Nigerian Journal of Ecology (2015) 14:29-36.

ISSN: 1116-753X

COMPARATIVE EFFECTS OF BREWERY-BASED COMPOST AND NPK MINERAL FERTILIZER ON YIELD OF TWO VEGETABLES IN IBADAN, OYO STATE, NIGERIA

AdeOluwa, O. O.[1] and O. E. Ogunsanya,
Department of Agronomy, University of Ibadan, Ibadan, Nigeria

[1]Corresponding author: adeoluwaoo@yahoo.com

(Accepted 30 April 2015)

ABSTRACT

Increasing awareness of the importance of organic fertilizers is leading to development of several such products. Thus, the effectiveness of a new compost product (brewery waste-based compost) was compared with NPK mineral fertilizer.

The investigation which was a field experiment was conducted at the Department of Agronomy, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria. Four (4) fertilizer treatments were investigated, namely, Ibadan Brewery waste-based grade A (IBBW1) compost, Ibadan Brewery waste-based grade B (IBBW2) compost, mineral fertilizer NPK 15:15:15 and control (no soil additive). The fertilizer treatments were laid in a Randomized Completely Block Design (RCBD) with three replicates, using amaranth and corchorus as test crops. The fertilizer treatments were applied at the rate of 100 kgN/ha and the effects on fresh and dry weights of amaranth and corchorus were observed. Both the main and residual fertility effects of the fertilizer treatments were investigated.

The Ibadan Brewery waste-based grade A compost (IBBW1) was found to have the best performance in terms of total fresh weight of for the two test crops yield (44.10 t/ha and 28.19 t/ha for Amaranth and corchorus respectively). Thus, Ibadan Brewery waste-based compost can serve as a good alternative to mineral fertilizers for Amaranth and corchorus production.

Key words: Compost, Ibadan Brewery waste-based compost, IBBW1 and IBBW2, *Amaranthus caudatus, Corchorus olitorus*.

Introduction

Continuous and intensive use of NPK mineral fertilizer has been reported to adversely affect agricultural soils with time. Moreover, due to the challenges of scarcity and high cost of chemical fertilizers, there is a need to investigate locally available and cheap sources of organic fertilizers for vegetable production (Agbede and Ojeniyi, 2009). The use of inorganic fertilizers on arable soils often leads to decline in soil fertility, increase in soil acidity, nutrient leaching and degradation of soil organic matter, as well as soil physical conditions (Nottidge *et al.*, 2005). For optimum performance of a crop, the nutrient contents of the soil should be adequate. The nutrient status of most tropical soils is however low (Smithson and Giller, 2002). Although, it has been reported that fertilizer use between 1998/99 and 2007/08 in Malawi increased from 50,200 to 125,153 tons of nutrients

(NPK), Nigeria from 163,200 to 497,697 tons, Uganda from 3,535 to 18,976 tons and Zambia from 36,700 to 117,978 tons (NEPAD, 2011), yet, most resource - poor farmers have little or no access to inorganic or chemical fertilizers;. This is mostly due to high cost of the mineral fertilizers when available.

Organic fertilizers have been suggested to compliment inorganic fertilizers in order to bridge the demand and supply gap of mineral fertilizers for economic and environmental reasons (Adeniyan and Ojeniyi, 2005). Generally, organic fertilizers increase soil nutrient status and enhance the biological, chemical and physical properties of the soil (FAO, 2005). They increase the nutrient status of the soil through gradual release of nutrients, a characteristic that can help to improve the fertility of degraded soils (Egherevba and Ogbe, 2002; Ibeawuchi *et al.*, 2006) and support crop performance (Adebayo and Akoun, 2002).

Vegetables could alternatively play a major role in alleviating problems associated with malnutrition as they possess capacity to supply adequate vitamins, calories and other nutrients needed in a balanced diet (Van den Heever, 1995). This is because foods of animal origin, which are known to be main sources of vitamins and proteins, are in most cases too expensive for poor households (Aphane *et al.,* 2003). However, a major limitation to production of commonly cultivated vegetables like amaranth (*Amaranthus caudatus*) and corchorus (*Corchorus olitorius*) is poor soil fertility. *Amaranthus caudatus* is mostly grown and used as a leaf vegetable in Africa where tender leaves and stems are boiled as greens and added to soups and stews (Olufolaji and Tayo 1989; Schippers, 2000). Grains of *Amaranthus* contain 13 to 18 % protein with well-balanced nutritional quality; including a high level of lysine, an essential amino acid that is often lacking in most cereals and tuber-based diets. *Corchorus olitorius* is rich in beta-carotene, iron, calcium, and Vitamin C. The plant has an antioxidant activity with a significant α-tocopherol equivalent Vitamin E (Leung *et al.,* 1968). In Africa, it is generally cultivated as a pot-herb and its leaves are used to make mucilaginous soup. In Nigeria and most other tropical countries of Africa, where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most readily available sources of important vitamins, minerals and essential amino acids (Thompson and Kelly, 1990).

While a lot of reports have been produced on the influence of mineral and organic fertilizers on yield of crops, there is little or no information on the responses of amaranths and corchorus to brewery-based compost. Moreover, there is a need to compare the effects of Ibadan Brewery waste-based compost with that of mineral fertilizer NPK 15:15:15 on yield and quality of amaranths and corchorus. Thus, the objective of this research was to compare separately, the effectiveness of two Ibadan Brewery waste-based composts with that of mineral fertilizer NPK 15-15-15, on the yield of *Amaranthus caudatus* and *Corchorus olitorius*.

Materials and methods

The experimental site was located at the Department of Agronomy, University of Ibadan, Nigeria. The experiment was replicated three times in a Randomized Completely Block Design. Planting was done twice; a main planting and the other residual fertilizer trial (without further treatments application), using amaranth and corchorus as test crops. Experimental soils of the amaranth and corchorus plots were slightly acidic, very low in N (0.2 g/kg), high in P (43 and 25 mg/kg), and low in exchangeable K (0.3 and 0.2 cmol/kg) respectively for amaranth and corchorus.

The treatments used were IBBW1 (N=0.93%, P= 0.92% and K = 0.74 %), IBBW2 (N=0.98%, P= 0.94% and K = 1.12%), NPK 15:15:15 and Control (no soil additive). All the treatments (except control) were applied on dry matter basis at the rate of 100 kg N/ ha. While the organic sources were applied a week before planting, the inorganic was applied two days to planting. Seeds of both crops (*Amaranthus caudatus* and *Corchorus olitorus)* were sown in drills at the rate of 1, 800,000 plants per hectare. Both the main and residual fertility effects of the fertilizer treatments were investigated on the two crops.

Land clearing was done manually using hoe and cutlass, followed by the seed bed preparation. Weeding was done by handpicking. Observations were carried out on plant fresh and dry weights. The dry weight was obtained by oven-drying plants samples at 60 °C to constant weight. The data collected were analysed using analysis of variance (ANOVA) with significant treatment means separated by Duncan Multiple Range Test (DMRT) at 5% level of significance (Duncan, 1955) using GENSTAT 4^{th} edition software.

Results

Effects of fertilizer treatments on amaranth

The three applied fertilizer treatments produced significantly (p<0.05) better fresh edible yield of amaranth compared to the control, with IBBW1 producing the highest yield of 22.99 t/ha (Table 1). The IBBW1 produced the highest fresh total yield of 44.10 t/ha amaranth, although not significantly different from those that received NPK and IBBW2 treatments. At residual fertilizer trial, fresh edible yield by the IBBW1 compost was the highest (8.67 t/ha) and it was significantly (p<0.05) better than those of other treatments. As shown in Table 2, IBBW1 compost produced the highest dry edible weight (6.88 t/ha) and was significantly better than IBBW2, NPK and the control.

There was no significant difference with regards to dry weights of root (DW Rw) among IBBW1, IBBW2 and NPK, although they were better than that of the control treatment. The IBBW1 performed best in the total dry weight (DW Total), though not significantly different from IBBW2 and NPK, but all better than the control (P<0.05).

It was observed that IBBW1 performed best and was significantly different from IBBW2 and NPK 15:15:15 which also performed better than the control at the residual fertilizer trial for DW E, at DW Rw IBBW1 performed better than the other treatments and for DW Total at P<0.05.

Effects of fertilizer treatments on corchorus

The IBBW1 produced the highest fresh edible yield (15.97 t/ha) of corchorus. Although this yield was not significantly (p<0.05) different from that from IBBW2 and NPK, but it was significantly better than that of the control (Table 3). The IBBW1 also had the highest fresh total weight (28.19 t/ha) of corchorus, although not significantly different from those from IBBW2 and NPK, but better than the control. The soil amendments applied to the soil had no significant (p<0.05) effects on the corchorus plants crop during the residual fertilizer trial. The IBBW1 had the highest dry edible weight yield which was not significantly different from that from IBBW2, NPK and control treatments. The IBBW1, IBBW2 and NPK had no significant difference but were significantly better than that of the control (Table 4).

Table 1: Comparative effects of soil amendments and residual fertilizer trial on the fresh yield of *A. caudatus* (t/ha) at University of Ibadan, 2013

Treatments	FW E	FW Rw	FW Total	FW E	FW Rw	FW Total
	Main planting (t/ha)			Residual effects (t/ha)		
Control	6.48a	0.54b	9.72b	1.85b	0.25b	4.50b
IBBW1	22.99b	3.91a	44.10a	8.67a	1.84a	30.00a
IBBW2	16.02b	2.52a	30.60a	3.13b	0.86b	19.20a
NPK 15:15:15	22.01b	3.42a	41.94a	2.21b	0.63b	25.98a

Means in the same column with same letter are not significantly different at p≤0.05

Legend:
FW E = fresh weight edible;
FW Rw = fresh weight root;
FW Total = fresh weight average of 4;
IBBW1: Ibadan brewery waste based compost grade A;
IBBW2: Ibadan brewery waste based compost grade B

Table 2: Comparative effects of soil amendments and residual fertilizer trial on the dry yield of *A. caudatus* (t/ha) at University of Ibadan, 2013

Treatments	FW E	FW Rw	FW Total	FW E	FW Rw	FW Total
	Main planting (t/ha)			Residual effects (t/ha)		
Control	1.22c	0.08b	1.31b	0.15c	0.02b	0.27b
IBBW1	6.88a	0.58a	7.45a	0.84a	0.36a	2.27a
IBBW2	4.61b	0.41a	5.02a	0.41b	0.15b	0.68b
NPK 15:15:15	4.63b	0.46a	5.09a	0.36b	0.06b	0.64b

Means in the same column with same letter are not significantly different at p≤0.05

LEGEND:
DW E = dry weight Edible;
DW Rw = dry weight Root;
DW Total = total dry weight
IBBW1: Ibadan brewery waste based compost grade A;
IBBW2: Ibadan brewery waste based compost grade B

Table 3: Comparative effects of soil amendments and residual fertilizer trial on the fresh yields of *C. olitorus* (t/ha) at University of Ibadan, 2013

Treatments	Edible fresh weight	Total fresh weight	Edible fresh weight	Total fresh weight
	Main planting (t/ha)		*Residual effects (t/ha)	
Control	5.29b	8.53b	1.62	2.57
IBBW1	15.97a	28.19a	3.83	5.45
IBBW2	13.19a	21.11a	3.55	4.63
NPK 15:15:15	14.38a	21.37a	1.67	3.01

Means in the same column with same letter are not significantly different at $p \leq 0.05$

Legend:
IBBW1: Ibadan brewery waste based compost grade A;
IBBW2: Ibadan brewery waste based compost grade B;
*: no significant difference at $p<0.05$)

Table 4: Comparative effects of soil amendments and residual fertilizer trial on the dry yield of *C. olitorus* (t/ha) at University of Ibadan, 2013

Treatments	Edible fresh weight	Total fresh weight	Edible fresh weight	Total fresh weight
	*Main planting (t/ha)		*Residual effects (t/ha)	
Control	2.88	3.04	0.25	0.72
IBBW1	3.89	4.48	1.12	1.67
IBBW2	2.57	3.04	0.47	1.29
NPK 15:15:15	3.22	3.58	0.67	1.55

LEGEND:
IBBW1: Ibadan brewery waste based compost grade A;
IBBW2: Ibadan brewery waste based compost grade B;
*: no significant difference at $p<0.05$)

However, the applied fertilizer treatments did not result into any significantly different fresh yield of corchorus at the residual fertilizer trial. Likewise, all treatments means were not significantly different for the dry edible weight, dry root weight and dry total weight at the residual fertilizer trial.

Discussion

The result of this study showed that IBBW1 produced the best total fresh yield of 44.10 t/ha amaranth (during the main planting), compared to the findings of Mshelia and Degri (2014) who obtained 21.70 t/ha when 15 t/ha poultry manure was applied to similar crop, during the dry season of 2013 (January-April) in Bama, Borno State, Nigeria. The NPK 15:15:15 treatment yielded 41.3 t/ha of total fresh amaranth which was higher than that reported by AdeOluwa and Adeogun (2010) who got 16.2 t/ha when NPK 15:15:15 was applied at the rate of 100 kgN/ha. The influence of the treatments on amaranth's dry weight followed the same trend as that of the fresh weight during the first planting and the residual fertilizer trial. All the treatments had significantly better effect on the dry weights compared to the control treatment. The IBBW1 resulted in the highest value of 7.45 t/ha, which is higher than 4.3 t/ha obtained by AdeOluwa *et al. (*2006), using 10 t/ha *Gliricidia sepium* and 4.0 t/ha reported by Grubben and Van Slotten (1981). At the residual fertilizer trial, IBWW1 had the highest dry yield value (2.27 t/ha), which was lower than that reported by AdeOluwa *et al.* (2006), in Ibadan Nigeria, using different green manures.

Similar trend of the effects of applied treatments on amaranth were observed in the corchorus. The IBBW1 resulted into the best total fresh yield of 28.19 t/ha of corchorus, that is greater than the yield of NPK 15:15:15 which produced 21.37 t/ha of total fresh weight (although they were not significantly ($P<0.05$) different from each other). The influence of the treatments in this study on corchorus' dry weight followed the same trend as that of the fresh weight. This is in agreement with the findings of Olaniyi and Ajibola (2008). The fresh yield of corchorus obtained with IBBW1 in this investigation was greater that obtained by Emuh (2013), when he applied 20 and 30 t/ha of poultry manure as soil amendment. This implied that the Ibadan Brewery waste-based compost grade A could be a good fertilizer for raising both amaranth and corchorus, especially in an organic cropping systems where only organic fertilizers must be used.

Conclusions

It was revealed that brewery waste based compost is a suitable source of nutrients for amaranth and corchorus especially if applied as Ibadan Brewery waste-based compost grade A (IBBW1). The use of the Ibadan Brewery waste-based compost grades A and B composts increased amaranths and corchorus yields compared to the application of NPK 15-15-15 fertilizer, thus these composts are recommended for sustainable production of amaranth and corchorus, especially in organic farming systems.

Acknowledgements

Appreciation to administration of the University of Ibadan, Ibadan, Oyo State, Nigeria through the Senate Research Grant that funded this research, as well as the provision of spent grain by the Nigerian Brewery Plc, Ibadan.

References

Adebayo, O., and Akoun, J., (2002). Effect of organic manure and spacing on the yield and yield components of *Amaranthus cruentus*. In: Proceedings of *20th Annual conference of Horticultural Society of Nigeria* held at National Horticultural Research Institute (NIHORT), Ibadan, Pp. 30-32.

Adeniyan, O. N., and Ojeniyi, S. O., (2005). Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian Journal of Soil Science*, 15: 24-41.

AdeOluwa, O. O., Adeoye, G. O., and Ogunmola, P. O., (2006). Performance of African Egg Plant (*Solanum macrocapon*) and

Amaranths (*Amaranthus caudatus*) under the influence of some organic fertilizers. *Journal of Agriculture, Forestry and Social Science* (JOAFSS) 4(1): 127-134.

AdeOluwa, O. O. and Adeogun, O. O., (2010). "Evaluation of feather as organic fertilizers on Amaranthus (*Amaranthus caudatus*)," in Proceedings of the *1st Technical Workshop on Organic Agriculture Conference,* Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Pp. 16–19

Agbede, T. M., and Ojeniyi, S. O., (2009). Tillage and Poultry manure effects on soil fertility and sorghum yield in South Western Nigeria. *Soil and Tillage Research.* Pp. 280 - 291.

Aphane, J.; Chadha, M. L., and Oluoch, M. O., (2003). Increasing the consumption of micronutrient-rich foods through production of indigenous foods. In: *FAOAVRDC International Workshop Proceedings*, 5-8 March 2002, Arusha, Tanzania. Asian Vegetable Research Development Centre - the World Vegetable Centre Shanua, Taiwan: AVRDC Publication No. 03-561: 1-77.

Duncan, D. B., (1955). Multiple range and multiple F test. *Biometrics* 11: 1-42

Egherevba, R. K. A., and Ogbe, F. M., (2002). The effects of different levels of organic and mineral fertilizers on the yield performance of two Amaranths (*A. cruentus*) cultivars. *Plant Science*, 3: 62-72.

Emuh, F. H., (2013). Growth and yield performance of *Corchorus olitorious* L. influenced by levels of poultry manure in Niger-Delta, Nigeria. *African Journal of Biotechnology* 12(19): 2575-2580, May, 8. Available online at *http://www.academicJournals.org/AJB. DOI: 10.5897/AJB12.356*

FAO, (2005). The importance of soil organic matter .Key to drought resistant soil and sustained food production. *FAO Soils Bulletin 80*. Food and Agricultural Organization of the United Nations, Rome, Italy Pp. 78.

Grubben, G. J. H. and Van Sloten, D. H., (1981). Genetic resources of amaranths:: a global plan of action, including a provisional key to some edible species of the family Amaranthaceae by Laurie B. Feine-Dudley. *International Board for Plant Genetic Resources*, Rome, Italy Pp 57.

Ibeawuchi, I. I., Onwerenmadu, E. U. and Oti, N. N. (2006). Effect of poultry manure on green (*Amaranthus cruentus*) and water leaf (*Talinum triangulare*) on degraded Ultisol of Owerri, South Eastern Nigeria. *Journal Animal Veterinary Adv.,* 5(1): 53-56.

Leung, W. T. W., Busson, F. and Jardin, C., (1968). *Food composition table for use in Africa.* FAO, Rome, Italy. Pp. 306

Mshelia, J. S., and Degri, M. M., (2014). Effect of different levels of poultry manure on the performance of amaranthus (*Amaranthus caudatus* L.) in bama, Nigeria. Department of Agronomy, Faculty of Agriculture, Federal University, Kashere, P. M. B 0182, Gombe State, Nigeria. *International Journal of Science and Nature,* 5(1): 121-125.

NEPAD., (2011). Status of Implementation at Regional and National Levels: *The Abuja Declaration on Fertilizers for an African Green Revolution.* Pp. 1-4.

Nottidge, D. O., Ojeniyi, S. O., and Asawalam, D. O., (2005). A comparative effect of plant residue and NPK fertilizer on nutrient status and yield of maize in a humid Uultisol. *Nigerian Journal of Soil Science* 15: 1-8.

Olaniyi, J. O., and Ajibola, A. T., (2008). Growth and Yield Performance of *Corchorus olitorus* Varieties as Affected by Nitrogen and Phosphorus Fertilizers Application, *American-Eurasian Journal on Sustainable Agriculture*, 2(3):235-241.

Olufolaji, A. O., and Tayo, T. O., (1989). Performance of four morphotypes of Amaranthus cruentus L under two harvesting methods. Tropical Agriculture. (Trinidad) 66: 273-276.

Schippers, R. R., (2000). African Indigenous Vegetables: An Overview of the cultivated species. Chatham UK. *Natural Resource Institute/ACP-EU Technical Centre for Agricultural Resources and Rural Cooperation*. Pp. 89-98.

Smithson, Paul C., and Giller, Ken E., (2002). Appropriate farm management practices for alleviating N and P deficiencies in low-nutrient soils of the tropics. Plant and Soil, Vol. 245, Issue 1, pp 169-180.

Thompson, H. C., and Kelly, W. C., (1990). *Vegetable Crops*. 5th Ed. New Delhi: Mac Graw Hill Publishing Company Limited. Pp. 561-563.

Van den Heever, E., (1995). The use and conservation of indigenous vegetables in South Africa. Paper presented at the workshop Genetic Resources of Traditional Vegetables in Africa. Options for Conservation and Use", Nairobi Kenya. *http//www.biodiversityinternational.org/publications.* Viewed on January 31, 2014.