EFFECTS OF ORGANIC FERTILIZER AND SPACING ON GROWTH AND YIELD OF LAGOS SPINACH (C*ELOSIA ARGENTEA* L.)

AKINFASOYE, J. A., D. J. OGUNNIYAN, W. B. AKANBI AND A. O. OLUFOLAJI

ABSTRACT

Experiments were carried out at National Horticultural Research Institute (NIHORT), Ibadan to investigate the effects of maize-stover compost fertilizer and plant spacing on the growth and shoot yield of Celosia argentea L. var. TLV8. Plants were spaced 15x 15cm; 20 x 20cm and 25 x 25cm and the compost fertilizer was applied at 2, 4, and 6 t ha^{-1}. Each experiment was arranged in a split-plot design with three replications, and a control where compost was not applied was set up for each spacing treatment. All data were reported as means, and analyzed combined across the two experiments. Spacing had no significant effect on plant height, stem, girth, number of leaves and cumulative shoot yield but leaf area, number of off shoots and dry matter yield were significantly affected. 25 x 25cm spacing produced the highest number of offshoots whereas the largest leaf area and highest dry matter yield were obtained at 20 x 20cm spacing. Compost rates significantly increased growth and yield of the crop. Plant height and stem girth increased with compost rate up to 6 t ha^{-1}. But plant performance at 6 t ha^{-1} was not statistically difference from that obtained with 4 t ha^{-1}; dry matter was accumulated most, at 4 t ha^{-1}. Hence, 4 t ha^{-1} was most outstanding in supporting the production of the crop. Interactive effects of spacing and compost were significant for both growth and yield. The highest plant height was obtained with 15 x 15cm x 6 t ha^{-1}. 20 x 20cm x 6 t ha^{-1} produced highest leaf area and 20 x 20cm x 4 t ha^{-1} produced the highest dry matter and cumulative fresh shoot yield. Considering the cost, ease and time of organic fertilizer transportation and application as well as the usable product of the crop obtainable with 20 x 20cm x 4 t ha^{-1} compost, it appeared to be the most suitable for optimum growth and shoot yield of Celosia.

Keywords: *Celosia*, Compost, Spacing, Organic fertilizer, Organic farming

INTRODUCTION

Lagos spinach (Ce*losia argentea* L.) is a leafy vegetable commonly found in traditional intercropping system of the tropics (Olufolaji and Ayodele, 1988; Rehm and Espig, 1991) and it is popular in South Western Nigeria (Schippers, 2000). The leaves and young shoots which are rich in protein, calcium, phosphorus and iron are used in soup and stews. *Celosia* thrives in well-drained soil with a pH of 6.0 to 6.4 (Gill *et al.,* 1999). Yields of the crop is low on Nigerian farmers' fields (16-28 t ha^{-1}) (Tindall, 1984; Schippers, 2000), unlike higher yield of up to 59 t ha^{-1} obtainable under research conditions (Olufolaji and Ayodele, 1988). Chiefs among the factors that result in the crop low yield include poor soil fertility and low plant density. Fertilization practices and increased population undoubtedly increase yields of crops.

Inorganic fertilizers commonly used by farmers in Nigeria for the cultivation of vegetables include NPK and other nitrogenous sources such as urea and calcium ammonium nitrate. *Celosia* plants need relatively high amounts of nutrients; and nitrogen is the key element (Messiaen, 1992; Gill *et al.,* 1999). Importation of these chemical fertilizers and their increasing demand may become a burden on the nation's economy (Ehigiator, 1998). It may also have unexpected side effects on crops tolerance to diseases and pests (Trembley, 1993). The current ecological movement with its fear of soil and water pollution by inorganic fertilizers calls for the use of organic fertilizers that are renewable and less harmful (Ehigiator, 1998). Farmyard and green manuring replace nitrogen and other elements and build organic matter content of the soil, support a greater abundance of invertebrates and lead to reduced weeds growth (Hole *et al*., 2005, Herencia *et al.*

2007)). Schippers (2000) observed that burnt organic waste, poultry and cattle manure significantly increased the green leaf yield of *Celosia* and that the optimum rate of poultry manure for the crops ranges from 0.4 to 20 t ha^{-1}.

Spacing in the field depends on the type of crop grown (Gill *et al.,* 1999), number of harvest envisaged (Gill *et al.,* 1999; Schippers, 2000), and the soil condition (Schippers, 2000). But there is virtually no unified information on the best population density that enhances optimum utilization of available environmental resources and also produces the best edible yield of *Celosia*. Spacing suggested for *Celosia* cultivation ranges from 7.5 x 7.5cm to 35 x 35cm (NIHORT, 1996; Schippers, 2000). Babatola and Olaniyi (1997); Ugaru (1997); Olaniyan *et al.* (1999) reported that yield per plant in vegetable beans and pepper respectively increased with spacing. Schippers, (2000) reported wider spacing (15-30cm apart each way) in fertile soils improves harvesting period, thus yield is increased.

In recent years, food production has suffered a serious set back due to a general shortage and unaffordable cost of chemical fertilizers. Much attention is therefore directed towards the search for alternative fertilizer sources to boost crop production. Biofertilizer has been identified as an alternative to chemical fertilizer to increase soil fertility and crop production in sustainable farming (Wu *et al.,* 2005). Organic fertilization has been reported to produce better yields of crops that keep longer and more nutritious than inorganic fertilizers (Mc Robie, 1990; Yinda and Adeoye, 1994; Adediran *et al*., 1998). Apart from supplying plant nutrients, organic fertilizer improves soil physical and microbial properties and eliminates pollution of underground water. In view of this, efforts are being put in to develop crop residues as fertilizer sources.

Maize is well produced in Nigeria and the stovers are either burnt or packed out of the field when land is prepared for subsequent planting. Poultry manure is also available and even constituting environmental havoc. Considering the abundance of the cheap and readily available organic materials, a detailed study on the use of these materials as fertilizer and optimum plant spacing is required to increase yields and quality of *Celosia,* and at the same time maintain an ecologically balanced system. Based on the foregoing, this study aimed at determining the effect of maize-stover compost and plant spacing on the growth and yield of *Celosia*.

MATERIALS AND METHODS

Experimental Site. Two field experiments were conducted at NIHORT, Ibadan in the rainy and early dry season of 2004, when the respective average rainfall of 192.8mm and 21.7mm were recorded. Soil of the experimental site was routinely analyzed. It had pH: 5.7; Total N: 0.06g kg^{-1}; Available P: 2.6mg kg^{-1} and 9, 7, 0.41 and 21.94 cmol kg^{-1} for Exchangeable Calcium (Ca); Magnesium (Mg); Potassium (K) and Cation Exchange Capacity (CEC) respectively.

Composting. **C**ompost was made from maize-stover and well cured Poultry Manure (PM). The stovers were air-dried, chopped into material size below 5cm using a chaff cutter. The poultry manure was air-dried too and non-biodegradable materials were sorted out. Three parts by weight of maize stover were mixed with one part PM and composted in concrete pit. The compost was watered and turned once a week for the first three weeks and fortnightly for the next six weeks. At maturity, the compost was evacuated from the pit, air-dried and shredded to pass 0.2mm sieve. Samples of both organic materials and organic matter were analysed nutrient and the result is as shown (Table 1).

Table 1. Chemical properties of compost materials and mature compost used in the experiments

Property	Maize stover	Poultry manure	Mature compost

pH*		-	-	7.50
Total	N (%DW)	1.02	1.92	2.41
	P "	0.82	1.84	1.40
	K "	1.27	2.30	2.09
	Ca "	1.16	9.46	1.85
	Mg "	0.22	0.42	0.40
	Fe "	0.31	1.90	0.57
	Zn (ppm)	ND	192.00	141.00
	Cu "	24.0	42.00	43.96

Treatments and Experimental Design. Treatments consisted of three spacing 15 x 15cm (S_1), 20 x 20cm (S_2) and 25 x 25cm (S_3) and four rates of compost fertilizer (0, 2, 4, and 6 t ha^{-1}). The combination of the three spacing and four rates of compost resulted in 12 different treatments. The experiment was laid out in split plot design with spacing as main plot and compost as sub-plot and replicated three times. The sub-plot size was 2.0m^2. The compost was broadcasted and worked into the soil by light hoeing a week before transplanting. Seeds of *Celosia argentea* L. var. TLV8 were sown in wooden trays and watered well. Three weeks later, the resulting seedlings were transplanted at 15 x 15cm, 20 x 20cm and 25 x 25cm spacing and watered to ensure establishment. Compost was applied to each plot at 2, 4 and 6 t ha^{-1}. The treatment 0 t ha^{-1} where no organic manure was applied was set up as a control experiment for each spacing treatment.

The plots were hoed and sprayed weekly against fungi with benlate, and leaf eating insects with Cypermetrin (10% EC) at 400ml in 500 litres H_2Oha^{-1}. All these agronomic practices were repeated in the second trial. At four weeks after transplanting (WAT), five plants were randomly sampled per plot to determine plant height, stem girth, number of leaves, number of offshoots and leaf area per plant. Harvesting, by cutting the plant at 10cm above soil surface, started 4WAT and subsequent cutting of branches (offshoots) was done bi-weekly. A total of four cuttings were made before shoot regeneration became negligible and inflorescence appeared on stumps of the crop. Cumulative fresh shoot yield was determined at the end of last harvest. For dry matter yield, another five plants were randomly sampled per plot at 4WAT, uprooted and cut into root and shoot. The shoot fresh weights were recorded as the shoot yield. The roots and shoots were dried in oven at 80^0 C for three days till constant weight. Hence, the dried matter yield per plant was estimated.

Statistical Analysis. Data collected were subjected to Analysis of Variance (ANOVA) procedures for split plot design as described by Gomez and Gomez (1984). Means were compared using Duncan Multiple Range Test at P=0.05. All data are reported as means, and analyzed combined for the two growing periods.

RESULTS

Plant Growth. Maize stover – poultry manure compost application rates had significant effects on all the growth parameters considered (Table 2). Growth increased with increasing rates of compost, but 4 t ha^{-1} compost produced the highest dry matter accumulation. However, no significant difference was obtained between the effects of 4.0 and 6.0 t ha^{-1} on the growth of the *celosia*. Growth also increased with spacing but had no significant difference on plant height, stem girth and number of leaves per plant. Number of offshoots per plant also significantly varied among spacing. Leaf area and dry matter per plant also varied among spacing and 20 x 20cm spacing was significantly different (Table 2).

The interaction effect between compost and spacing on the growth and yield parameters of the crop is as on Table 3. The plant height ranged from 32.7cm at 15cm x 15cm x 0 t ha^{-1} to 78.2cm at 15cm x 15cm x 6 t ha^{-1}. 25cm x 25cm x 6 t ha^{-1} and consistently produced significantly higher stem girth, number of leaves and number of offshoot per plant. The largest leaf area per plant of 7432.96cm^2 was obtained with 20cm x 20cm x 6 t ha^{-1}, though this was not significantly different from that produced by treatment combinations 20cm x 20cm x 2 t ha^{-1}, 20cm x 20cm x 4 t ha^{-1} and 25cm x 25cm x4 t ha^{-1}, 25 x 25cm x 2 t ha^{-1} and 25 x 25cm x 6 t ha^{-1} (Table 3).

Table 2. Simple effects of compost and spacing on some growth parameters of *celosia*

Treatment	Plant height (cm)	Stem girth (cm)	No. of leaves /plant	No. of offshoot /plant	Leaf area (cm^2)	Dry matter (g/plant)
Compost (t ha^{-1})						
0	33.33^{a}	1.27^{a}	15.3^{a}	4.7^{b}	809.8^{a}	3.05^{a}
2	43.00^{ab}	1.73^{a}	21.3^{b}	13.0^{b}	3864.6^{b}	4.79^{a}
4	61.33^{bc}	2.70^{ab}	25.3^{b}	17.7^{b}	5532.7^{c}	9.51^{b}
6	72.67^{c}	3.13^{b}	27.3^{b}	19.0^{b}	6367.3^{c}	7.90^{b}
Spacing						
15 x 15cm (S_1)	51.75^{a}	1.95^{a}	20.8^{a}	8.0^{a}	2879.2^{a}	5.73^{a}
20 x 20cm (S_2)	52.75^{a}	2.05^{a}	22.5^{a}	14.8^{b}	5162.8^{b}	7.15^{b}
25 x 25cm (S_3)	53.25^{a}	2.53^{a}	23.5^{a}	17.5^{b}	4388.9^{b}	6.06^{ab}

Means with similar letter(s) are not significantly different at P=0.05

***Dry Matter Yield (DM*).** This responded to compost, spacing and their various combinations as shown in Table 2. Compost increased plant dry matter up to 4.0 t ha^{-1} when it accumulated 9.51g/plant but DM declined at 6 t ha^{-1} to 7.90g/plant, though not significantly different, from the former. The simple effect of 20cm x 20cm spacing on plant dry matter was highest and similar to 25cm x 25cm spacing. The interaction between compost and spacing was significant for dry matter yield. The highest dry matter yield was produced by using 20 x 20cm x 4 t ha^{-1}.

Table 3. Interaction effects of levels of compost and spacing on some growth parameters of *Celosia*

Spacing	Compost	Plant height (cm)	Stem girth (cm)	No. of leaves /plant	No. of offshoots /plant	Leaf area (cm^2)
15 x 15cm	0	32.7^{a}	0.8^{a}	15^{a}	2^{a}	482.9^{a}
	2	38.1^{a}	1.6^{a}	19^{a}	7^{ab}	2118.3^{b}
	4	59.6^{ab}	2.4^{b}	22^{a}	11^{b}	4630.6^{c}
	6	78.2^{b}	3.0^{bc}	27^{b}	13^{b}	4284.9^{c}
20 x 20cm	0	34.2^{a}	1.2^{a}	15^{a}	4^{a}	1079.6^{b}
	2	47.0^{ab}	1.8^{ab}	22^{a}	14^{b}	5432.4^{cd}
	4	66.3^{b}	2.4^{b}	26^{b}	22^{bc}	6706.2^{cd}
	6	64.1^{b}	2.8^{b}	27^{b}	20^{b}	7433.0d
25 x 25cm	0	34.0^{a}	1.4^{a}	16^{a}	8^{ab}	867.0^{ab}

2	44.0^{ab}	1.8^{ab}	23^{a}	18^{b}	4043.2^{c}
4	59.1^{b}	3.3^{bc}	27^{b}	20^{b}	5261.3^{c}
6	76.4^{b}	3.6^{c}	28^{b}	24^{c}	7384.1^{d}

Means with similar letter(s) are not significantly different at P=0.05

Shoot Yield. The interaction effect of compost and spacing on shoot yield is presented in Table 4. Use of compost increased shoot yield significantly over unfertilized plants. The highest cumulative shoot yield (32.2kg ha^{-1}) was obtained with the highest compost rate of 25 x 25cm x 6 t ha^{-1}. Application of compost at 4 t ha^{-1} rate produced similar shoot yield of 27.55 t ha^{-1}. Spacing had no significant effect on the cumulative shoot yield. However, 20cm x 20cm produced the highest shoot yield (24.2kg ha^{-1}) and cumulative shoot yield was increased with wider spacing and higher rates of compost.

Table 4. Simple and interactive effects of compost and spacing on shoot yields of *celosia*

Treatment	Harvests /Yields (Kgha^{-1}) 1	2	3	4	Cumulative
Compost (tha^{-1})					
0 (C_o)	1.35	1.40	1.55	0.80	5.10_a
2 (C_1)	2.30	3.35	8.25	2.25	15.20_b
4 (C_2)	6.50	7.59	8.45	4.50	27.55_c
6 (C_3)	6.80	13.20	7.45	4.75	32.20_c
Spacing					
15 x 15cm (S_1)	4.20	6.35	4.15	2.70	17.35_a
20 x 20cm (S_2)	5.05	6.15	10.25	3.95	24.20_a
25x 25cm (S_3)	3.50	6.95	6.20	2.55	18.45_a

Compost x Spacing

$(S_1) \times (C_o)$	0.80	1.20	1.10	0.60	3.70_a
$(S_1) \times (C_1)$	2.05	3.15	5.10	1.10	11.40_b
$(S_1) \times (C_2)$	3.85	10.05	5.20	5.15	24.25_{bc}
$(S_1) \times (C_3)$	10.00	11.05	5.05	3.95	30.05_c
$(S_2) \times (C_o)$	1.90	2.15	1.90	0.80	6.75_a
$(S_2) \times (C_1)$	2.65	3.05	11.70	4.70	22.10_{bc}
$(S_2) \times (C_2)$	10.4	3.95	15.00	5.00	34.70_c
$(S_2) \times (C_3)$	5.15	15.50	7.30	5.20	33.15_c
$(S_3) \times (C_o)$	1.30	0.90	1.60	0.95	4.75_a
$(S_3) \times (C_1)$	2.25	3.90	8.00	0.90	12.50_b
$(S_3) \times (C_2)$	5.30	10.00	5.10	3.30	23.70_{bc}
$(S_3) \times (C_3)$	5.20	13.00	10.05	5.10	33.35_c

Means with similar letter(s) are not significantly different at P=0.05

DISCUSSION

From the analysis of the composted materials, it was observed that the organic sources did not contain heavy metals such as lead (Pb) and selenium (Se). This made the source of fertilizer suitable for cropping of vegetables free of heavy metals or contaminants. Mature compost contained higher amount of N, and optimum amount of P, K and Mg as in either of maize stover or poultry manure. Percent increase of nutrient contents of mature compost over maize stover were 136.3, 70.7, 64.5, 59.5 and 81.8% for N, P, K, Ca and Mg respectively. The higher nutrient contents of mature compost over either of maize-stover residues obtained in this experiment confirmed the findings of Yinda and Adeoye (1994).

Increase in plant growth as a result of application of compost is expected in that manure contained and released considerable amount N and Mg for plant use. These are essential for formation of chlorophyll for photosynthesis in plants. The soil reaction for the survival and growth of *Celosia* is 6.0 – 6.4 (*Gill et al.,* 1999) and this fall in line with the pH of 7.50 of the compost manure. This conforms with the fact that nutrients released by the manure were essential in crop production because soil pH affects nutrient release and uptake by plants. The rate of application was more essential at 6.0 t ha^{-1} since this rate produced more positive results in the growth of the crop and this agreed with Schippers (2000) that burnt organic waste, poultry and cattle manure significantly increased the green leaf yield of *Celosia.*

The observed higher plant height at wider spacing was primarily due to the availability of optimum micro-climate. Though plant height, stem girth and number of leaves increased with spacing, the increment was not significant. However, the number of shoots per plant at 15 x 15cm, a closer spacing, was lower because of competition among the crops. This agreed with Ugaru (1997); Olaniyan *et al.* (1998); Schippers (2000) that there were increases in yield of crops with increasing plant spacing. Accordingly, the numbers of shoot per plant and leaf area (LA), vegetative growth were not significantly influenced by spacing. There were differences in actual values, but these differences were not statistically significant enough to agronomically affect the crop. As number of off-shoots (NS) were not significantly affected by compost rate, however wider spacing increased branching and large surface area of leaves were produced per plant. DM was highest in 20 x 20cm probably because LA was also highest under the treatment. This may also be expected because larger LA reduced height, stem and number of leaves but produced higher DM through photosynthesis. This finding agreed with Ugaru (1997).

Interaction effects of compost application rate and spacing on vegetative growth of the plant was definite in that 15x15cm x 6 t ha produced plant with higher heights owing to the enhanced soil fertility in the crop ecology. Wider stem girth, higher number of leaves per plants ($LP^{-1)}$ and higher number of off-shoots per plant as well as larger LA were produced with 25 x 25cm x 6 t ha^{-1} because the soil was more fertile and the space wider thus there were less competition among crops. Competition was also responsible for resulting status of shoot growth and number LP^{-1} at 15cm x 15cm and 20cm x 20cm.

Compost singly enhanced shoot yield from the first to the last harvest. Shoot yield ranged from 3.70-34.7kg ha^{-1} this is within the range as observed by Tindall (1984); Olufolaji and Ayodele (1984); Schippers (2000). Increase in harvest with compost was also expected as more compost rate was expected to release more nutrients. Though spacing had little effect, it still produced highest shoots weight at 20 x 20cm. Compost at adequate spacing consistently increased shoot weight but the increase in weight was more prominent at 20 x 20cm under respective compost weight. Also within the 20 x 20cm, higher rate of 4 and 6 t ha^{-1} compost had greater effect. 20 x 20cm x 4 t ha^{-1} was better still when one considers the time, cost and ease of transportation and application manure, this agreed with Schippers (2000) that the optimum rate of poultry manure for the large-leaved cultivars is 0.4 t ha^{-1}.

CONCLUSION

Maize stover –poultry manure compost and spacing, singly and or combined, influenced growth and development of *Celosia*. Considering cost, ease and time of application, optimum rate of compost is 4 t ha^{-1} at 20cm x 20cm spacing because it enhanced vegetative growth of the crop. The result of these experiments showed that 20cm x 20cm x 6 t ha^{-1} spacing produced better interaction favourable for plant growth while 20 x 20cm x 4 t ha^{-1} compost was optimal and effective. Hence for economic reasons, combination of compost at rate 4.0 t ha^{-1} and 6 t ha^{-1} with spacing 20cm x 20cm are recommended for optimum shoot yield of *Celosia.*

REFERENCES

Adediran, J.A. Taiwo, L. B. Akande, M. O. and Sobulo, R. A. (1999) Comparative effects of organic- based fertilizer and mineral fertilizer on the dry matter yield of maize. Boise Research Communication.

Babatola, L. A. and Olaniyi, J.O. (1997) Effect of NPK fertilizer levels and plants spacing on performance of okra. Proceeding of 15th Annual Conference of Horticultural Society of Nigeria (HORTSON), (NIHORT), Ibadan.

Ehigiator, J. O. (1998) Farm Yard Manure (FYM): Need for its adoption as an alternative to chemical fertilizer use in Nigeria. Nigerian Journal of Horticultural Science (NJHS) 3:1-9.

Gill, S., MacLachlan, W., Balge, R., Klick, S. and Dutky, E. (1999) Production of Celosia as cut flower. FS-684. University of Maryland & Maryland Cooperative Extension Service.

Gomez, K. A. and Gomez, A. A. (1984) Statistics procedures for agricultural research. John Wiley & Sons, New York, 680p.

Herencia, J. F., J. C. Ruiz-Porras, S. Melero, P. A. Garcia-Galavis, E. Morillo and C. Maqueda (2007) Comparison between organic and mineral fertilization for soil fertility levels, crop macronutrient concentrations and yield. Agronomy Journal. 99:973-983.

Hole, D. G., Perkins, A. J., Wilson, J. D., Alexander, I. H., Grice, P. V. and Evans, A. D. (2005) Does organic farming benefit biodiversity? Biological conservation 122:113-130.

Mc Robie, G. (1990) Tools for organic farming. A manual of appropriate equipment and treatments. Intermediate Technology Publication. UK. 77p.

Messiaen, C. M. (1992) Tropical vegetable garden. Macmillan, Basingstoke, UK. pp. 488.

National Horticultural Research Institute (NIHORT) (1996) Advances in fruits and vegetables research at NIHORT. A Comparative Publication. Ibadan.

Olaniyan, A. A., Fawusi, M. O. A., Ayodele, V. I. and Kolade, J. A. (1998) Influence of population density on growth and yield of pepper *(Capsicum annuum* L.) cv "Rodo". Proceeding of 16th annual conference of Horticultural Society of Nigeria (HORTSON), UNNAB, Abeokuta.

Olufolaji, O. A. and Ayodele, O. J. (1988) Spacing and cutting height requirements for optimum production of *Celosia argentea*. NIHORT Research Bulleting No. 4. 6p.

Rehm, S. and Espig, G. (1991) The cultivated plants of the tropics and subtropics: Cultivation, Economic value, utilization. (Verlag Josef margraf eds.). Scientific Books. Germany. 139p.

Schippers, R. R. (2000) African indigenous vegetables. An overview of the cultivated species. Natural Resources Institute. ACP-EU Technical Centre for Agricultural and Rural Cooperation. Chatham, UK. pp. 16-23.

Tindall, H. D. (1984) Vegetables in Tropics. Macmillan Education Ltd. London. 387p.

Trembley, W., Michand, M. H. and Charbonneau, F. (1993) Plant nutrient composition as a component of crop production. Acta Horticulturae 339: 85-98.

Ugaru, M. I. (1997) Effect of plant spacing and harvest interval on pod yield and quality of decumbent vegetable cowpea. Proceeding of 15th Annual Conference of Horticultural Society of Nigeria (HORTSON), (NIHORT), Ibadan.

Wu, S. C., Z. H. Cao, Z. G. Li, K. C. Cheung and M. H. Wong (2005) Effect of biofertilizer containing N fixer, P and K solubilizers and AM fungi on maize growth: a greenhouse trial. ScienceDirect-Geoderma. Volume 125, Issues 1-2. pp. 155-166.

Yinda, G. S. and G. O Adeoye (1994) A comparative study of two composting methods. Proceeding of 3rd African Soil Science Society Conference, Ibadan, 1994.