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Growth and Yield of Three Indigenous Vegetables (*Amaranthus caudatus, Celosia argentea L., Corchorus olitorius L.*) Grown in Soil Supplemented with Poultry Manure

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ABSTRACT: This study tests the hypothesis that sustainable indigenous vegetable production can be achieved through organic fertilization. To that end, three tropical indigenous vegetable (*Amaranthus caudatus, Celosia argentea, Corchorus olitorius*) croppings were subjected to poultry manure fertilization in order to appreciate the plant's response observed using some growth traits and yield variations. The experiment was carried out at the organic farm of Federal University of Agriculture, Abeokuta in Nigeria. A split plot arrangement fitted into a randomized complete block design considered 3 species x 2 treatments (10t/ha manure and control) x 3 replicates. Plants that were marked were each measured weekly from the third week after planting for their height, leaf number, leaf area, root length, fresh mass and dry mass. Yield values ranging from 2.03t/ha to 10.07t/ha depending on species and treatments. The highest yield results were from *A. caudatus* and the lowest from *C. olitorius*. The poultry manure application caused significant increases in the height of *A. caudatus* and *C. argentea* height ($p<0.05$) and compared to the controls. However, this did not affect the leaf number and area. Poultry manure induced higher yields 1.9 times of the control (5.33 t/ha) for *Amaranthus caudatus*. However, *Celosia argentea* and *Corchorus olitorius* gave decreased yields of 5.21% and 12.9% respectively. Indigenous species responded differently to the poultry manure. Further studies are needed to test the response abilities of more indigenous vegetables to organic fertilizers.

Keywords: indigenous vegetables, poultry manure, growth.

Introduction

The leaves and stems of traditional vegetables as *Amaranthus caudatus, Celosia argentea L., Corchorus olitorius L.*, commonly found in tropics particularly Nigeria, are largely consumed by Nigerians because of their richness in minerals and vitamins [10, 15,19]. Hence soils have not always been managed properly to maintain and enhance these crops production capability [7]. The technologies and approaches used to produce have exploited the natural resources, degraded the environment, and in the end, impaired the socio-economic well-being of the people. All of these have together caused the decline in soil quality, reduced soil productivity as well as crop and vegetable yields. Optimum crop growth and development are attained by timely application and accurate placement of fertilizers. However, [5] reported that in Nigeria, food production has suffered a serious setback due to a general shortage and unaffordable cost of chemical fertilizers. Much attention is therefore directed towards the research for alternatives. Fertilizers sources to boost crop residues as organic fertilizer have received much attention in recent years. The beneficial effects of organic materials as fertilizers have been studied by many researchers [1, 22]. Organic manure as poultry manure is one of the inputs needed to achieve maximum yield [8]. The present study was initiated to test the response of *Amaranthus caudatus, Celosia argentea L., Corchorus olitorius L.* to poultry manure.

Research methodology

Experimental design and agronomic practices

Field experiments were conducted during the dry season (December 2011 to February 2012) on the research plots of the working group on organic agriculture at the Federal University of Agriculture, Abeokuta (latitude 7° 09N and 7° 19N and longitude 3^0 29E and $3^0$41E). The experiment was laid out as split plot arrangement fitted into a randomized complete block design with three replications. The main plot was the application of poultry manure with two variants (no poultry manure and 10t/ha of poultry manure application) and the sub-plot was the vegetable species (*Amaranthus caudatus, Celosia argentea, Corchorus olitorius*). The experimental plot sizes were 1x2.5 m^2 with a footpath of 0.5 and 1 m between the plots and replicates, respectively. The poultry manure was mixed with the topsoil. Five (5 g) gram of the seeds of the vegetables seeds, obtained from Organic Center of the Federal University of Agriculture, Abeokuta, was mixed with 0.5 g of sandy soil and used to plant one plot in 3 lines at 25 cm intra row spacing. Fifteen days after planting, each plot was mulched with 3 kg of rice straw for weed control and soil moisture conservation. In order to determine the most profitable species, the vegetables obtained from the experiments were sold at the organic kiosk of University of Agriculture, Abeokuta.

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Data collection
Soils samples and poultry manure were collected randomly and later physico-chemical properties determined using standard procedures (Tables 1 and 2). Two plants chosen at the middle random of each plot were marked and their height, number and area of their leaves were measured each week by the beginning the third week after sowing. After the fourth week of planting, fives plants were collected each week for root length, fresh weight and dry weight determination. The dry weight was obtained by oven drying the sample at 65°C for 72 h. For the leaf area, length of non-destructive leaf only was measured. At the end of the experiment, 60 different sizes leaves of each species were randomly chosen. Each leaf was placed on graph sheet, its length and number of squares taken up was determined (Figure 1). With algorithm method, an equation for leaf area estimation according to its length were by $Y= 2{,}6109 X^{2{,}3724}$ ($R^2=0{,}921$), $Y= 5{,}0372 X^{1{,}9162}$ ($R^2=0{,}9466$), $Y= 5{,}4703 X^{2{,}0901}$ ($R^2=0{,}9466$) respectively for *Amaranthus caudatus, Celosia argentae, Corchorus olitorius.*

Statistical analysis
Growth and yield data were subjected to Analysis of Variance using one way ANOVA, of Statistix 8.1 package and the differences in means compared by Least Significant Difference at the 5% probability level.

Results and Discussion

Effect of poultry manure on growth of *Amaranthus caudatus, Celosia argentea* and *Corchorus olitorius*
Under the present study, plant growth showed significantly differences depending on vegetables species at different Week After Sowing (WAS). Poultry manure application had significantly improved *Amaranthus caudatus* and *Celosia argentea* height and root length at the beginning of 4WAS (Table1). Poultry manure also increased the root length, the fresh and dry matter. The same results were obtained by the use of farmyard manure for *Amaranthus* growth [3] or poultry manure [17] or organic root [4]. Poultry manure also significantly ($p<0.05$) increased the fresh and dry matter of *Amaranthus caudatus* (Table 3). High parameter values were obtained for *Amaranthus caudatus*. The differences among species were due to the fact that *Amaranthus* is a C_4 while *Corchorus olitorius* and *Celosia argentae* are both C_3 plant [20]. The C_4 plant is a more efficient user of light for rapid vegetative growth [9, 11, 13, 16, 20]. For *Corchorus olitorius*, the effect of poultry manure on its height was noticeable at the end of the experimentation with 5.82%. This growth was significant ($p < 0.05$) at the 5WAS and disappeared at the end of the experimentation for *Celosia argentea*. The application of poultry manure does not affect significantly ($p < 0.05$) the number and area of leaves of these vegetables (Table 2). Contrary results were observed with [18]. More rapid growth of area of leaves was realized with the use of poultry manure for *Corchorus olitorius* and *Celosia argentea.* The maximum leaf area increase (69.31%) was obtained with *Celosia argentea* produced with poultry manure.

Effect of poultry manure on *Amaranthus caudatus, Celosia argentea* and *Corchorus olitorius* yields
Only *Amaranthus caudatus* yield was affected by poultry manure (Figure 2). Its yield was 10.07 t/ha when the poultry manure was used as against 5.33 t/ha when it was not used. [12] found a significant increase of the crop yield at 12 t/ha and [17] at 30Mt/ha with particular broilers droppings. At the reverse, the case of *Celosia argentea* and *Corchorus olitorius* showed respectively a decreased yield in the magnitude of 5.21% and 12.9%. The rate of 10 t/ha is very low to permit *Corchorus* grow. In fact, *Corchorus* need more nitrogen to grow fast [2, 6, 14] found that poultry manure increased growth and yield of *Corchorus olitorus* at 30 t/ha. Globally, Poultry manure induced higher yields, 1.9 times of the controls (5.33 t/ha) for *Amaranthus caudatus.*

Table 1: Soil physico - chemicals

Parameters	Values
Sand	77.52
Silt	1.50
Clay	7.48
Organic carbon	2.71
Total nitrogen	0.25
pH	7.50
OM	4.69
P (cmol/kg)	89.60
K (cmol/kg)	0.87
Na (cmol/kg)	1.82
Mg (cmol/kg)	4.31
Ca (cmol/kg)	19.5

Table 2: Poultry manure physic chemical components

Total nitrogen %	P	K	Ca	Mg
		(cmol/kg)		
0.70	46.01	0.65	3.02	2.84

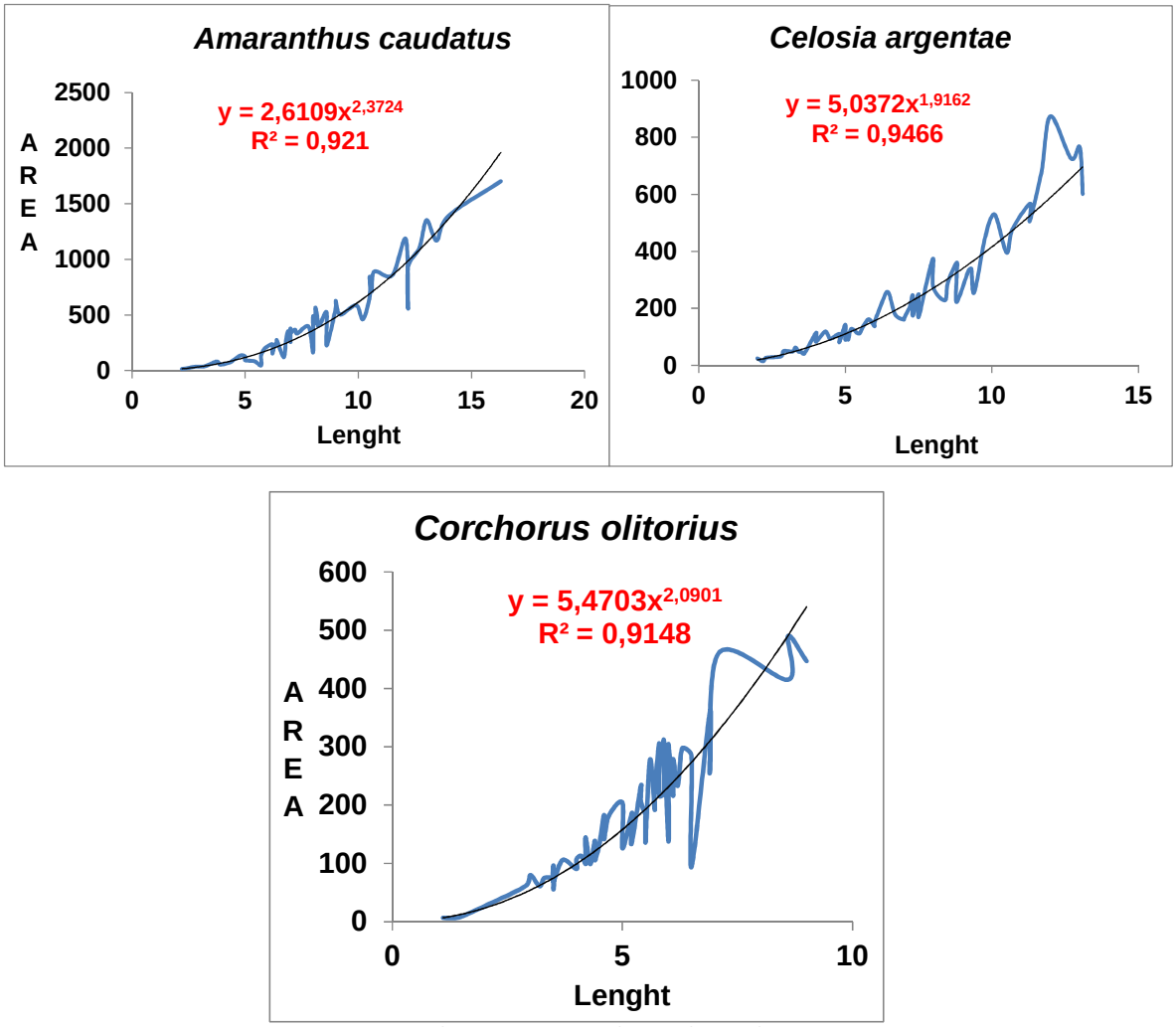

Figure 1: Equation for determination of the leaf area of the vegetables

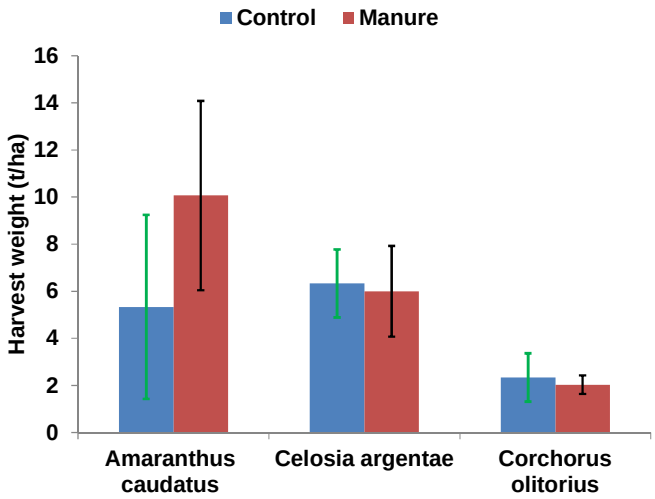

Figure 2: Vegetables yield according to the treatment

Table 3: Effect of poultry manure and vegetable species on plat height and root lenght

	Plant height (cm)				Root lenght (cm)		
Weeks After Sowing	**3**	**4**	**5**	**6**	**4**	**5**	**6**
Factor A: Manure							
Control	4.11 a	8.67 a	20.89 a	32.77 b	4.00 a	5.67 b	10.22 a
Manure	3.89 a	10.22 a	25.11 a	39.78 a	4.67 a	7.33 a	10.22 a
$LSD_{0.05}$	NS	NS	NS	*	NS	*	NS
Factor B: Species							
Amaranthus caudatus	5.00 a	16.00 a	33.00 a	42.83 a	5. 17 a	8.00 a	10.50 a
Celosia argentea L.	3.00 a	5.83 b	19.67 b	41.00 a	3.67 a	6.17 b	11.33 a
Corchorus olitorius L.	4.00 a	6.50 b	16.33 b	25.00 b	4.17 a	5.33 b	8.83 a
$LSD_{0.05}$	NS	**	**	*	NS	***	NS
A x B							
Control							
Amaranthus caudatus	5.33 a	13.67 ab	28.00 ab	37.33 ab	4.67 a	6.67 b	10.33 a
Celosia argentea L.	3.00 a	5.67 c	18.33 b	36.33 ab	3.33 a	5.67 bc	11.67 a
Corchorus olitorius L.	4.00 a	6.67 bc	16.33 b	24.67 b	3.33 a	4.67 c	8.67 a
Manure							
Amaranthus caudatus	4.67 a	18.33 a	38.00 a	48.33 a	5.67 a	9.33 a	10.67 a
Celosia argentea L.	3.00 a	6.00 bc	21.00 b	45.67 a	4.00 a	6.67 b	11.00 a
Corchorus olitorius L.	4.00 a	6.33 bc	16.33 b	25.33 b	4.33 a	6.00 bc	9.00 a
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS

**: $LSD_{0.05}$<0.05 and effect was significant at 5%; **: $LSD_{0.05}$<0.01 and effect was significant at 1%.*
****: $LSD_{0.05}$<0.001 and effect was significant at 0.1%; ns: $LSD_{0.05}$>0.05 and effect was not significant at 5%.*

Table 4: Effect of poultry manure and vegetable species on number and leaves area

Weeks After Sowing	Number of leaves				Leaves area (cm^2)			
	3	**4**	**5**	**6**	**3**	**4**	**5**	**6**
Factor A: Fertiliser								
Control	5.67 a	10.78 a	23.67 a	28.89 a	208.44 a	1720.4 a	4114.4 a	7373.7 a
Manure	5.44 a	10.33 a	21.78 a	26.00 a	267.56 a	1678.1 a	3911.9 a	9684.4 a
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS
Facteur B: Species								
Amaranthus caudatus	5.50 a	13.83 a	27.50 a	31.33 a	333.67 a	3154.3 a	5981.2 a	13122 a
Celosia argentea L.	6.17 a	9.83 b	23.33 a	29.17 a	243.17 a	1036.8 a	4355.5 ab	9050 ab
Corchorus olitorius L.	4.83 a	8.00 b	17.33 a	21.83 a	137.17 a	906.7 a	1702.8 b	3405 b
$LSD_{0.05}$	NS	***	NS	NS	NS	NS	*	*
A x B								
Control								
Amaranthus caudatus	5.67 a	15.67 a	33.00 a	38.33 a	202.00 a	3694.7 a	6208.70 a	12144 a
Celosia argentea L.	6.00 a	9.00 b	21.00 a	26.33 a	273.67 a	968.3 a	4471.00 ab	6721 abc
Corchorus olitorius L.	5.00 a	7.67 c	17.00 a	22.00 a	149.67 a	498.3 a	1663.70 b	3256 c
Manure								
Amaranthus caudatus	5.33 a	12.00 ab	22.00 a	24.33 a	465.33 a	2614.0 a	5753.70 ab	14121 a
Celosia argentea L.	6.33 a	10.67 ab	25.67 a	32.00 a	212.67 a	1105.3 a	4240.00 ab	11379 ab
Corchorus olitorius L.	4.67 a	8.33 b	17.67 a	21.67 a	124.67 a	1315.0 a	1742.00 ab	3553 bc
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS

**: $LSD_{0.05}$<0.05 and effect was significant at 5%; **: $LSD_{0.05}$<0.01 and effect was significant at 1%.*
****: $LSD_{0.05}$<0.001 and effect was significant at 0.1%; ns: $LSD_{0.05}$>0.05 and effect was not significant at 5%.*

Table 5: Effect of poultry manure and vegetable species on fresh and dry matter

Weeks After Sowing	Fresh matter (kg)			Dry matter (kg)		
	4	5	6	4	5	6
Factor A: Fertilizer						
Control	0.17 a	32.44 b	81.44 a	0.22 a	2.56 b	8.67 a
Manure	2.17 a	47.22 a	112.44 a	0.44 a	5.89 a	11.44 a
$LSD_{0.05}$	NS	*	NS	NS	*	NS
Factor B: Species						
Amaranthus caudatus	2.25 a	75.83 a	138.0 a	0.83 a	8.67 a	10.50 a
Celosia argentea	1.08 a	33.33 b	120.3 a	0.17 b	2.83 b	10.17 ab
Corchorus olitorius	0.17 a	10.33 b	32.5 b	0.00 b	1.17 b	4.50 b
$LSD_{0.05}$	NS	**	*	**	***	*
A x B						
Control						
Amaranthus caudatus	0.17 a	54.67 b	113.67 abc	0.33 ab	4.00 b	13.00 ab
Celosia argentea L.	0.67 a	32.33 bc	102.67 ab	0.33 ab	2.67 b	9.33 ab
Corchorus olitorius L.	0.33 a	10.33 c	28.00 c	0.00 b	1.00 b	3.67 b
Manure						
Amaranthus caudatus	4.33 a	97.00 a	162.33 a	1.33 a	13.33 a	18.00 a
Celosia argentea L.	1.50 a	34.33 bc	138.00 ab	0.00 b	3.00 b	11.00 ab
Corchorus olitorius L.	0.67a	10.33 bc	37.00 bc	0.00 b	1.33 b	5.33 b
$LSD_{0.05}$	NS	NS	NS	*	**	NS

**: LSD $_{0.05}$<0.05 and effect was significant at 5%; **: LSD $_{0.05}$<0.01 and effect was significant at 1%.*
****: LSD $_{0.05}$<0.001 and effect was significant at 0.1%; ns: LSD $_{0.05}$>0.05 and effect was not significant at 5%.*

Conclusion

The pronounced effects of poultry manure application on the growth, development and yield of *Amaranthus caudus, Celosia argentea and Corchorus olitorius* were visible in the study as shown in the results. From the study, it was evident that poultry manure use was suitable for the good production of the vegetable both as food crop and also for economic considerations. The effect of poultry manure on vegetables depends on the species grown and the rate of fertilizer application. Poultry manure can be used to help in reducing fertilizers costs in vegetables production with a good profit. Hence, further research is recommended to identify the best rate for optimum yield for all these vegetables. Same research must be done with other crops.

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