compost gave the highest values. Again, the values obtained with this rate was in most cases not significantly different from what was obtained from plants that received 25 kg N + 3.0 Mg /ha compost and 25 kg N + 4.0 Mg /ha compost.

Okra Leaf Area Index (LAI) and Crop Growth Rate (CGR)

Leaf Area Index (LAI) and Crop Growth Rate (CGR)

The simple effects of N and compost application on Okra LAI is shown in Table 4. Generally, LAI increased with crop age up to 8 WAP, thereafter declined. Nitrogen application had significant effect on okra LAI throughout of the sampling period with the highest value at 75 kg N ha^{-1}. There was however, no difference between 50 and 75 kg N ha^{-1}. Compost application had significant effect on okra LAI ($P < 0.01$) at all sampling period. Increasing compost rate application increased the LAI at all sampling periods. There were no significant differences observed between LAI produced by plants treated with 0 and 2 Mg/ha compost and between 3 and 4 Mg /ha compost in most of the sampling periods. However, LAI produced at 3 and 4 Mg /ha Compost was significantly higher than those produced at 0 and 2 Mg /ha compost rates. Among the two-way –interactive effect, the effect of the interaction of N and compost rate was significant on LAI at all growth periods (Table 4).

The CGR increased gradually up to 10WAP, thereafter decreased. Nitrogen application had high significantly effect on okra CGR ($P < 0.01$) at all the sampling periods. At each sampling period, CGR increased with increasing N level reaching peak at 75 kg N /ha. Plant treated with 0 kg N /ha gave the least CGR while the plants fertilized with 75 kg N /ha produced the best. The observation holds throughout of the growth periods. Crop growth rate was highly significantly influenced by compost application throughout of the sampling periods. The response of okra CGR to compost rate was linear. The 4 Mg /ha compost rate consistently had the best CGR. This was significantly better than other compost rates expect 3 Mg /ha. Significant N and compost interaction was observed for CGR between 6-12 WAP. The highest CGR was with application of 50 kg N with 3 Mg /ha compost for most of the sampling periods (Table 4).

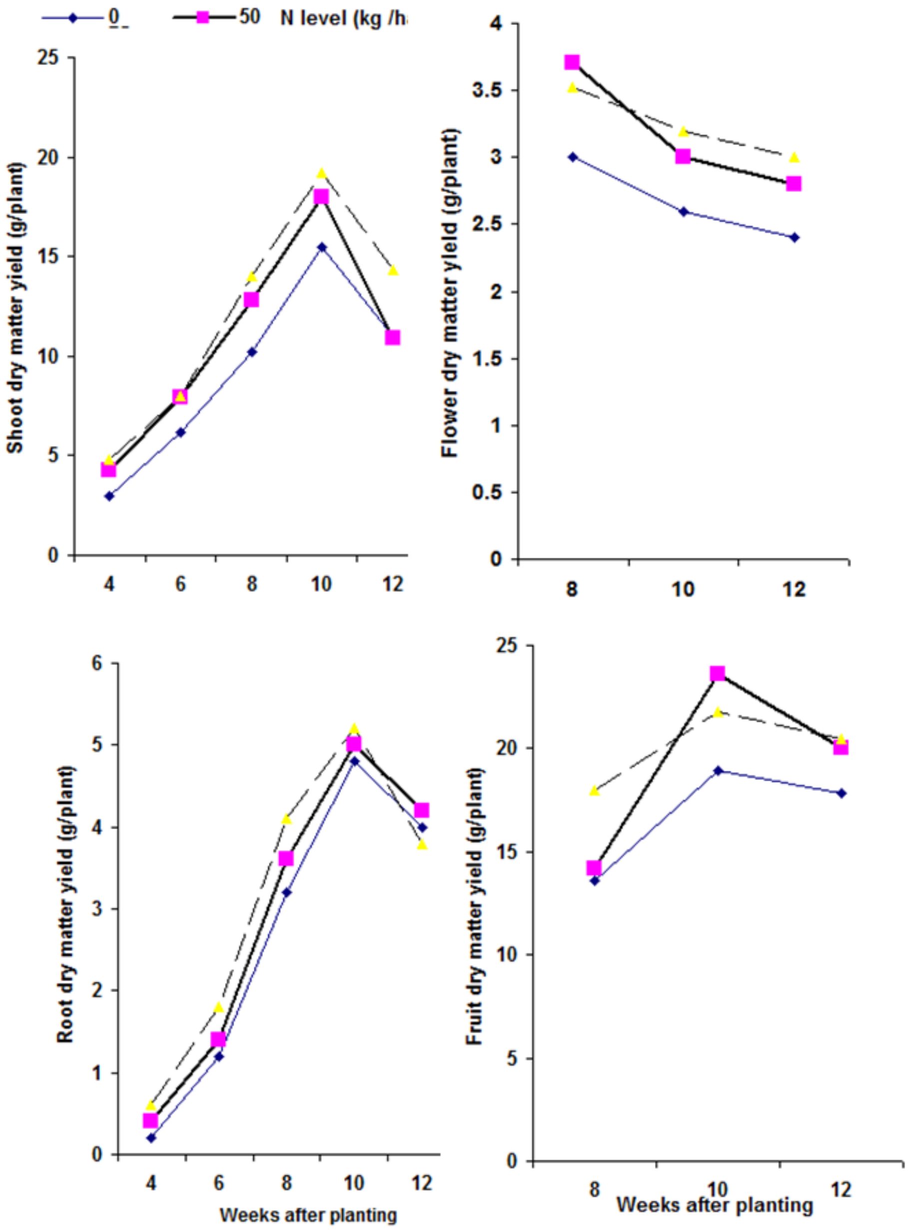

Fig. 4: Effects of nitrogen levels on dry matter partitioning of field grown okra plants

Fresh fruit yield of okra

The main effects of N fertilizer and compost on okra marketable fresh fruit yield are contained in Fig 5. The fresh fruit yield was highly significantly influenced by N application. Fruit yield increased with increases in N level reaching peak with the highest N level. Fresh fruit yields obtained with 50 and 75 kg N /ha were not significantly difference. The fruit yields of these two N levels were between 8.96 and 18.75 % higher than what was observed with 0 kg N /ha control treatment. Compost application significantly influenced the okra fresh fruit yield. (Fig.5). Fruit yield taken increased with increasing compost rate reaching peak at 4 Mg /ha compost. Fresh fruit yield of 3 and 4 Mg /ha compost was similar. However, there were differences between the values 0 control plants and other compost rates. The total fruit yield of plants treated with 3 and 4 Mg /ha compost were 11.13 and 11.41Mg/ha, respectively and these values were significantly higher than all other compost rates.

The interactive effects of N and compost on fresh fruit yield of okra are presented in Tables 5. Combine application of 75 kg N /ha and 4 Mg /ha compost gave the highest fresh fruit yield of (12.01 Mg /ha). Nevertheless, this fruit yield was similar to the one obtained with 50 kg N x 4 .0 Mg /ha compost (11.89 Mg /ha) and 50 kg N x 3.0 Ma .ha compost (11.30 Mg/ha).

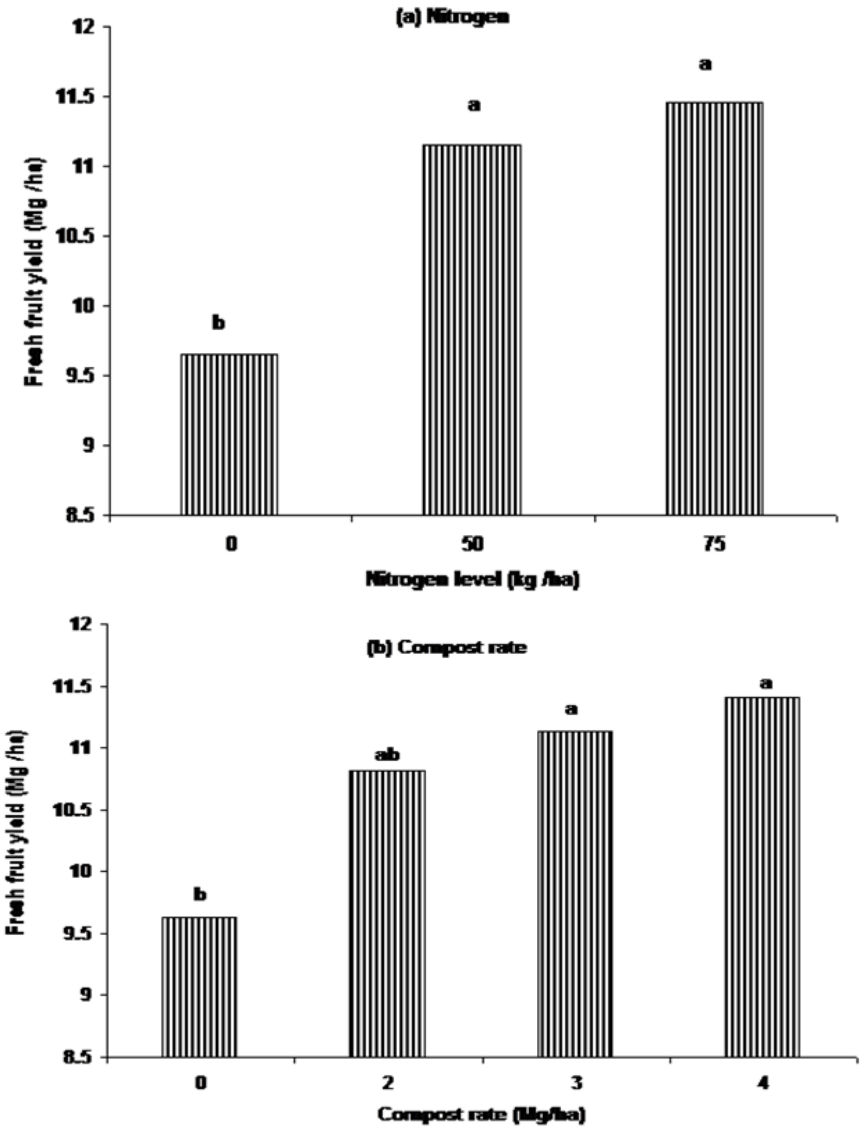

Fig. 5: Effect of (a) N fertilizer and (b) compost rates on fresh fruit yield of field grown okra

Discussion

Optimum crop performance is usually limited by inadequate availability of essential nutrients. The results of this trial highlighted the superiority of fertilized plants over non-fertilized ones in term of growth, dry matter accumulation and partitioning as well as fresh fruit yield. The consistently poor performance of non-fertilized plants shows that when nutrients are available in adequate amount there is tendency for plants to produced at their optimum potential. The results of this experiment show that N fertilizer and compost application significantly influenced the growth, dry mattered production, fruit yield of okra. Soil application of N and compost improved the growth attributes of the okra in both pots and field. The highest value for height and leaf area were maintained by the application of 50 kg N /ha or 4 Mg /ha, while the other growth characters were also considerably improved by these application rates. In the field, 50 and 75 kg N /ha had similar values for some growth attributes although they were still significantly higher than other fertilizer levels, indicating that application of 50 kg N /ha seems to be the best of optimum growth of okra. This rate is within the range earlier reported by other scientists (Fatokun and Chheda, 1983; Babatola and Olaniyi, 1997).

Dry matter production of okra were considerably enhanced by increasing N fertilizer and compost levels up to 75 kg and 4 Mg /ha respectively in both pots and field. In the absence of fertilizer the control plants produced the lowest dry matter. This kind of positive influence of N or compost on okra dry matter production and partitioning had been reported by NIHORT (1983, 1986) and Katurg *et al* (1996). Katurg *et al* (1996) indicated that higher dry matter production at high nutrient levels favoured the development of plant parameters which

Table 3: Effect of compost on dry matter portioning (g / plant) in okra in the field experiment (1998)

Week after Planting	Compost rate (Mg /ha)	Vegetative portion		Reproductive portion	
		Shoot	Root	Flower	Fruit
4	0	3.32c	0.32c		
	2	4.09b	0.38b		
	3	4.29ab	0.38b		
	4	5.13a	0.47a		
	Mean	4.21	0.39		
6	0	6.37c	1.39b		
	2	8.23a	1.29b		
	3	7.40b	1.84a		
	4	9.32a	1.85a		
	Mean	7.84	1.59		
8	0	10.72c	3.37b	3.44a	14.47b
	2	13.64ab	3.22b	3.24b	14.90ab
	3	11.57b	3.55b	3.16b	16.31a
	4	14.16a	4.19a	3.52a	16.00a
	Mean	12.52	3.58	3.34	15.34
10	0	16.00b	4.79a	2.66b	19.21b
	2	17.13b	4.54b	2.99b	22.86a
	3	18.57a	4.80a	2.95b	20.13ab
	4	18.70a	5.77a	3.26a	23.01a
	Mean	17.60	4.98	2.96	21.30
12	0	10.56c	3.65c	2.88c	16.02b
	2	10.99b	3.79b	3.13b	16.84b
	3	11.99b	4.34a	3.23b	17.76b
	4	15.37a	3.81b	4.23a	25.73a
	Mean	12.23	3.90	3.37	19.09

Mean along the same column for each growth period with the same alphabet are not significantly difference at $P \leq 0.05$

Table 4: Effect of N fertilizer and compost rates on Leaf area index and crop growth rate of field grown okra

Treatment	Leaf area Index (LAI) Weeks after planting				Crop Growth Rate (CGR) (g/m^2 /week) Weeks after planting			
	4	6	8	10	4-6	6-8	8-10	10-12 WAP
Nitrogen level (N) (kg /ha)								
0	0.17b	0.33b	1.06b	0.77b	6.93c	12.79b	13.62	-8.79b
50	0.20a	0.38a	1.10b	0.84a	9.20a	14.71a	13.59	-8.95b
75	0.20a	0.37a	1.16a	0.75b	7.83b	15.63a	15.25	-7.56a
Compost rate (C) (Mg /ha)								
0	0.18b	0.37a	1.01b	0.77ab	7.29ab	13.20b	12.49b	-9.69c
2	0.18b	0.34b	1.09a	0.75b	8.38a	14.90a	12.51b	-8.76b
3	0.20a	0.37a	1.10a	0.79a	7.11b	14.04b	15.86a	-8.70b
4	0.20a	0.35b	1.07a	0.84a	9.17a	15.37a	15.76a	-6.58a
Mean	0.19	0.36	1.07	0.79	7.99	14.38	14.15	-8.43
N x C interaction	**	**	*	**	ns	**	**	*

Mean along the same column for each growth period with the same alphabet are not significantly difference at $P \leq 0.05$
*, ** = Significant at 0.05 and 0.01 probability levels respectively; ns = not significantly different at P = 0.05

Table 5: Interactive effect of N fertilizer and compost rate on fresh fruit yield of field grown okra

Compost rate (C) (Mg /ha)	Nitrogen level (N) (kg /ha)			Mean
	0	50	75	
0	7.52	10.26	11.16	9.65b
2	10.34	11.14	10.97	10.83ab
3	10.40	11.30	11.69	11.13a
4	10.34	11.89	12.01	11.41a
Mean	9.65b	11.15a	11.46a	
Prob. of F C x N		**		
LSD (5%) C x N		0.90		

Mean along the same row /column with the same alphabet are not significantly difference at $P \leq 0.05$
*, ** = Significant at 0.05 and 0.01 probability levels respectively; ns = not significantly different at P = 0.05

culminated in better production of dry matter. When nutrient is available in the right proportion, the photosynthetic activity of the plants will be considerably favoured. This improves light interception, dry matter production, accumulation and partitioning (Robert and Walker, 1989; Hartz *et al*; 1996; Smith *et al*; 1992).

Fruit yield was significantly influenced by N fertilizer and compost application. The 50 kg N and 4 Mg /ha compost maintained the highest fruit yield. The fruit yield obtained with these rates was significantly higher than other rates. Significant enhancement of fruit production by okra with fertilizer application corroborate the report of Smith *et al*; 1992), Fatokun and Chheda (1983) and Babatola and Olaniyi (1997). This was linked to the positive effect of availability of adequate amount of nutrient for plant use. This improved their vegetative growth, synthesis and translocation of photosynthesis from the sources to the sink, and significant increase in number and weigh of fruit yield and yield components. Application of 75 kg N ha-^{1} gave the highest okra fruit yield of 11.46 Mg ha-^{1}. This is not significantly different from 11.41 and 11.44 Mg ha-^{1} fruit yield obtained when the crop was fertilized with either 50 kg N/ha or 4.0 Mg ha-^{1} compost, this implied their adequacy in supply needed nutrients for optimum crop growth and development.

Conclusions

There is an increase in cultivation of okra in the south Western Nigeria. This is despite the poor physical and chemical conditions of soil cropped by many farmers. The resultant effect of this is poor yield. The high cost and non-availability of chemical (inorganic) fertilizer has placed them out of the reach of many farmers. In spite of this, reasonable crop yield can hardly be achieved without the use of fertilizer; hence there is need for searching for alternative. The experiment was aimed at determining the effect of N fertilizer and maize stover compost on the growth, dry matter and fruit yield of okra. The results obtained in this study revealed that for optimal performance of okra, there is need to augment soil nutrients with fertilizer, be it organic or organic. It is concluded that for optimum performance of okra, 4 Mg ha-^{1} compost that could be reduced if fortified with small amount of mineral fertilizer is adequate.

References

Abad, M.B., M.D.Clement, R.E.P. Aragan and A.S. Camarero, 1997. The influence of soil Urban waste compost and nitrogen mineral fertilizer on growth and productivity in potatoes. Commun. Soil Sci. plan anal., 28(17&18): 1653.

Adediran, J.A., L.B. Taiwo, M.O. Akande and R.A. Soluble, 1999. Comparative effect of organic – based fertilizer and mineral fertilizer in the dig matter yield of maize. Bioscience Research communications, 11(4):17-24.

Akanbi, W.B., J.A. Adediran, A.O. Togun and R.A. Soul, 2000. Effect of organic – base fertilizer on the growth, yield and storage life of tomato (Lycopersicon esculoutum Mill) Bioscierce Research Communication, 12(4): 14-18.

Arnon, L., 1975. Miniral Nutrition of maize international Potash Institution. Bern, Switzerland, pp: 452.

Asif, M.I., 1977. Estimation of leaf area in okra (Abelmoschus esculents (L) Moorish). Tropical Agriculture (Trindad), 54: 192.

Babatola, L.A. and J.O. Olaniyi, 1997. Effect of NPK 15 – 15-15 – fertilizer level and plant spacing on performance & shelf life of okra. In: proc. 15th HORTSON conference, NIHORT, Ibadan 8th –11th April, 1997.

Char-fen, L., 1981. The recycling of crop residues in Taiwan. In food and fertilizer Technology center Extension Bulletin No 177: 1-8.

Dalzell, H.W., K.R. Gray and A.T. Biddlestone, 1981. Composting in Tropical Agriculture. The International Institute of Biology Husbadry, Review paper Series No 2: 480.

Fatokun, C.A., 1976. Genetic and Agronomic studies of Okra (Abelmoschus esculentus Thesis, University of Ibadan, Ibadan, Nigeria, pp: 264.

Fatokun, C.A. and H.R. Chedda, 1983. The effects of Nitrogen and Phosphorus on yie Chemical composition of okra Okra (Abelmoschus esculentus. Acta Horticulture, 123: 283-290.

Gomez, A.K. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Ed. John Wiley & Sons New York, pp: 680.

Hartz, T.K., F.J. Coasta and W.L. Schrander, 1996. Suitability of composted green wastes fro horticultural uses. Hortscience, 31(6): 961 -964.

Katung, M.D., J.D. Olanrewaju, U.S. Gupta and I. Kureh, 1996. Fruit and seed yields of okra as influenced by farm yard manure and Nitrogen fertilizer. In: Proc. 14th HORTSON Conf; Ago-Iwoye, 1 -4 April, 1996.

Lombin, J., A. Adepeju and K.A. Ayotade, 1991. Complementary use of organic and in organic fertilizers in arable crop production. In: organic Fert. In the Nigerian Agriculture. Kaduna, Nigeria. March 26 -27, 1991.

National Horticultural Research Institute (NIHORT), 1983. Annual Report for 1984, NIHORT; Ibadan, pp: 84.

National Horticultural Research Institute (NIHORT), 1986. Advances in fruit and vegetable research at NIHORT (1978 - 1986), pp: 62.

Olasantan, F.O., 1999. Nitrogen fertilization of okra in an intercropping system with cassava and maize in south –western Nigeria. Journal of Agric. Sc. Cambridge, 133: 325-334.

Purseglove, J.W., 1984. Tropical Crops Dicotyledons. Vols. 1 and 2. Longman, London.

Robert, K.M. and J. Walker Andrew, 1989. An Introduction to the Physiology of Crop Yields. Pub. U. S. John Wiley & Sons. Inc. New York.

Shama, S.N., R. Prasad and S. Singh, 1996. Residual effects of growing mung beans and urid bean on the yield and nitrogen uptake of a succeeding wheat crop. Fertilizer Research, 44: 163-168.

Smith, S.R., J.E. Hall and P. Hadley, 1992. Composting sewage sludge wastes in relation to their suitability for use as fertilizer materials for vegetable crop production. Acta Hort., 302: 202-215.

Tindall, H.D., 1983. Vegetables in the Tropics. Macmillan Education Ltd. Houndmills Hampshire, pp: 533.