P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of Agriculture and Biosciences

www.ijagbio.com; editor@ijagbio.com

Research Article

Response of Eight Accessions of Amaranthus *(Amarantus cruentus L.)* to Poultry Manure Application under Field Conditions

*1Agboola K and 2Aina OA

Department of Soil and Environmental Management, Kogi State University, Anyigba, Nigeria

***Corresponding author:** kay.agboola.ka@gmail.com

Article History: Received: March 02, 2015 Revised: June 04, 2015 Accepted: August 04, 2015

ABSTRACT

Amaranthus is an important leaf and seed vegetable crop in Nigeria and in the tropics. Field experiment was conducted in the research field of the Department of Agronomy, University of Ibadan, between September and November 2011 to determine the effect of poultry manure application at 2.5 tha $^{-1}$ on the growth and yield of seven accessions of Amaranthus, and also on microbial dynamics. One accession of Celosia argentum was also added as a check crop. The eight accessions of amaranthus were subjected to two levels of fertilizer treatment: 0 and 2.5 tha $^{-1}$ poultry manure application. These were assigned randomly into three replicates and fitted into factorial experiment in a split plot design. Data collected on the growth and yield parameters were analyzed using ANOVA. There were significant differences between means of the various accessions both at 2 and 6 week after transplanting for plant height, however there were no significant differences between means gotten for number of leaves and stem girth both at 2 and 6 weeks after transplanting ($P \geq 0.05$). The crown and total biomass production also differ significantly at 8 weeks after transplanting while there were no significant differences at 10 weeks after transplanting. The combined effect of fertilizer and accession was only significant for crown weight at 8 weeks after transplanting while other parameters were not significant. The population of both bacteria and fungi were also increased through the application of poultry manure. Accessions 2 and 5 responded optimally to poultry manure application at the rate assayed. Therefore, Accessions 2 and 5 are adjudged best and are more reliable in terms of production in South Western Nigeria.

Key words: Amaranthus accessions, poultry manure, microbes, soil fertility, yield

INTRODUCTION

Amaranthus cruentus (Linnaeus) is a popular leafy vegetable cultivated in Nigeria and other West African countries. It originated from South America (Saunder and Beciker, 1984) and serves as a good source of vegetable as well as an effective alternative to drug therapy in people with hypertension and cardiovascular disease (Martiorosyan and Miroshnichen, 2007). FAO (2007), reported that the yield per hectare of this crop is low (about 7.60 tha^{-1}) when compared to that of United States (77.27 tha^{-1}) and world average (14.27 tha^{-1}). For commercial production, optimum performance of the crop must be desirable through changes in cultural practices (Sterrett and Savage, 1989). Such cultural practices will include higher planting density and application of organic manures and fertilizer for improving growth and yield of crop.

Application of inorganic fertilizer to improve soil productivity ensures quick release of nutrients to crops but, this is not without its own problems. According to IFDC (2005), improper chemical fertilizer application has ruined tropical soils through its abuse. Agriculture is now seen in a new perspective based on problems of chemical fertilizer. Modern agriculture is seen, not just as a technical problem for human beings to solve, but as a process which has a long term effect on the environment. This effect in the long term must be beneficial if agriculture is to be sustainable. The use of organic fertilizers and microbial inoculants is an important part of modern day agriculture; to make it sustainable and to also provide a healthy ecosystem.

Egharevba and Ogbe (2002), Ibeawuchi *et al*. (2006) and Mbonu and Afrifalo (2006), reported that many crop species respond well to the application of organic manure and it can sustain yield under continuous cropping

Cite This Article as: Agboola K and Aina OA, 2015. Response of eight accessions of amaranthus *(Amarantus cruentus L.)* to poultry manure application under field conditions. Inter J Agri Biosci, 4(4): 139-144. www.ijagbio.com

through the high potential of gradual nutrient release to the soil that can help to improve the fertility of a degraded soil. Poultry droppings could be very useful in practicing organic agriculture. Livestock Census (2003) reported that the increasing population of poultry leaves large amount of poultry refuse every year. Ewulo (2005) observed that poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants. FAO (2000) also reported that nitrogen is a major nutrient required for plant growth. Omolayo *et al.* (2011) observed that application of poultry manure improved vegetative growth and yield of Amaranthus.

Scanty information exists on the effect on poultry manure application on the seed and leaf production of several different accessions of amaranthus. It is important to know if different accessions up to eight, will respond uniformly or differently to poultry manure application. Therefore, this work was aimed at determining the effect of poultry manure on the growth and yield of different accessions of *Amaranthus cruentus, on* nutrient uptake of the different accessions and on soil microbe dynamics.

MATERIALS AND METHODS

Description of the experimental site

The experiment, a field trial was conducted in the research field at Parry road, University of Ibadan, Oyo State, Nigeria. Ibadan is located in the northern limit of lowland rainforest zone of western Nigeria with bimodal distribution of annual rainfall of about 1289.2mm The research field is located on latitude 7^0 27'N and longitude 3^0 53'E. The experiment was conducted between September and November, 2011. Rainwater was supplemented with irrigation water (through watering can) when there is no rainfall.

Method

The experiment was a 2 x 8 factorial with a split plot design. The experimental plot was divided into three (3) sub-plots with a spacing of 1 meter in between the plots. Each of the sub-plots was further divided into two. One part of each of the sub-plot received poultry manure treatment while the other part did not. The manure treatment was administered in the main plot while the accession treatment was administered in the sub-plot. Seedlings were first raised in trays before they were transplanted to the field. Poultry Manure (PM) was collected from the deep litter of the Teaching and Research Farm of the University. The field measuring 20m x 15m was cleared manually using hoe and cutlass while 15.5m x 12m area of the land was used for the experiment. Raised bed was constructed and the cured poultry manure was incorporated at the rate of 2.5 tha^{-1} to the seed bed a day after it was prepared. Incubation time of two weeks was allowed before transplanting the seedlings at a spacing of 30cm x 70cm (within and between rows). Seedlings were supplied to missing stands a week after transplanting (WAT). Pre-cropping soil sample representative of the field was collected for laboratory analysis before application of poultry manure. The factorial experiment comprises two (2) levels of poultry manure application – with and without on seven different accessions of *Amaranthus cruentus* and one accession of *Celosia argentum* used as check. The rate of application of the poultry manure (PM) is 2.5 tha^{-1}. The parameters measured were plant height, stem diameter, number of leaves, fresh and dry weight of biomass, crown weight.

Accessions

The following accessions (from NACGRAB) were sown in seed trays.

ACCESSION 1 = NG/AO/11/08/042
ACCESSION 2 = NG/SA/DEC/07/0423
ACCESSION 3 = NG/TO/AUG/09/007
ACCESSION 4 = NHGB/09/108
ACCESSION 5 = NGB/06/105
ACCESSION 6 (Celosia) = NG/MR/MAY/09/014
ACCESSION 7 = NG/AO/11/08/040
ACCESSION 8 = NG/OE/MAR/09/011

The seedlings were first raised in the nursery with routine management like watering and weeding when necessary for two weeks after which they were transplanted to the field.

Data collection

Measurement of growth parameters was carried out at two and six weeks after transplanting (WAT) while yield parameters were taken at eight and 10 weeks after transplanting.

The growth parameters monitored were:

- Height (cm) - the height of the plants growing in the field were taken with a measuring tape
- Number of leaves – leaves on each plant were counted manually
- Stem diameter - this was taken at 3cm above the soil surface with the use of a vernier caliper.

Harvesting

The experiment was terminated in 10 weeks after transplanting. The plants were uprooted and soil sample from the root were collected for microbial count. Then the plants were cut at the base with secateurs to separate the roots from the stem and subsequently the leaves were separated from the shoot. Shoot weight, leaf weight and root weight were taken before and after oven drying at 70^0C. Fresh crown weight was also taken while dry weight was taken after sun-drying.

Soil analysis

Soil samples from the top soil (0 – 15 cm) were collected from the experimental field. The soils were air-dried for five days under ambient temperature and sieved through 2mm sieve. Thereafter, they were analyzed for their various physical and chemical properties including total nitrogen, pH, organic carbon, available phosphorus exchangeable Ca, K and Mg. Procedures followed for particle size analysis was by hydrometer method with sodium hexametaphosphate (calgon) as the dispersant as described by Bouyoucus (1951); pH was determined in a 1:1 of soil and water as described by IITA (1976). Total nitrogen and organic carbon were determined by the kjeldahl (Bremer, 1965) Walkey and Black procedures (Nelson and Sommers, 1982) procedures respectively. Available phosphorus was analyzed by the Bray P-1 method (Bray and Kurtz, 1945). Potassium was determined by flame spectrophotometer while magnesium and calcium were determined by atomic absorption.

Microbial analysis

Ten grammes (10g) of 2-mm sieved soil samples were added to 90ml of sterile distilled water and shaken vigorously with a mechanical shaker for 30 minutes. Thereafter, Serial dilutions were prepared up to 10^7 by repeated transfer of 1ml of each sample using sterile pipette into 9ml of sterilized distilled water into test tubes. Plates of molten nutrient agar (NA) and Potato dextrose agar (PDA) were prepared for bacteria and fungi count respectively. Total viable counts of culturable aerobic heterotrophic bacteria were obtained by surface plating 1ml of the serial dilution on to sterile nutrient agar while fungi counts were obtained by surface plating 1ml of the serial dilution on to potato dextrose agar (PDA). The medium was incubated at room temperature (28^0C ± 2^0C) for 24 hours and 48 hours for bacteria and fungi respectively before counts were made. Colonies which developed on the plates were counted and the counts were multiplied by the dilution factor and recorded as colony forming units per gram ($CFUg^{-1}$) of soil.

Model estimating response of accessions to poultry manure application

This mathematical model was used to estimate the percentage response of the various accession to the poultry manure applied.

$$\frac{An\,(PM)\,t_k - An(WPM)t_k}{An\,(WPM)t_k} \times 100$$

Where:
An (PM) = n^{th} accession with poultry manure
An (WPM) = n^{th} accession without poultry manure
t_k = specific time

Data analysis

All data were analyzed using Analysis of Variance (ANOVA) with GENSTAT. Means were separated using Least Significant Difference (LSD).

RESULTS

The pre-cropping soil physical and chemical analysis showed that the soil has a pH of 5.8 (Table 1) which is slightly acidic. The soil had a low Nitrogen (N) content suitable to evaluate plant response to fertilizer applied. The soil was sandy in texture.

Table 2 showed that there was a significant difference between the plant height of accessions both at second and sixth week after transplanting (WAT). The plant / shoot height for accessions with poultry manure showed that Accession 5 (A5) has the highest height at second week after transplanting (WAT) and was significantly higher than Accession 3 (A3) which had the lowest mean plant height at second week after transplanting (WAT). At six weeks after transplanting, result showed that the highest height was obtained in Accession 2 (A2) followed by Accession 5 (A5) while the lowest height was obtained in Accession 3 (A3). The number of leaves for accessions with and without poultry manure application showed that there was no significant difference both at two and six weeks after transplanting. Stem girth at second and sixth weeks after transplanting followed a similar trend. The interaction between poultry manure and accessions was also not significant for the three parameters.

At maturity (Table 3), it was observed that Accession 2 (A2) responded best to poultry manure application at the rate assayed followed by Accession 1 (A1) and Accession 5 (A5). The least crown weight was recorded for Accession 4 (A4). The crown weight for the second harvesting done at 10 weeks after transplanting showed that there was no significant difference between the means of the accessions under the treatments with and without poultry manure. However, at eight weeks after transplanting, Accession 2 (A2) can be considered best for total biomass production because it gave the highest mean weight while the lowest mean weight for total biomass was obtained in both Accessions 4 (A4) and 7 (A7) aside accession 6 (A6) which is Celosia. At the tenth week after transplanting, there was no significant difference between the means of the accessions for total biomass production at both treatment levels. This is similar for crown weight. The interaction between poultry manure and accessions was not significant for crown weight and total biomass production at 10 weeks after transplanting.

Table 4 showed that there was no significant difference in the means obtained for nutrient content of calcium, potassium, magnesium and nitrogen of the different accessions except for phosphorus. Phosphorus was the only nutrient that has significant difference. In the treatment with poultry manure, Accession 4 (A4) had the highest phosphorus content while Accession 8 had the lowest. Under the treatment without poultry manure application, Accession 5 (A5) had the highest. Although, fertilizer applied did not affect the values obtained for calcium significantly, because the LSD value was not significant for poultry manure; using the LSD value for the accessions, result showed that the means vary significantly.

In Figure 1 the total viable count of bacteria obtained from the soil samples of the various accessions that received poultry manure treatment ranged from 4.73 x 10^5 to 1.56 x 10^5 CFU per gram of soil while the soils of the accessions without poultry manure ranged 4.1 x 10^5 to 1.96 x 10^5 CFU per gram of soil. Of all eight samples examined, the highest bacterial count of 4.73 x 10^5 CFU per gram of soil was recorded for Accession 8 under the treatment with poultry manure while Accession 5 had a count of 1.56 x 10^5 CFU per gram of soil; this represents the least. Accession 2 gave the second highest mean of 4.1 x 10^5 CFU per gram of soil. The highest count of bacteria was obtained in the soil treated with poultry manure.

In Figure 2 total viable count of fungi ranged from 0.33 x 10^5 to 0.16 x 10^5 CFU per gram of soil; for samples treated with poultry manure while samples treated without poultry manure ranged from 0.3 x 10^5 to 0.1 x 10^5 CFU per gram of soil (Fig 4.2). In soils treated with poultry manure the highest total viable count of fungi was obtained in the soil of Accessions 7 and 8 while the lowest was recorded in the soils of Accessions 2 and 5.

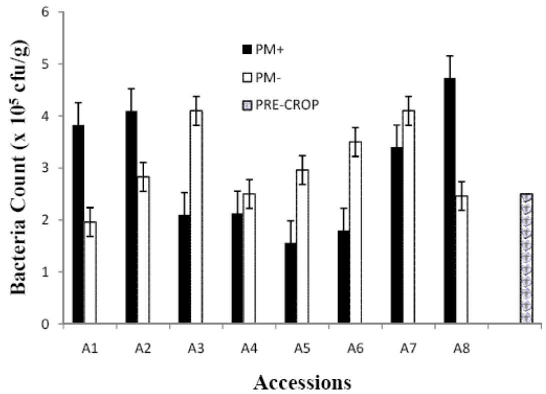

Fig. 1: Total viable bacteria counts obtained from the soils of the accessions; A_{1-8} = accessions

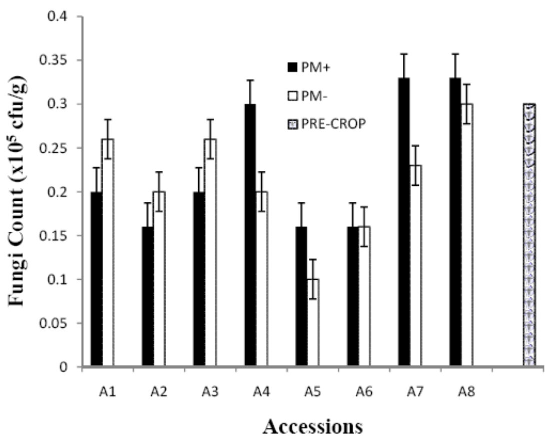

Fig. 2: Total viable fungi counts obtained from the soils of the accessions; A_{1-8} = accessions

DISCUSSION

The influence of poultry manure on the growth and yield, nutrient uptake of different accessions of *Amaranthus cruentus* and on the microbial population in the soil was assayed in this study. At six weeks after transplanting (6WAT), accession 2 was most effective to achieve high plant height of the test crop when poultry manure was applied at 2.5tha^{-1}; this is similar to the findings of Bala and Manga (2009). For a farmer who wants more leaves, Accessions 1 and 2 should be considered because they had the highest number of leaves at six weeks after transplanting. This indicates that Accessions 1 and 2 responded best to poultry manure application in terms of leaf production. Thus, they should be most desirable for leaf production. This agrees with the work of Odiete *et al.* (1999), who reported an increase in plant height and number of leaves of amaranth when treated with organic manure. Considering crown and total biomass production, 2.5 tha^{-1} application of poultry manure positively influenced crown and total biomass production with Accession 2 being the best.

Nutrient content of the various accessions tested showed that poultry manure applications did not affect the uptake of the nutrients tested (i.e. calcium, potassium, magnesium, nitrogen) except phosphorus. It could be that, at the rate of 2.5 tha^{-1} application of poultry manure is not enough to influence or significantly increase the nitrogen, calcium, potassium and magnesium content of the accessions used. Probably, higher rates of 5.0 tha^{-1} and 10.0 tha^{-1} could g ive a different result. Nevertheless, 2.5

Table 1: Pre-cropping physical and chemical soil characteristics of the experimental plot

Soil properties	Value
pH (H_2O)	5.8
N (g kg^{-1})	0.55
P (mg kg^{-1})	13
K (cmol / kg)	0.11
Ca (cmol / kg)	27.2
Mg (cmol / kg)	2.64
Org C (g kg^{-1})	5.32
Sand (g kg^{-1})	828.0
Silt (g kg^{-1})	100.0
Clay (g kg^{-1})	72.0
Textural class (USDA)	Loamy sand

Table 2: Effect of poultry manure on growth of the accessions

Treatments accessions	PM application	Plant height (cm) WAT		No of leaves WAT		Stem girth (mm) WAT	
		2	6	2	6	2	6
1	+	11.6	84.6	13.67	108.7	0.58	1.40
2	+	14.3	100.2	13.67	99.9	0.65	1.65
3	+	9.36	53.1	11.58	86.5	0.53	1.32
4	+	15. 7	65.1	13.42	80.2	0.65	1.47
5	+	19.1	93.7	15.17	43.1	0.78	1.61
6	+	9.69	99.2	17.08	159.2	0.56	1.18
7	+	15.6	75.9	12.75	92.2	0.62	1.43
8	+	16.6	83.1	13.33	101.4	0.74	1.43
1	-	10.0	78.3	12.92	79.9	0.61	1.41
2	-	11.1	90.3	12.58	85.2	0.71	1.67
3	-	7.62	56.1	9.67	94.7	0.49	1.45
4	-	15.4	55.7	11.58	64.4	0.61	1.54
5	-	13.0	54.8	12.58	35.6	0.64	1.21
6	-	10.4	92.0	14.00	163.1	0.51	1.17
7	-	12.2	53.1	11.50	69.4	0.65	1.42
8	-	14.6	69.9	12.08	92.9	0.64	1.39
LSD(5%level)))	PM	1.77	13.06	NS	NS	NS	NS
	A	3.02	20.13	2.07	44.74	0.133	NS
	PM x A	NS	NS	NS	NS	NS	NS

PM =Poultry manure, A= accession, PM *x* A= poultry manure *x* accessions, NS = not significant.

Table 3: Effect of poultry manure on dry matter yield of the accessions

Treatment	PM application	Crown weight (g) WAT		Total biomass (g) WAT	
Accessions		8	10	8	10
1	+	4.00	17.3	21.3	38.6
2	+	6.27	17.6	43.4	54.4
3	+	0.86	6.96	23.4	44.0
4	+	0.16	8.54	18.0	51.6
5	+	2.30	16.9	27.5	56.4
6	+	1.20	6.93	8.7	32.5
7	+	1.20	14.8	18.0	42.2
8	+	2.23	20.2	23.7	49.3
1	-	2.80	10.2	19.1	21.7
2	-	0.29	19.7	13.7	62.1
3	-	0.02	6.47	12.7	27.5
4	-	0.38	5.56	14.6	35.7
5	-	1.03	7.58	9.9	24.8
6	-	0.93	5.44	6.8	15.3
7	-	1.10	5.74	21.6	20.6
8	-	3.80	8.39	27.6	32.9
LSD(5% level)	PM	0.78	NS	3.88	NS
	A	1.92	5.41	11.4	18.7
	PM *x* A	2.56	NS	NS	NS

PM =Poultry manure, A= accession, PM *x* A= poultry manure *x* accessions, NS = not significant

Table 4: Effect of poultry manure application on nutrient content of the accessions

Treatment	PM	Ca	K	Mg	N	P (%)
Accessions	application	(%)	(%)	(%)	(%)	
1	+	1.51	2.31	1.05	0.24	0.0026
2	+	1.23	2.83	0.94	0.24	0.0026
3	+	1.34	2.24	0.84	0.35	0.0026
4	+	0.91	2.37	1.07	0.29	0.0030
5	+	0.89	2.13	0.83	0.19	0.0028
6	+	0.96	2.94	0.97	0.27	0.0027
7	+	1.30	2.19	0.77	0.26	0.0023
8	+	1.00	1.88	0.84	0.26	0.0021
1	-	1.42	2.57	1.14	0.28	0.0020
2	-	1.69	3.31	1.05	0.22	0.0019
3	-	1.77	2.51	1.13	0.30	0.0019
4	-	1.28	2.28	1.10	0.33	0.0018
5	-	1.47	2.21	0.86	0.31	0.0020
6	-	0.89	2.26	0.77	0.29	0.0017
7	-	1.47	2.17	0.90	0.30	0.0022
8	-	0.81	2.25	0.81	0.21	0.0018
LSD(5% level)	PM	NS	NS	NS	NS	0.00049
	A	0.47	NS	NS	NS	NS
	PM *x* A	NS	NS	NS	NS	NS

PM =Poultry manure, A= accession, PM *x* A= poultry manure *x* accessions, NS = not significant.

tha^{-1} poultry manure application influenced the uptake of phosphorus in the various accessions used.

Poultry manure application increased total viable count of bacteria in the soils of the different accessions used. The total viable count of bacteria in the soil samples were higher in most of the soils of the various accessions than those obtained in the pre-crop soil sample. Increase in the amount of total viable count of bacteria, may be as a result of the presence of organic matter provided by the organic material (i.e poultry manure) which encourages microbial activity (Nestar *et al*., 1998; Pimental *et al*., 2005). Poultry manure at the rate assayed also increases the amount of total viable count of fungi. Total viable count of fungi was higher in the soil treated with poultry manure than that without poultry manure and the pre-crop sample. This is similar to the findings of Porter (2003).

The responses of the accessions to poultry manure application were represented in percentage (Appendix 1-3). Appendix 1 showed that at two weeks after transplanting (WAT) accessions 5 and 2 had the highest growth percentage while accession 4 had the least. All the amaranth accessions responded positively to poultry manure application. However, Celosia accession (check crop) responded negatively to poultry manure application. At six WAT, accession 3 responded negatively to poultry manure application while accession 5 had the highest height. Number of leaves was higher in accession 5 at two WAT while accession 1 had the least. None of the accessions responded negatively to poultry manure application. At six WAT, accession 3 and 6 responded negatively to poultry manure, while accession 1 and 7 had the highest number of leaves. Three accessions (1, 2, 7), negatively responded to poultry manure application in terms of stem girth at two WAT. Accession 5 had the

Appendix 1: Growth response of amaranthus accessions to poultry manure application according to the model estimating response

Accessions	PH (%) 2 WAT	PH (%) 6 WAT	NOL (%) 2 WAT	NOL (%) 6 WAT	SG (%) 2 WAT	SG (%) 6 WAT
1	16	8.05	5.80	36.05	- 4.45	-0.71
2	28.8	11.0	8.82	17.25	- 8.49	- 1.20
3	22.8	- 5.35	19.8	- 8.66	8.78	- 9.17
4	1.95	16.9	15.89	24.5	6.07	- 4.55
5	46.9	71.0	20.59	21.07	21.31	33.64
6	-6.8	7.83	22.0	-2.39	9.75	1.11
7	27.9	42.9	10.87	32.85	-5.08	0.92
8	13.7	18.9	10.35	9.15	15.63	2.88

PH= plant height, NOL= number of leaves, SG= stem girth, WAT = weeks after transplanting

Appendix 2: Yield component response of amaranthus accessions to poultry manure application

Accessions	Crown weight (%) 8 WAT	Crown weight (%) 10 WAT	Total biomass (%) 8 WAT	Total biomass (%) 10 WAT
1	42.86	69.40	11.52	77.88
2	2,062.07	-10.47	216.79	-12.40
3	4,200	7.57	84.25	60
4	-57.89	53.59	23.29	44.54
5	123.30	1.23	177.77	127.42
6	29.03	27.39	27.94	112.42
7	9.09	159.23	-16.66	104.85
8	-41.32	140.16	-14.13	49.85

WAT = weeks after transplanting

Appendix 3: Plant nutrient content of the accessions as influenced by poultry manure application according to the model estimating response

Accessions	P (%)	Ca (%)	K (%)	Mg (%)	N (%)
1	30	6.13	-10.36	-7.63	-14.13
2	36.84	-27.08	-14.46	-10.42	12.5
3	36.84	-24.59	-10.88	-25.66	16.66
4	66.6	-28.69	3.94	-2.09	--9.17
5	40	-39.58	-3.48	-3.50	-38.11
6	58.82	7.17	30.26	26.86	-6.83
7	4.54	-11.36	1.15	-14.73	-14.19
8	16.66	23.12	-16.42	3.32	24.40

largest stem girth followed by accession 8. At six WAT, accessions 1, 2, 3, and 4 all responded negatively to poultry manure while other accessions responded positively to poultry manure application.

Crown yield (Appendix 2) showed that accessions 2, 3 and 5 produced bigger crown while only accessions 4 and 8 responded negatively to poultry manure at eight WAT. Accessions 2, 3 and 5 had the highest for total biomass production while accession 7 and 8 responded negatively to poultry manure application at eight WAT.

Phosphorus uptake (Appendix 3) showed that all accessions responded positively with accession 4 having the highest followed by accessions 5, 2 and 3. Accessions responded negatively to nitrogen uptake except for accessions 2, 3 and 8. Potassium uptake showed that most of the accessions responded negatively as well with the exception of accession 4 and 8.

Conclusion and Recommendations

The observations in the present investigation showed that accessions 2 and 5 were significantly higher and appear to be more reliable in terms of plant height, leaf production, crown weight, total biomass production and phosphorus uptake. Therefore, accessions 2 and 5 responded optimally to poultry manure application at the rate assayed.

It is therefore recommended that further studies be conducted on different application rates of poultry manure on the accessions used in this study.

REFERENCES

Bala MG and AA Manga, 2009. Evaluating the response of Cabbage (*Brassica olereceae* var. capitata L.) to different types of organic manure. Savannah J Agric, 4: 40-44.

Egharevba RKA and FM Ogbe, 2002. The effects of different levels of organic and mineral fertilizers on the yield performance of two Amaranthus (*A. cruentus*) cultivars. The Plant Scientists, 3: 62-72.

Ewulo BS, 2005. Effect of poultry and cattle manure on sandy clay loam soil. J Anim Vet Sci, 4: 839-841.

FAO, 2000. Fertilizer and their use. FAO Rome Italy.

FAO. 2007. Food and Agriculture Organisation. 2007 FAOSTAT. FAO Statistic Division. Rome.

Ibeawuchi II, EU Onweremadu and NN Oti, 2006. Effects of poultry manure on green (*Amaranthus* cruentus) and waterleaf (*Talinum triangulare*) on degraded ultisol of Owerri, Southeastern Nigeria. J Anim Vet Adv, 5: 53-56.

IFDC, 2005. Input subsidies and agricultural development issues and for developing and transitional economics. IFDC Paper Series IFDC B, IDC, Musde Shoals, USA, pp: 27.

Livestock Census, 2003. Department of animal husbandry, dairying and fisheries. Ministry of Agriculture, Government of India. http://dahd/nic.in/census.htm.

Martirosyan D and LA Miroshnichenko, 2007. Amaranth oil for cardiovascular disease. Functional food centre. Dallas.

Mbonu O A and SA Arifalo. 2006. Growth and yield of Amaranthus cruentus L. as directed by organic amendments. Port Harcourt, Nigeria. Niger J Hortic Sci, 11: 44-46.

Nester EW, NN Pearsall and DG Adreson, 1998. A human perspective. 2nd ed. Mcgraw Hill Companies, Inc. USA. Microbiology. And Biochemistry. (Academic Press: San Diego, CA) pp: 2-4.

Odiete I, S O Oseniyi, O M Akinola and AA Achor, 1999. Effect of goat dung manure on soil chemical properties and yield components of Okra, Amaranthus and maize. Pages: 174- 178. In Babalola, O Omoti, UAE (eds) Proceedings of 25th Annual Conference of soil science society of Nigeria held at Benin from 21st to 25th November, 1999.

Omolayo FO, OJ Ayodele, AS Fasina and K Godonu, 2011. Effects of poultry manure from different sources on the growth and marketable yield of leaf amaranth (*Amaranth cruentus*) L. Inter Res J Agric Sci Soil Sci, 1: 029-034.

Pimental D, P Hepperly, J Hanson, D Douds and R Siedel, 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. Bioscience, 7: 573-582.

Porter P, 2003. Organic practices slightly affect corn and soybean yields: The use of microbial and organic fertilizers in crop production. Madison, WI, US, pp: 9.

Saunder RA and R Beciker, 1984. Amaranthus. A potential food and feed resource. In: "Advanced Science Technology" cereal chemist. St Paul, MN, p: 352.

Sterrett SB and GP Savage, 1989. Culinary herbs as alternative crops. The vegetable Growers News, 42: 3-4.