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EFFECTS OF SEEDBED TYPES AND POULTRY MANURE APPLICATION ON THE GROWTH AND YIELD OF CELOSIA (*Celosia argentea* L.) IN THE HUMID ULTISOLS ENVIRONMENT

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ABSTRACT

A study was conducted at the Experimental Farm of the Faculty of Agriculture, University of Benin, Edo State, Nigeria in 2015 and 2016 to evaluate the growth and herbage yield of *Celosia argentea*L. in response to seedbed type and different levels of poultry manure application. The treatments were laid out in a 2 × 4 split plot design with three replications. The main plots were seedbed types (flat bed and raised bed) and the subplot comprised four levels 0, 30 (9.12 t ha^{-1}), 60 (18.24 t ha^{-1}), 90 (27.36 t ha^{-1}) Kg N ha^{-1} of poultry manure. Growth variables (plant height, number of leaves, leaf area index and stem girth) at 4 and 8 weeks after transplanting as well as herbage yield and total dry matter were assessed. Application of poultry manure at 60 (18.24 t ha^{-1}) Kg N ha^{-1} on raised bed had taller plants, more profuse leaves and thicker stems and higher herbage yield and total dry matter compared to control and other levels of poultry manure on flat bed and raised bed. It could therefore, be concluded that application of poultry manure at 60 Kg N ha^{-1} on raised bed is sufficient for optimum performance of Celosia.

Keywords: Seedbed types; Poultry manure; Ultisols environment

INTRODUCTION

Celosia argentea L. is an edible species of the genus *Celosia*, belonging to the family *Amaranthaceae* which originated from India, and well known for its medicinal and traditional uses (Ramesh *et al.,* 2013). *Celosia* is primarily used as a leafy vegetable. The leaves and tender stems are cooked into soups, sauces or stews with various ingredients including other vegetables such as onions, hot pepper and tomato, and with meat or fish and palm oil. The soup is consumed with staple food of maize, rice and cassava or yam. The young inflorescences are also eaten as pot herb (Denton, 2004). The leaves contain high level of calcium, phosphorus and iron. The plant is an important source of protein, calories, vitamins and minerals (Akinyemi and Tijani –Eniola, 1997).

The flowers and seed can be used as medicine. The flowers and seed are astringent, hemostatic, parasiticides and poultice. They are used in the treatment of bloody stool, hemorrhoid bleeding, uterine bleeding, leucorrhea and dysentery. The seeds are widely used in India for treatment of diabetes. It is used in Africa to help control the growth of the parasitic striga (Denton, 2004). It can also be used for soap making (Akinyemi and Tijani-Eniola, 1997). In Kenya, the “Masai” use the liquid extract from leaves and flowers as body wash for convalescents. The whole plant is used as an antidote for snake bites and the roots for treating colic, gonorrhea and eczema (Denton, 2004).

The crop is predominantly produced in Nigeria as compound gardens by resource-poor farmers where it is intercropped with arable starchy staples to produce enough food to satisfy their dietary and cash requirements (Akinyemi and Tijani-Eniola, 1997). The productivity of this crop is low (7.60 t ha^{-1}) (FAO, 2004)). The major production constraints among others are moisture limitations and low fertility as a result of environmental degradation. Thus, Soil management practices should be adopted to conserve soil moisture and nutrient on a sustainable basis. Kusnarta *et al.,* (2006) reported that the system of soil management controls root distribution and soil properties such as porosity, compaction, water content and concentration of organic matter. Unsuitable land preparation practices causes degradation in soil health (depletion of organic matter and other nutrients) as well as decline in crop productivity. Soil tillage is among the important factors affecting soil properties and crop yield among the crop production factors, tillage contributes up to 20 % and affects the use of sustainable soil resources through its influence on soil properties (Ramos *et al.,* 2011). Seedbed types have effect on seedling emergence, growth and productivity of Celosia through its influence on the physical, chemical and biological properties of the soil (Tijani-Eniola, 2002).

Increasing population pressure has resulted in the intensification of crop production and the use of inappropriate farming practices (Akinyemi and Tijani-Eniola, 1997). Nutrients loss through leaching, erosion and crop removal need to be replenished with nutrients from external inputs (Uzoh *et al*., 2015). This necessitated the use of organic fertilizers which are relatively cheap, readily available and environmentally friendly to maintain sustainable crop yield and soil fertility (Belay *et al*., 2001). Organic fertilizer has been reported to increase number of leaves, stem girth, root length, stem and leaf length of *Celosia*. It was also reported to produce higher leaf N, P, K, CA, Mg contents compared to inorganic fertilizers (Opeyemi and Adegboyega, 2003). Also organic materials including crop residues, animal manure, sewage sludge and composted organic matters have been reported to produce high yield and quality of food crops (Uzoh *et al*., 2015). Hence, the objective of this study is to evaluate the effect of seedbed types and different levels of poultry manure application on the growth and yield of *C. argentea*.

MATERIALS AND METHODS

Study Area

The study was conducted at the Experimental Farm of the Faculty of Agriculture, University of Benin, Benin City (Latitude 5^0 44′ and 7°34′ N and Longitude 5° 44′ and 6^0 43′ E), Edo State, Nigeria from October to December, 2015 and repeated at the same time in 2016. The area is characterized by a humid tropical climate. It has a mean rainfall of 1762 mm and daily temperature of 26.4 ^{0}C. It lies within the rainforest of agro-ecological zone of Edo State, Nigeria, now degraded to secondary forest due to shifting cultivation.

Experimental Design and Field Trial

The experiment was laid out in a 2 × 4 split design with three replications. The main plots were seedbed types (flat seedbed and raised seedbed). The sub-plots were four levels (0, 30, 60, 90 Kg N ha^{-1}) of poultry manure.

The experimental area was prepared manually and twenty four plots arising from three blocks were marked out. Raised seedbeds were constructed on 12 plots as per treatment at a height of 0.3m, 1.5m width and 2.5m long while twelve plots were flat seedbeds (tilled at 1.5 m width and 2.5 m long). Each plot was separated from the next by 0.5 m border row and 1.0 m was maintained between the blocks.

A composite soil sample was collected at a depth of 0-15 cm using auger. The samples were used for physical and chemical properties of the soil using standard Laboratory procedures. The soil was sandy loam with a pH of 5.40, organic carbon content of 15.20 g kg^{-1} (OC), 0.74 g kg^{-1}total nitrogen (TN), 20: 1 C: N ratio, 8.10 mg kg^{-1}, 0.23 cmol kg^{-1} K^{+}, 0.80 cmol kg^{-1} Ca^{2+}, 0.24 cmol $kg^{-1}$$Mg^{2+}$, 0.14 cmol $kg^{-1}$$Na^{+}$, 1.03 cmol $kg^{-1}$$H^{+}$ and 0.60 cmol kg^{-1} Al^{3+}. The properly cured poultry manure was obtained from the University of Benin Commercial Farm.The poultry manure on analysis had a pH of 6.60 with 33.60 OC, 10.20 g kg^{-1} TN, 3.29:1 C: N ratio, 30.70 mg kg^{-1} available P, 0.53 cmol kg^{-1} K^{+}, 30.86 cmol kg^{-1} Ca^{2+}, 0.45 cmol kg^{-1} Mg^{2+}, 0.24 cmol kg^{-1} Na^{+} and 0.08 cmol kg^{-1} H^{+}. Seeds of Celosia "Uselu local" variety were obtained from "Edaiken" Market, Benin City.

The seeds of the crop were sown by broadcasting in raised nursery beds erected closed to the experimental site. The nursery beds were shaded and incorporated with manure before sowing. Watering was done at 2 days interval. After three weeks, seedlings were transplanted to the prepared plots in the field and spaced at 40 × 40cm to achieve a population of 62,500 plants per hectare. The plots were watered and mulched after transplanting. The poultry manure was applied at rate of 0, 30 (9.12 t ha^{-1}), 60 (18.24 t ha^{-1}), 90 (27.36 t ha^{-1}) Kg N ha^{-1} to designated plots, four weeks before transplanting. After transplanting; watering, weeding, disease control were carried out appropriately.

Data Collection and Analysis

Within the net plot four plants were randomly selected and tagged. Data were collected on number of leaves, plant height, leaf area index (LAI) and stem girth at four and eight weeks after transplanting (WAT). Stem girth was measured at 5 cm above ground level on each sampled plant with the use of a vernier caliper and the average computed to obtain value per plant per plot. LAI was determined by measuring the length and breadth of the leaf and average computed and used to estimate leaf area (LA) as thus:

LA = $\frac{1.908+(0.496LB).number\ of\ leaves}{1600}$ (Ojo and Kintomo, 2001)

Where L = length; B = breadth

From LA, LAI was computed as:

LAI = $\frac{LA}{A}$ (Remison, 1997) Where A = land area occupied by the plant.

Dry matter was taken at eight weeks after transplanting (WAT). It was done by uprooting two plants out of the four tossed plants on each plot and oven dried at 70°C to a constant weight (ISTA, 1993). The data collected were combined for two years and analyzed using Analysis of Variance. Treatment means were separated using Least Significant Differences (LSD) at 5% level of significant.

RESULTS

Growth of *C. argentea*

Effect of seedbed types and different rates of poultry manure on plant height and stem girth of C. *argentea* at 4 and 8 WAT are presented in Table 1. At 4 and 8 WAT, plant height was significantly ($P<0.05$) influenced by seedbed types and poultry manure application rates. On both periods of measurement, plants on raised bed were taller than plants on flat bed.At 4WAT, there was no significant ($P>0.05$) difference among plants treated with different nitrogen levels of poultry manure except at 60 Kg N ha^{-1} of poultry manure. At 8 WAT, all poultry manure treated plants were significantly ($P<0.05$) taller than non-fertilized plants. There was significant ($P<0.05$) interaction of seedbed type and different levels of poultry manure on plant height at 4 WAT. The tallest plants were observed in plants cropped on raised seedbeds and treated with 60 and 90 Kg N ha^{-1} (Fig. 1).

At 4 and 8 WAT, the plants on raised bed were significantly ($P<0.05$) thicker than plants on flat bed. All other levels of poultry manure were not significantly ($P>0.05$) different except at 60 Kg N ha^{-1}. At 8 WAT, plants treated with 60 Kg N ha^{-1} of poultry manure had the thickest plants while thinnest plants were observed on control plots. Plants treated with 90 Kg N ha^{-1} of poultry manure were similar with non-fertilized plants. The interaction of seedbed type and different levels of poultry manure on stem girth was not statisticslly significant ($P>0.05$).

At 4 WAT, there was no significant ($P>0.05$) difference in the number of leaves between flat bed and raised bed (Table 2). At 8 WAT, plants on raised bed were more foliated than plants on flat bed. Only addition of poultry manure at a rate 60 Kg N ha^{-1}had higher number of leaves over unfertilized plants and other treated plants at 4 WAT. At 8 WAT, all fertilized plants were significantly ($P<0.05$) more foliated than non-fertilized plants. There was significant ($P<0.05$) interaction of seedbed type and levels of poultry manure on number of leaves as plants cropped on raised seedbeds fortified with 60 Kg N ha^{-1} of poultry manure had the highest number of leaves (Fig. 2). At 8 WAT, there was also significant ($P<0.05$) interaction between seedbed types and levels of poultry manure as plants treated with 60 Kg N ha^{-1} of poultry manure on raised seedbed had the highest number of leaves (Fig. 3).

Table 1: Effects of seedbed types and levels of poultry manure application on the height and stem girth of Celosia

Treatment	Plant height (cm) Weeks after transplanting		Stem girth (cm) Weeks after transplanting	
	4	8	4	8
Seedbed type				
Raised	26.85[a]	96.80[a]	1.66[a]	2.12[a]
Flat	20.86[b]	79.30[b]	1.20[b]	1.83[b]
$LSD_{(0.05)}$	5.471	13.170	0.316	0.431
Poultry manure (Kg N ha^{-1})				
0	18.69[c]	71.50[c]	1.02[b]	1.63[c]
30	23.04[bc]	91.10[b]	1.28[b]	2.04[b]
60	30.85[a]	105.50[a]	1.57[a]	2.32[a]
90	22.84[bc]	84.00[b]	1.26[b]	1.93[b]
$LSD_{(0.05)}$	5.546	9.980	0.282	0.275
Interaction	7.22	ns	ns	ns

means with the same superscript(s) along the column are statistically similar ($P<0.05$)

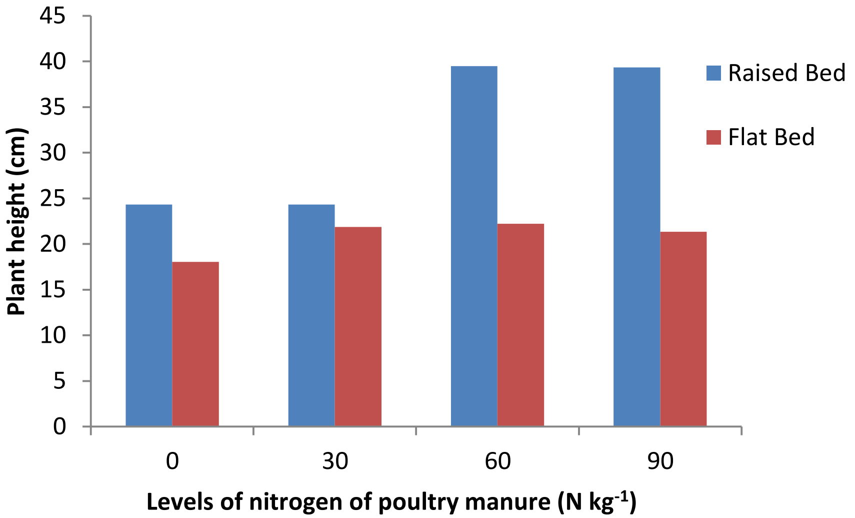

Fig. 1: Interaction of seedbed type and levels of nitrogen of poultry manure on plant height of Celosia at 4 WAT

At 4 WAT, there was no significant ($P>0.05$) difference on LAI in plants on raised bed and flat bed. There was no significant effect of levels of poultry manure on LAI of plants treated except 60 Kg N ha^{-1} of poultry manure at 4 WAT. At 8 WAT, plants on raised beds had higher LAI than those on flat beds. At 8 WAT, only plants on plots amended with 60 Kg N ha^{-1} had significantly higher LAI values than non-fertilized plants.

At 4 and 8 WAT, plants on raised seedbed fortified with 60 Kg N ha^{-1} had the highest LAI (Figs. 4 and 5).

Table 2: Effects of seedbed types and levels of poultry manure application on number of leaves and leaf area index of Celosia

Treatment		Number of leaves		Leaf area index	
		Weeks after Transplanting		Weeks after Transplanting	
		4	8	4	8
Seedbed type					
Raised		48.70	323.50[a]	0.97	6.94[a]
Flat		29.60	217.30[b]	0.54	3.70[b]
$LSD_{(0.05)}$		ns	70.270	ns	2.922
Poultry manure (kg N ha^{-1})					
	0	23.80[b]	177.50[c]	0.32[b]	3.33[b]
	30	33.60[b]	270.90[b]	0.59[b]	5.04[b]
	60	64.00[a]	389.50[a]	1.49[a]	8.21[a]
	90	35.30[b]	234.60[b]	0.56[b]	4.69[b]
$LSD_{(0.05)}$		23.990	57.720	0.744	2.172
Interaction		33.930	78.120	1.077	3.016

means with the same superscript(s) along the column are statistically similar ($P<0.05$)

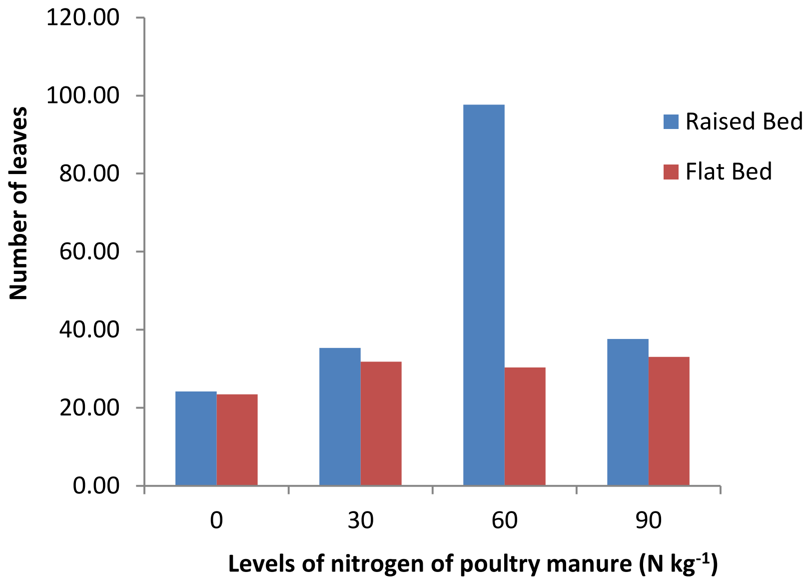

Fig. 2: Interaction of seedbed type and levels of nitrogen of poultry on number of leaves of Celosia at 4 WAT

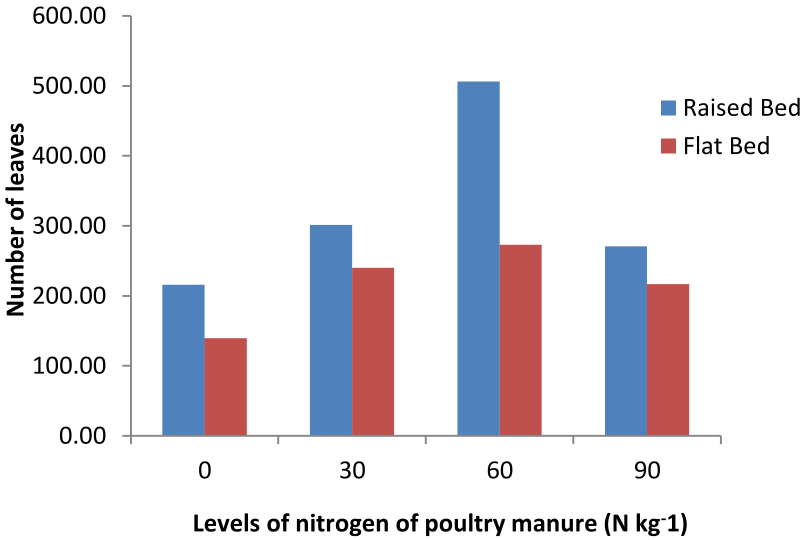

Fig. 3: Interaction of seedbed type and levelsof nitrogen of poultry manure on number of leaves of Celosia at 8 WAT

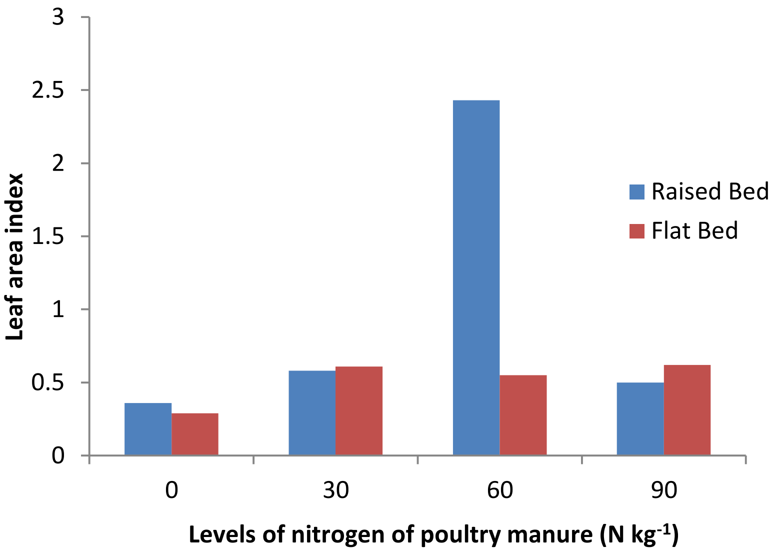

Fig. 4: interaction of seedbed type and levels of nitrogen of poultry manure on leaf area index of celosia at 4 WAT

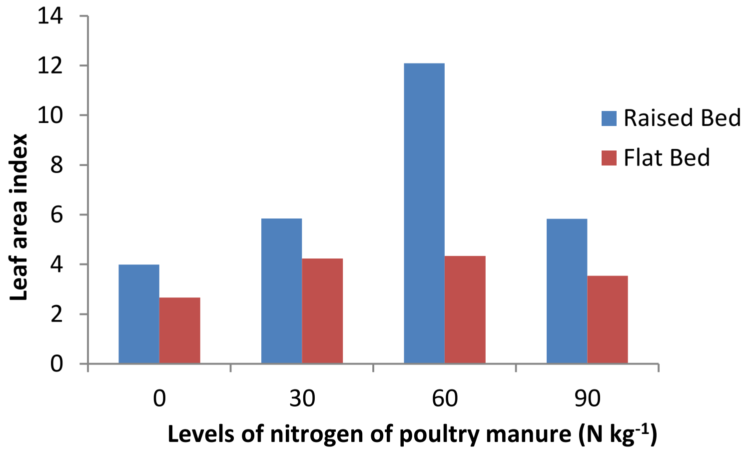

Fig. 5: interaction of seedbed type and levels of nitrogen of poultry manure on leaf area index of celosia at 8 WAT

Herbage Yield and Dry Matter

The effects of seedbed types and different levels of poultry manure on herbage yield, dry matter and nitrogen use are presented in Table 3. Plants on raised bed were significantly ($P<0.05$) higher in herbage yield than those on flatbed. Plants treated with 60 Kg N ha^{-1} of poultry manure had the highest herbage yield. The plants without fertilizer treatment and 90 Kg N ha^{-1}of poultry manure treated plants showed no significant ($P<0.05$) difference. Seedbed types had no significant ($P<0.05$) effect on dry matter. Only 60 Kg N ha^{-1} of poultry manure treated plants had higher dry matter than non-fertilized plants.

Table 3: Herbage yield, dry matter and nitrogen use efficiency of celosia as influenced by land preparation methods and poultry manure application

Treatment	Herbage yield (t ha^{-1})	Dry matter (g m^{2})
Land preparation method		
Bed	5.75^{a}	28895^{a}
Flat	3.48^{b}	15369^{b}
$LSD_{(0.05)}$	1.437	ns
Poultry manure (N kg ha^{-1})		
0	2.23^{c}	11805^{b}
30	4.96^{b}	22374^{b}
60	7.25^{a}	35190^{a}
90	4.02^{bc}	19160^{b}
$LSD_{(0.05)}$	2.416	12794.1
Interaction	ns	ns

means with the same superscript(s) along the column are statistically similar ($P<0.05$)

DISCUSSION

The soil was low in plant nutrients since most of the nutrients were below critical levels as outlined by Enwezor *et al.* (1989). This accounted for the poor performance of plants in the non-fertilized plots compared to those in the fertilized plots. The enhancement of growth and yield of Celosia of poultry manure treated plants is an evidence of utilization of adequate nutrients. Nutrients availability has been indicated to improve crop growth and yield variables. Results of the poultry manure showed high content of organic carbon, nitrogen and other nutrients which indicated that the soil could be enriched with high nutrient content that is required for a successful growth and yield of *Celosia.* This confirmed the findings of Adewale *et al.* (2001) that increase in plant growth and yield as a result of application of organic fertilizer is expected in that manure contained and released considerable amount of N for plant use during the process of mineralization. These are essential for formation of chlorophyll for photosynthesis in plants and the variation in growth variables was probably due to variation in the availability of major nutrients. This also is in consonance with the findings of Frank (2000) that nitrogen enhances physiological activities in crops thereby improving the synthesis of assimilates. The ability of poultry manure to increase the performance of *Celosia* could also be attributable to the fact that poultry manure enriched soil with nutrients, activate microbial soil activities and improvement of soil properties (Yahaya, 2008).

Herbage yield was highest at 60 Kg N ha^{-1}, this agreed with Schippers (2000) who reported that cured poultry 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}. Total dry matter was highest at 60 Kg N ha^{-1}, this finding is in line with that of Aliyu (2003) who reported significant response in dry matter yield to different types of manure rate application and source.

The plants on raised bed were observed to be significantly taller and have better stem girth than those on flat. This agreed with the report of Atkinson *et al*. (2007) who observed that tillage is crucial for crop establishment, growth and ultimately yields. There were higher number of leaves and LAI on raised bed than on flat bed. Raised seedbeds are associated with higher number of reproductive sites such as more number of branches which leads to increased number of leaves (Egli and Zhen-Wen, 1991). Increase in number of leaves is a precursor to increase in LAI. Changes in number of leaves are bound to affect the general plant growth and vigor as they are the major organs of photosynthesis of the plant (Law-Ogbomo and Remison, 2009). The herbage yield on raised bed was significantly better than on flat bed. This was probbly due to the early and better crop establishment which ultimately led to a better yield (Blake *et al*., 2003). An increased LAI enhanced photosynthetic capacity due to better utilization of solar radiation and hence increased fresh yield per hectare (Law-Ogbomo and Remison, 2008).

CONCLUSION

Poultry manure is an essential soil amendment for enhancing crop productivity. The required quantity varies with the intensity of cropping, crop combination and types of crop grown. Seed bed types also have great impact on the growth and establishment of C. *argentea*. The application level of 60 (18.24 t ha^{-1}) Kg N ha^{-1} poultry manure was significantly higher than the other treatments in all variables assessed. Raised seedbed improved Celosia productivity than flat bed. Therefore, poultry manure at the rate of 60 Kg N ha^{-1} on raised bed is optimum for the cultivation of C. *argentea* in the study area.

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