Journal of Agriculture & Forestry Research
Volume no.2, Issue no. 3, Year 2023
www.sarpo.net

Research Article **Open access**

Agronomic Performance and Yield of *Celeosia argentea* and *Amaranthus caudatus* Treated With Organic Manure And Mineral Fertilizer

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Keywords:

Amaranthus caudatus
Celosia argentea
Chemical fertilizer
Organomineral
Poultry manure
Urea fertilizer

Received: 01.05.2023
Received in revised form:
25.05.2023
Accepted: 26.05.2023

ABSTRACT

Most Nigerian soils have low nitrogen status usually supplemented with nutrient sources, like chemical fertilizers. However, the problem with the usage of chemical fertilizer is that though enhances high crop yield, it can result in groundwater pollution, which is hazardous to human health. A field experiment was conducted to evaluate the effect of organic manure, organomineral fertilizer and inorganic (urea) fertilizer on two vegetable types namely; *Celosia argentea* and *Amaranthus caudatus*. The experiment was carried out at the Teaching and Research Farm, Faculty of Agricultural Science, Ekiti State University, Ado-Ekiti. The experimental design was a randomized complete block design with three replications. The treatments used in the experiment are; poultry manure applied at the rate of 15 tons/ ha, organomineral fertilizer (7.5 tons/ha of poultry manure + urea 50kg/ha), Urea (46%N) at 100kgN/ha and control (no fertilizer). The result showed that application of organomineral fertilizer (urea + poultry manure) to the *Amaranthus caudatus* gave the highest plant height, stem girth, number of leaves, number of branches of leaves of 45.5 cm, 18.0 cm and 69.7 cm respectively at 4weeks after sowing when compared with values obtained in plots treated with urea, poultry manure and control. In addition, the application of organometal on the vegetables produced the highest yield and was significantly different from the other sources of nutrients used in the experiment.

INTRODUCTION

Agricultural land loses fertility after a long period of cultivation as a result of degradation of soil due to natural phenomena, and improper land use management practices over many years. Also, soils naturally are no longer able to supply all the needed nutrients required by crops for proper growth and development. Thus, it becomes imperative to supplement the soil nutrient with additional nutrient sources. Fertilizer plays an important role in increasing the soil nutrients which helps to nourish the plants. Thus, fertilizer application is essential for enhancing soil fertility for proper crop production. Common types of fertilizers used in crop production are organic and fertilizers for good crop productivity. Organic and inorganic fertilizers are essential for plant growth. Both fertilizers supply plants with the nutrients needed for optimum performance (Erisman et al. 2008). Organic fertilizers have been used for many centuries whereas chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution. Inorganic fertilizer has significantly supported global population growth, it

has been estimated that almost half the people on the earth are currently fed as a result of chemical fertilizer use (Erisman et al. 2008). Commercial and subsistence farming have been relying on the use of inorganic fertilizers for crop production (Masarirambi et al. 2010), because they are easy to use, quickly absorbed and utilized by crops. But the continued dependence on inorganic fertilizers has made the prices of agricultural products skyrocket (Makinde et al. 2010). Furthermore, the high price of inorganic fertilizers and the possible environmental hazard posed by overuse of same, are of great concern. Research has shown that organic fertilizers are less leached into groundwater and cheaper than chemical fertilizer (Sridhar and Adeoye, 2003). As a result of this fact, the use of organic fertilizer has found favor in boosting crop production in Nigeria. In addition, it improves soil fertility status as well as increases the income of farmers at a cheap cost of production.

Celosia argentea L. (Lagos spinach) is an edible species of the Amaranthaceae family, widely grown in home gardens in Nigeria and other parts of West Africa. It is cultivated during the rainy and dry seasons. This green vegetable is an essential component of people's diet in Nigeria. The leaves and young shoots are used in soups and stews. The leaves contain high levels of calcium, phosphorus and iron. The plant is an important source of vegetable proteins, calories, vitamins and minerals (Akinyemi and Tijani-Eniola, 1997) that enrich the diet of the people of West Africa. The crop is produced in Nigeria by poor farmers and in compound gardens where it is intercropped with other arable crops like maize and cassava to produce enough food and meet-up the dietary and cash requirements of these farmers (Akinyemi and Tijani-Eniola, 1997). *Amaranthus caudatus* is grown mainly for its leaves and is among the highest-priced leafy vegetables in Nigeria, one of the important vegetables of the family Amaranthaceae. Several amaranth species are useful as food crops and are grown both for their leaves and for their edible seeds. Amaranthus, like a number of other vegetables, requires soil with a high nitrogen content and adequate nutrient reserve for optimum yield. Many researchers have reported that the complementary use of organic fertilizers is able to give the desired higher sustainable crop yields than sole use of inorganic fertilizer (Ogunlade, et al. 2011; Akanbi, et al. 2010). In addition, most vegetable farmers in tropical Africa are smallholders who cannot afford the high cost of inorganic fertilizers. Fertilizer application rates for intensive agricultural systems have increased rapidly in recent years in Nigeria and farmers depend largely on locally and cheaply sourced organic fertilizers for enriching their soil (Makinde et al. 2010). In Nigeria, there are huge amounts of organic manure sources such as poultry waste, animal dung, sewage sludge, refuse soil and palm oil mills. The nutrients contained in manures are slowly released and can be stored for a longer period in the soil. This ensures longer residual effects that help in improving root development, and higher crop yields (Abou El Magd et al. 2005). Bayu et al. (2006) reported that the utilization of organic manure is necessary in order to reduce the cost of crop fertilization, thus improving the environmental conditions and reducing the cost of production. Organic manure not only helps in sustaining cropping system through improved nutrient recycling (El-Shakweer et al. 1998), it also provide all necessary macro- and micro-nutrients in available forms on the farm, thereby improving the physical, chemical and biological properties of the soil (Abou El-Magd et al. 2006.. Various studies have been done on how fertilizer use affect the yield of different plants. Several studies have centered on the effect of organic, inorganic fertilizer or in combination on soil properties, nutrients uptake, growth and yield of crops. However, there is scarce research information on the effect of organic and inorganic fertilizer on production of *Amaranthus caudatus* and *Celosia argentea*. Thus, to enhance the optimal production of the vegetables, appropriate use of fertilizers have to be employed. The aim of this study is to evaluate the effect of fertilizer types on the growth and yield performance of *Celosia argentea* and *Amaranthus cadautus*.

MATERIALS AND METHODS

Experimental site

This work was carried out March - June, 2022. The site is located at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti (Lat. 70 45' North and Long. 5º 38' E) and 432 meters above sea level. The texture of the soil is predominantly loamy sand with some traces of clay loam. The site is covered with large vegetation which shows that the site has a good nutrients to cultivate on it, located on a bearing of 7° 31N and 70 49S and covers an appropriate elevation of 730m above sea level. The area has a humid tropical climate with marked wet and dry seasons. It is characterized by high temperature and relative humidity. The average annual rainfall for the area is

309mm with an average number temperature is between 21° and 27°C. The site being part of southern Nigeria has a rainfall period of about 6 - 7 months and moderate temperature with relatively assistant sunshine intensity during the dry season. The humidity is relatively high during the wet season. The common weed found on the site is Elephant grass (*Pennisetum purpureum*), some wild sunflower (*Tithonia deversifolia*), and (*Chromolaena odorata*) siam weed. The vegetative cover showed that there are lots of macros and micronutrient in the soil.

Land preparation

After selecting the site, it was cleared and ploughed, it was harrowed and plots were assigned. The length and breadth of the site were measured and divided to three replication, and each replication made up of eight plots, measuring 2m by 2m, each with 1m in between, giving total number of twenty-four (24) plots. Each plot was tilled using a hoe to loosen the soil, thus providing a good seed bed to enhance the easy germination of the seeds.

Experimental Design and Treatment

The seeds of celosia argentia (Lagos spinach) and *Amaranthus caudatus* planted were obtained from previous planting at the Teaching and Research farm. The inorganic fertilizer used (urea) was purchased from the local market, while organic fertilizer was obtained from the poultry unit of the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Ekiti State. The experimental design used was a randomized complete block design (RCBD). The planting of amaranths and celosia was carried out on the 25th of March. The poultry manure was applied 2 weeks preceding the planting day, while the application of urea was done a day before planting. Planting was done using the broadcasting method. The treatments used in the experiment are; poultry manure (PM8) applied at the rate of 15 tons/ ha; organomineral fertilizer i.e split application of poultry manure at 7.5 ton/ha and urea (46 % N) at 50 kg/ha (PM4+U20); Urea (46%N) at 100 kg N/ha (U40) and control (no fertilizer).

Data collection

The data taken include plant height, stem girth, number of leaves per plant and fresh vegetable weight/yield. The plant height was measured using meter rule (ruler). Plant height was measured from base of the plant to its tip, from 14 DAS to 42 DAS. The number of leaves was measured by counting fully opened leaves. Stem girth was measured with Vernier caliper from 14 DAS to 42 DAS on weekly interval. The harvesting of vegetables leaves were done 6 weeks after planting. Yield parameter was measured on the plants from by selecting the mid rows plants and uprooted from the root, shaking the soil away gentle, while the whole plants were placed on a weighing balance to ascertain weight per plant (fresh vegetable weight).

Data analysis

The data was subjected to Analysis of variance (ANOVA) using SPSS 23 version (Version 23.0, 2015). The least significant difference (LSD) test or turkey ($\alpha = 0.05$) was used for means separation among the treatments used.

RESULTS

Growth parameters measured in the experiment

Table 1 shows the effects of urea fertilizer, poultry manure and organomineral on plant height of the two vegetables varieties used in the experiment. From the result obtained, it could be clearly seen that there were no significant differences in all values recorded for the growth parameters measured on varieties of vegetables used at different levels of nutrients applications. Although application of organomineral fertilizer (PM4+U20) on *Amaranthus caudatus* gave the highest plant height, number of leaves and stem girth, which are 45.5 cm, 69.7 and 18.0 cm respectively at four weeks after planting, while the control (no application) gave the lowest values recorded in almost all the weeks sampled.

Yield parameters measured in the experiment

Yield of the different nutrients sources

Figure1 showed the yield values obtained on the two vegetable varieties used in this experiment as a result of the effect of nutrient sources used. From the chart, it could be seen clearly that application of organomineral fertilizer (PM4+U20) on the vegetables varieties gave the highest yield and differ significantly from all the other treatments used in the experiment, followed significantly by application of poultry

manure (PM8) at the rate of 15 ton/ ha and the control gave the lowest yield.

Yield of the two vegetable varieties as affected by the nutrient sources

Figure 2 showed the yield values obtained on the two vegetable varieties used in this experiment as a result of the influence of nutrient sources used on them. From the chart, it could be seen clearly that application of organomineral fertilizer (PM4+U20) on the vegetables varieties gave the highest yield, followed by poultry manure PM8, while the control gave the lowest yield. In addition, *Amaranthus caudatus* produced higher yield under the influence of treatment PM4+U20 when compare with *Celosia argentea* in the experiment.

Table 1. Plant height (PH), number of leaves (NOL) and stem girth (SG) of the two vegetables under different nutrient sources.

		WAP (cm)								
Veg		2	3	4	2	3	4	2	3	4
	Nutrient		PH			NOL			SG	
Celosia	PM8	4.3	13.2	27.5	7.7	13.3	28.3	0.4	5.5	8.9
	PM4+U20	8.3	20.5	42.7	9.3	22.0	51.7	0.6	8.8	16.4
	U40	5.2	9.3	16.3	4.7	9.7	20.7	0.2	5.2	8.4
	Control	4.7	11.3	22.0	7.3	11.0	22.7	0.3	4.9	8.3
Caudatus	PM8	6.8	19.0	38.7	7.0	18.3	40.3	0.5	9.9	16.8
	PM4+U20	7.3	17.0	45.5	8.3	36.3	69.7	0.5	10.7	18.0
	U40	6.0	11.5	23.0	5.3	8.7	23.7	0.3	6.2	13.8
	Control	3.8	7.3	12.2	6.7	6.3	9.7	0.3	4.0	8.2
	SEM	1.01	2.75	5.68	0.66	3.01	5.11	0.07	1.57	2.68
	$p < 0.05$	0.300	0.260	0.284	0.604	0.190	0.539	0.355	0.234	0.277

Veg: vegetable; WAP: weeks after planting; PM8: poultry manure; PM+U20: poultry manure + Urea; U40: 40 g Urea. SEM: standard error of the mean $P < 0.05$ means a 5% level of probability with means separated by Tukey test.

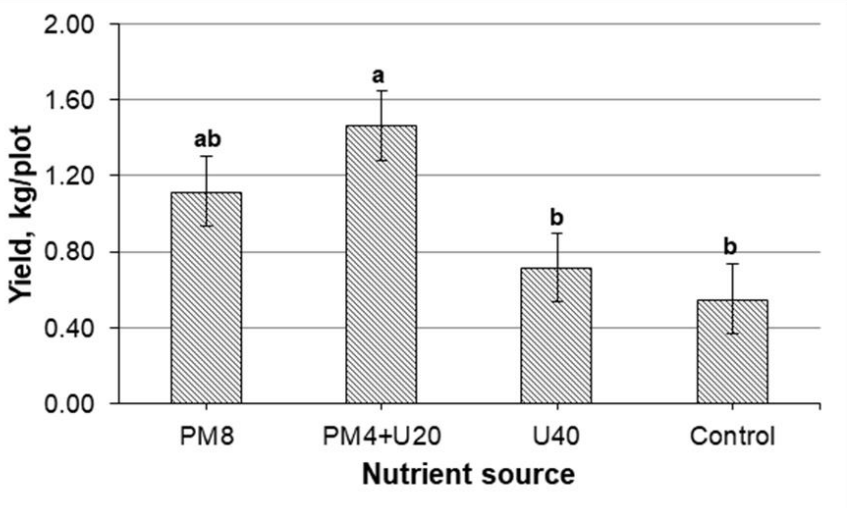

Figure 1. Yield of the different sources of nutrients. PM8: 8 kg poultry manure; PM4+U20: 4 kg poultry manure + 20 g Urea; U40: 40 g Urea. Bars with different letters differed significantly at 5% level of probability by Tukey test.

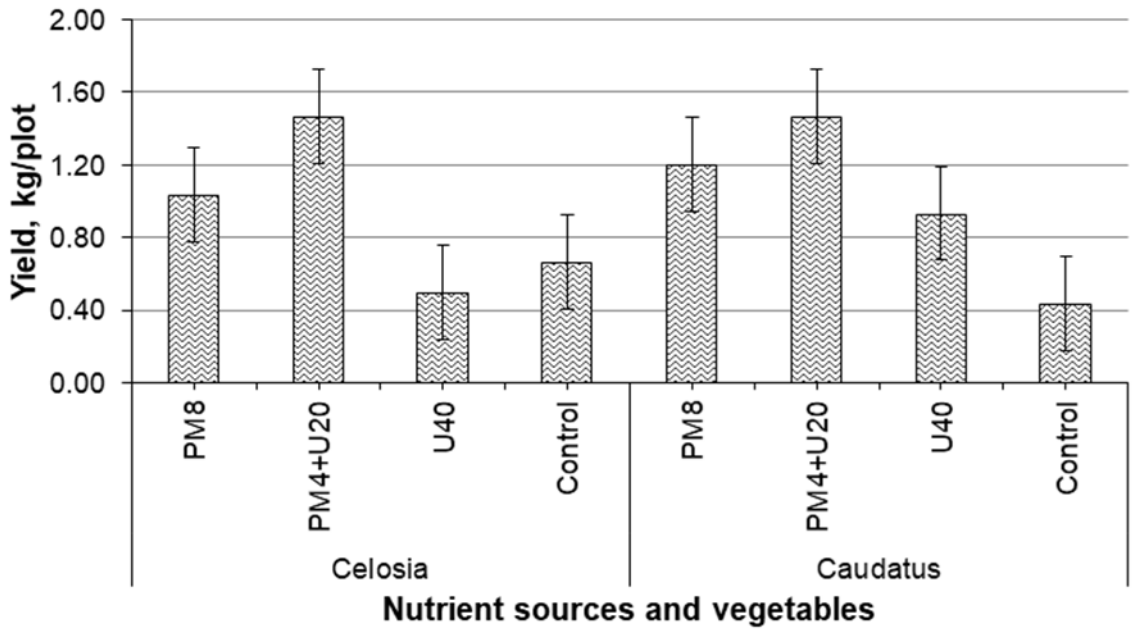

Figure 2. Yield of the two vegetable varieties as affected by the nutrient sources. PM8: 8 kg poultry manure; PM4+U20: 4 kg poultry manure + 20 g Urea; U40: 40 g Urea. Bars with different letters differed significantly at 5% level of probability by Tukey test.

DISCUSSION

Fertilizers play an important role in improving soil fertility by adding essential nutrients to soil which aid in adequate growth and yield of plants, hence the two varieties of amaranth grown under different level of urea fertilizer, and poultry manure (PM) had significantly showed increased in growth and yield rate when compared to the control plants. This effect could be associated to the vital nutrients contained in the mineral fertilizer as well as the poultry manure, which are deposited in the soil and thereby absorbed by the plants. Also, the two varieties of amaranths used in this experiment exhibited better response to organomineral fertilizer and poultry manure than urea fertilizer and control. This implies that minerals fertilizer quickly releases nutrients, which can easily be leached away from the soil than poultry manure. It could also be noted that increase in the dosage of the urea fertilizer and poultry manure had an increment effect on the plant height, an average number of leaves, stem girth and yield, which can be attributed to the increased amount of nutrient (nitrogen) supplied to the vegetables in the experiment. The highest plant height obtained from plants treated with organomineral (Pm4+U20) are 45.5 cm and 42.7 cm, for caudatus and celosia plants respectively, which might be due to favorable nutrient mineralization of this fertilizer as a result of the influence of the mineral component on its organic content (Sikora and Enkiri, 2000), while the control plants produced the shortest plants height (Fig 1), which could be due to the fact that they had to rely solely on the native soil fertility which might be deficient in nutrients. Figure 2 shows that organomineral (Pm4+U20) enhanced the production of leaves and maintained that trend in plant height and stem girth for both caudatus and celosia. An increase in the number of leaves over the weeks of samplings are bound to affect the overall performance of Amaranthus as the leaves serve as a photosynthetic organ of the plant (Law-Ogbomo and Ajayi, 2009). Although, there were no significant differences ($P < 0.05$) in the number of leaves, plant height and stem girth, obtained from the two vegetable types used in the experiment, among the treatments used, and all through the weeks samplings, all the same, the highest number of leaves, plant height and stem girth were obtained from plants (plots) treated with organomineral fertilizer, which are 69.7, 45.5 cm and 18 cm respectively. This could be due to continuous release of nutrients by the organomineral fertilizer (Ogunlade, et al. 2011). Thus, the increase in number of leaves under organomineral and urea fertilizers application, reconfirmed the role of fertilizer in promoting vegetative growth in leafy vegetables (Tijani-Eniola, et al. 2000).

The fresh yield of *Amaranthus caudatus* was significantly increased with application of organomeniral (PM4+U20). These results are in agreement with the findings of Bruce & Philip (2008) who reported a linear response of amaranth yield to N fertilization. The higher yield produced by the two vegetables varieties under organomineral treatment over other treatments used, could have been due to increased plant height, stem girth and the number of leaves obtained from the plants under this treatment, thus the higher performance of vegetables in PM4+U20 treatment over PM8 and U40 treatments are indicative of the ease dissolution of nutrients in the inorganic fertilizer at the initial stage of growth being a more soluble form, which could be enhanced by the poultry manure at the later growth stages. In addition, poultry manure also contains useful soil nutrients that are needed for the plant's growth, but their composition is in the crude form that is released slowly to the soil possibly accounting for the slow and steady growth of plants in both PM4+U20 and PM treated plots, when compared with urea treated plots and control. All the fertilizers applied were found to increase the plant height, stem girth, and yield of Amaranths caudatus and celosia when compared with the control. In Fig 2, it could be clearly seen that *Amarantus caudatus* produced the highest yield under the influence of treatment PM4+U20, followed by PM, then urea while the control plants produced the least. Furthermore, it can be noted that vegetable yield was the least in the control plots. This confirmed the findings of (Olowoake, 2014), who reported the application of organic, mineral and organomineral fertilizers for the enhancement of Amaranthus cruentus yield. There were significant differences ($P <$ 0.05) in the yield of two vegetables under the different treatments used. Fig 1 showed that organomineral (PM+U40) treated plots gave the highest yield compared to other treatments. This was similar to the works of Akanni et al. 2011.; Ayeni, 2008.; Ogunlade et al.; 2011, who reported that the combinations of organic and mineral fertilizers performed better on the yield of tomato, maize, and *Solanum macrocarpon* than when each of them is solely used.

Application of organic manures significantly increased levels of organic Carbon and Nitrogen, and the formation of water stable aggregates, when compared with application of chemical fertilizers (N'Dayegamiye, 2006). Makinde et al. (2011), also reported that Celosia and Corhorus treated with poultry manure had better yields, higher number of leaf, stem girth and higher moisture contents than vegetables fertilized with urea. The scarcity and high cost of obtaining mineral fertilizer calls for alternative nutrient sources (Akanbi et al. 2006), hence this research work. Also, Celosia as a productive leafy vegetable, yet its yields are lower when compare with the yield of *Amaranthus caudatus* (Denton, 2004).

CONCLUSIONS AND RECOMMENDATIONS

This study shows that *Amaranthus caudatus* and celosia exhibited a better response to split application of urea and poultry manure (organomineral) than sole urea, and poultry manure. Application of treatment PM4+U20 showed a significant increase in plant height, stem girth, number of leaves, and fresh weight (yield) for both celosia and caudatus than all the other treatments used in the experiment including control, though caudatus perform better for both growth and yield parameters. Therefore, it reveals the need for basal application of mineral fertilizer for the early proper growth and development of the vegetable plants. Organic manure and inorganic manure had a good influence on growth, development and yield of these vegetable varieties used. The results obtained revealed that both vegetables responded well to the application of organomineral fertilizer compared to other different nutrients sources used and control in the study. Therefore poultry manure could be used as the good organic nutrient source for increasing the productivity of the vegetables. The study concluded that leaf numbers increased with increase in poultry manure and urea fertilizer levels. This showed that increase in N level promoted the vegetative growth of the vegetable plants. This study showed that treatment PM4+U20 fertilizer gave the best performances in all growth and yield parameters measured. Given its superior responses, organomineral fertilizer could be a very attractive fertilizer alternative, particularly for annual crops with short growth cycles such as *Amaranthus caudatus* and celosia. It is therefore, reasonable to recommend the use of organomineral fertilizer in the cultivation of *Amaranthus caudatus* and *Celosia argentea*.

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