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Effect of Cassava Peel Compost on Growth and Nutritional Quality of Celosia (*Celosia argentea* L.)

[1]W.B. Akanbi, [1]O.A. Olaniran, [1]J.O. Olaniyi, [2]M.A. Ojo and [1]O.O. Sanusi
[1]Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[2]Raw Material Research Council and Development, Abuja

Abstract: Recent survey of indigenous vegetables in south western Nigeria revealed farmers' interest in their cultivation if not for lack of adequate technical knowledge. The efforts to develop appropriate production package prompted us to assess the effects of Cassava Peel Compost (CPC) in combination with or without mineral fertilizer on the growth, shoot yield and nutritional values of *Celosia argentea*. The treatments applied were: T1 = 375 kg ha^{-1} NPK; T2 = 2 t ha^{-1} CPC; T3 = 3 t ha^{-1} CPC; T4 = 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; T5 = 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; and T6 = 0 (non-fertilized plant). The treatments were laid out in a randomized complete block design with 4 replicates. Growth and nutritional quality assessments were done on stem height and girth, number of leaves, leaf area, dry matter and shoot yields, shoot proximate and elemental contents. Data collected were subjected to analysis of variance and significant means separated using Duncan Multiple Range Test. The highest growth parameters were recorded with application of 375 kg ha^{-1} NPK and this was not significantly different from what was observed with T3 and T5. In the case of crop nutritional contents, combined application of 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK produced plants that were better than other treatments. It could be concluded that the use of cassava peel compost is adequate for celosia production.

Key words: Indigenous vegetable, cassava peel compost, celosia, nutritional content

INTRODUCTION

In view of the current need for sustainable development strategy to maintain the agricultural land use and still produce high quality food to satisfy demand of ever increasing population in this country, attention and energy should be geared towards evolving alternate sources of fertilizer to boost the food production without necessarily destroying the environment. The use of commercial fertilizer on staple food crops has generally been restricted to only a few large scale farms endowed with resources and with high off-farm income (Niang *et al*., 1996). The majority of the smallholder peasant farmers in Nigeria, on the other hand, have lacked the financial resources to purchase sufficient fertilizers to replace soil nutrients exported with harvested crop products. As a result, soil fertility has declined and yields of staple food crops are typically low (Sanchez *et al*., 1997; Jama *et al*., 1999; Akanbi *et al*., 2006).

Organic resources are often proposed as alternatives to commercial mineral fertilizers. Many researchers have studied the beneficial effects of organic wastes as fertilizer and soil amendments. Akanbi *et al*. (2002) observed that application of maize straw compost enhanced the growth, development and nutritional quality of amaranth. Again, Abassi reported marketable yield increase of 33% when tomato was grown on plots amended with cannery waste over that of the non-amended control. Similarly, application of 4t ha^{-1} of maize stover compost was found to be adequate for optimum growth, nutrient uptake and yield of tomato and this has been further confirmed by Maharishnan *et al*. (2004).

Traditional organic materials such as crop residues and animal manure, however, cannot by themselves reverse soil fertility decline because they are usually not available in sufficient quantities on most farms, they are low in nutrients and their processing and application are labor demanding (Palm *et al*., 1997; Akanbi *et al*., 2006). In addition, some organic materials have competitive uses, such as fodder for livestock.

Unused, nontraditional organic resources grow on or near smallholder farms. Some have relatively high nutrient concentration, but little is known about their potential as nutrient sources to improve soil fertility and crop yields. Two of such organic resources are cassava peel and green biomass of tithonia (*Tithonia diversifolia*).

A great variety of local and introduced vegetables are grown in Nigeria and these crops together with

Corresponding Author: W.B. Akanbi, Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

a significant number of wild and semi-wild plants form a valuable complementary food in the daily diets (Akanbi *et al.*, 2006). Until recently, vegetable research was concentrated mainly on exotic or introduced species and very little attention has been paid to traditional or indigenous species. Indigenous vegetables are important commodity for poor households because they are relatively cheaper than other food items. For instance, *Celosia argentea* L. is a leafy vegetable commonly grown in mixed intercropping systems of the tropics because of the richness of its leaves and young shoot in protein, calcium, phosphorus and iron and as such used in soups and stews. Many nutritional studies have shown that indigenous vegetables are as nutritious as, or more than, exotic vegetables. Moreover, they are better adapted to local conditions and may be tolerant to biotic and abiotic stress. In a survey conducted by Adebooye 86% of the farmers showed great interest in the cultivation of indigenous vegetables if given appropriate cultivation package. This therefore lends credence to the need for development of appropriate agronomic and production packages for production of the wild indigenous vegetables of South west Nigeria.

This research work assesses the potentials of cassava peel compost as a source of nutrients to the indigenous vegetables.

MATERIALS AND METHODS

A field experiment was conducted in 2005 at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso (longitude 40° 10', latitude 8° 10'), Nigeria. The soil of the experimental site is sandy loam in texture with a pH of 6.2 and organic carbon of 0.19%. The soil N (9 kg^{-1}), P (m9 kg^{-1}) and K (cMol kg^{-1}) were 0.36, 7.93 and 0.23, respectively. The region has a hot humid tropical climate and receives 1,080 mm rainfall annually. A major part of the rain is received during April-October.

The compost used as source of nutrient was prepared from cassava peel and well cured poultry manure. Both materials were air dried and non biodegradable materials sorted out of them. They were then combined in ratio of 3:1 (dry weight) and composted in concrete pit. The heap was watered and turned every fortnight, while the pH and temperature taken weekly. At maturity, the compost was air dried, shredded and samples taken for nutrient analysis.

There were 6 treatments, viz: T1 = 375 kg ha^{-1} NPK; T2 = 2 t ha^{-1} CPC; T3 = 3 t ha^{-1} CPC; T4 = 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; T5 = 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; and T6 = 0 (non-fertilized plant).

The compost treatments were uniformly applied to the soil by light hoeing while the mineral fertilizer (for the treatments that contain it) were applied by top dressing 2 weeks after planting. Seeds of celosia were drilled at inter row spacing of 20 cm, the seedlings were thinned to one plant per stand two weeks after sowing to give 160, 000 plants ha^{-1}. Weeding was done manually at 2, 4 and 6 weeks after planting and insect pests were controlled by applying karate at the rate of 2 mL $Litre^{-1}$ of water 4 weeks after planting.

The plants were allowed to grow for period of 8 weeks. After the growth period, the soil was lightly tilled and re-seeded. There was no application of fresh fertilizer treatments. The second cropping cycle was established to determine the residual effects of the applied treatments. During the second cycle, the plants were allowed to grow for 6 weeks. At the end of each growth cycle, data collected include plant height, stem girth, leaf area and cumulative dry matter yield. The shoot cumulative yield and proximate analysis as well as nutritional composition were also assessed.

Cumulative shoot yield was obtained by adding together shoot harvest from the first and second cropping and expressed on hectare basis. Representative samples taken from the first and second shoot harvest, were washed, cut into pieces, dried (80°C for 48 h), ground and processed for proximate and nutritional content analysis. Proximate compositions for nutrients were determined using AOAC (1984) method. Total shoot tissue N was determined by a semi micro-kjeldahl procedure (Bremner, 1965; Ulger *et al.*, 1997). Shoot protein was calculated from the Kjeldahl nitrogen using the conversion factor 6.25. Lipid was estimated by exhaustively extracting a known weight of sample with petroleum ether (BP 60°C) using a Tecator Soxhlet apparatus. Fibre content was estimated from the loss in weight of the crucible and its content on ignition. Mineral elements were estimated using the AOAC (1984) method. The atomic absorption spectrometer was used to determine Fe. Phosphorus (P) was determined using the colorimetric molybdenum-blue procedure (Murphy and Riley, 1962).

Data collected were subjected to analysis of variance procedures for a Randomized Complete Block design (RCB) as described by Gomez and Gomez (1984). Where the difference among means of the treatments is significant, they were compared using Duncan Multiple Range Test at 5% probability level.

RESULTS AND DISCUSSION

Generally, fertilizer types affect the growth, dry matter yield and nutritional values of celosia. Crop growth parameters varied over the cropping cycles. Plant height, number of leaves and leaf area are better in the first cropping for 375 kg ha^{-1} NPK, 2 and 3 t ha^{-1} CPC treatments. For all other treatments, plant performance in the second cropping proved the best.

Fertilizer types also had significant effects on the growth parameters of celosia. Application of NPK fertilizer had the tallest plants, followed by plants that received 2 and 3 t ha^{-1} CPC, while the shortest was recorded for control non-fertilized plants. In the case of number of leaves plant^{-1}, the use of 375 kg ha^{-1} NPK, 3 t ha^{-1} CPC, 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK and 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK produced similar results. The values obtained from these treatments were 35 - 52% higher than what was observed with the application of 2 t ha^{-1} CPC and non-fertilized plants. Leaf area development in celosia had positive response to applied treatments with application of 3 t ha^{-1} CPC having the highest (178.5 cm^2/plant) while the least was obtained from 2 t ha^{-1} CPC. When the crop performance was compared over the cropping cycles, leaf area of the plants in the second cycle seemed to be treatment dependent. In general, leaf area of plant that received high amount of CPC was better in the second cropping in contrast to what was observed with 375 kg ha^{-1} NPK treatment (Fig. 1).

Effect of applied treatments on the cumulative shoot, root and total dry matter yield are presented in Fig. 2. The dry matter production is better in the second cropping than in the first cropping. On average, the shoot, root and total dry matter of second cropping plants were 25, 67 and 21% respectively, higher than the recorded values for the first cropped plants. Among the fertilizer types used, shoot dry matter was best among plants that were nourished with treatments 3 t ha^{-1} CPC, 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK and 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK.

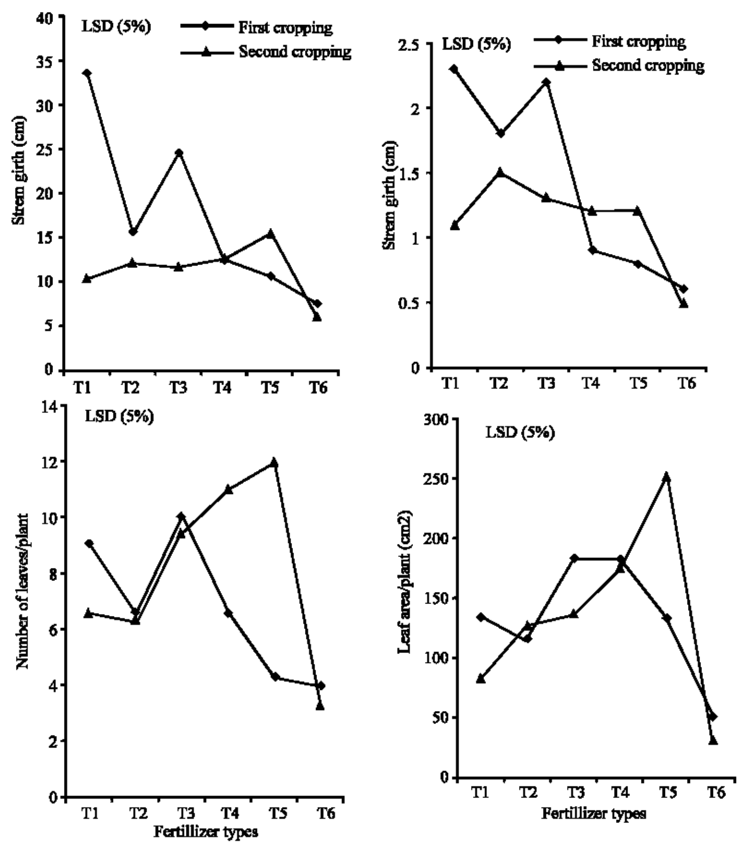

Fig. 1: Effect of fertilizer types on growth parameters of *Celosia argentea*. [T1 = 375 kg ha^{-1} NPK; T2 = 2 t ha^{-1} CPC; T3 = 3 t ha^{-1} CPC; T4 = 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; T5 = 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; and T6 = 0 (non-fertilized plant)]. Vertical bars represent LSD (5%) value

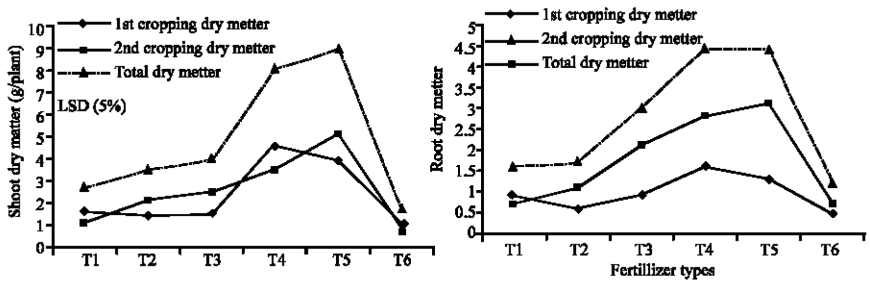

Fig. 2: Effects of fertilizer types on cumulative shoot and root dry matter yield of *Celosia argentea*. [T1 = 375 kg ha^{-1} NPK; T2 = 2 t ha^{-1} CPC; T3 = 3 t ha^{-1} CPC; T4 = 1t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; T5 = 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; and T6 = 0 (non-fertilized plant)]. Vertical bars represent LSD (5%) value

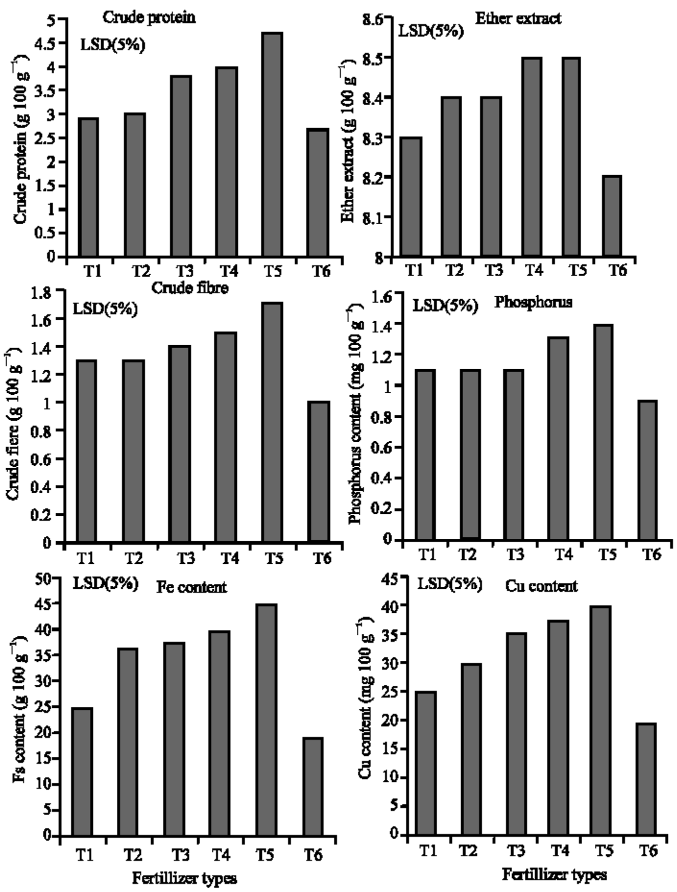

Fig. 3: Effects of fertilizer types on cumulative nutritional values of *Celosia argentea*. [T1 = 375 kg ha^{-1} NPK; T2 = 2 t ha^{-1} CPC; T3 = 3 t ha^{-1} CPC; T4 = 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; T5 = 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK; and T6 = 0 (non-fertilized plant)]. Vertical bars represent LSD (5%) value

Among the treatments that received combination of compost and inorganic fertilizer, 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK treatment gave result that were similar to that of situation where 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK was applied. When the cumulative total dry matter of plants under these two treatments were compared, the results were similar to what was observed with the situation where 375 kg ha^{-1} fertilizer was used. In all, dry matter productions of fertilized plants are better than that of non-fertilized ones.

Figure 3 presents the response of celosia proximate and some elemental nutritional values to the applied fertilizer types. The celosia cumulative crude protein, ether extract, Fe and Cu were significantly ($p = 0.05$) affected by the applied treatments. The crude protein varied from 2.9 g 100 g^{-1} in no fertilizer condition to 4.7 g 100 g^{-1} in plants where 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK was applied. This highest crude protein content (4.7 g 100 g^{-1}) was 25, 21, 15 and 55% higher than the observed values in 2 t ha^{-1} CPC, 3 t ha^{-1} CPC, 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK and control treatment, respectively. The ether extract followed the same trend as observed for crude protein. Despite non significant of crude fibre and P content to applied fertilizer types, the highest values for the two parameters were observed with treatments where both compost and inorganic fertilizer were jointly applied. The plant Fe and Cu contents were significantly ($p = 0.01$) affected by the fertilizer types used in this study. The highest tissue Fe concentration (45 mg 100 g^{1-}) was observed with 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK, followed by that of 1 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK (40 mg 100 g^{-1}), while the least (18.9 mg 100 g^{-1}) was observed from control treatment. The Cu content ranges from 19.4 mg 100 g^{-1} in control plants to 40 mg 100 g^{-1} in 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK treatment. Nevertheless, it is worth to note that irrespective of fertilizer types, tissue Cu content was not significantly different among the fertilized plants.

The use of fertilizer, be it organic or inorganic, enhanced the growth of celosia. That the crop performance in the second cropping cycle is better with treatment that received only the compost or compost with inorganic fertilizer is an indication of the residual value of these treatments. It has been reported that one of the disadvantages of compost as nutrient source (in short duration crops like leaf vegetables) is slow release of the nutrients (Palm *et al*., 1997). This means that farmers may crop land that was fertilized with organic fertilizer for more than once without repeated application of new nutrients. This implies reduction in the cost of transportation and application of the fertilizer materials. The stimulatory effects of inorganic fertilizer on organic compost have been reported by Akanbi *et al*. (2006). In their report with Amaranth, fortification of crop waste compost with small amount of mineral fertilizer was reported to produce crop with higher yield and better nutritional quality. In this present study, the better performance of second cropped plants that received both fertilizer types may be attributed to availability of sufficient amount of nutrients to the crop at all growth stages. The mineral fertilizer component of the treatment provide ready made nutrients for crop use in the first cycle and at the same time enhance mineralization of the organic compost components. Such enhancement and synergistic response has been reported by Abassi and Togun.

CONCLUSION

This study clearly demonstrated the potential of crop waste compost as fertilizer for production of vegetable crops. In this experiment, combined application of 2 t ha^{-1} CPC + 187.5 kg ha^{-1} NPK produced crops that compared favorably, in terms of yield quantity and quality, with the use of 375 kg ha^{-1} NPK. Taken into consideration the economic implication of applying high rate of compost to crop land and the environmental effects of loading our soil with high amount of inorganic fertilizer, the use of 2 t ha^{-1} CPC supplemented with 187.5 kg ha^{-1} NPK is therefore recommended for the production of celosia in south western Nigeria.

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