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EFFECTS OF PLANTING METHOD AND DIFFERENT NUTRIENT SOURCES ON THE YIELD, GROWTH AND QUALITY OF AMARANTHUS SPECIES IN NORTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT
Agronomic practices which includes planting methods and nutrition's are among the major constrains to the performance of crops in the tropics. Amaranthus cruentus is an important leafy vegetable that requires proper agronomic practices to enhance its growth, yield and quality. This research was conducted to determine the effect of nutrient sources and planting methods on the growth, yield and quality of Amaranthus cruentus. The study was conducted at University of Abuja (Latitudes 9°20" and Longitudes 7°28"), between September-January 2022. A Randomized Complete Block Design (RCBD) was used to lay-out the experiment, replicated three (3) times. Two (2) methods of planting (transplanting and direct sowing) and five levels of nutrient sources (poultry manure, cow dung, goat manure, NPK and control) constitute the treatments. Data were collected on plant height (cm), number of leaves, number of branches, stem girth (cm), leaf area (cm^2), harvest index, yield per plot (kg) and cumulative yield (tons/ha). Analysis of Variance (ANOVA) indicated that planting methods had no significant differences ($P<0.05$) on the growth and yield parameters of A. cruentus. The study also showed that poultry manure and NPK supported significantly taller plant, higher number of leaves, higher number of branches, wider shoot girth, as well as higher yield per plot and cumulative yield at ($P< 0.05$), at Abuja, compared to other sources of nutrients.

KEY WORDS
Planting methods, different nutrient sources, amaranthus species, Northern Guinea savanna, Nigeria.

Amaranthus belongs to the family Amaranthaceae and is commonly known as African spinach, bush greens, and spinach, among other names. There are two varieties of amaranths: grain amaranth and vegetable amaranth (Vorster, *et al*., 2008). Amaranths make excellent vegetables because they grow quickly and can provide 40 t/ha of fresh leaves or 4.5 t/ha of dry matter after four weeks of seeding. According to Chang and Palada (2003), amaranths respond well to fertilizers, especially organic manure. They are less susceptible to soil-borne illnesses when compared to other vegetables, are moderately easy to grow, reasonable for crop rotation with some other vegetable harvests, and compensate for the high mineral take-up that is inborn, to a high return and a decent dietary sythesis. You can consume amaranth leaves, stems, or complete plants raw or cooked like spinach or greens (Gupta *et al*., 2005). Animal manures have been used successfully to cultivate plants for ages (Eghball *et al*., 2002). Poultry manure has long been thought of as arguably the most desirable of these natural fertilizers due to its high nitrogen concentration, which ranges from 0.9% to 1.5%. (Eliot, 2005). Manures also supply additional nutrients and organic matter to the soil (Dauda *et al*., 2008). The permanence of organic matter in soil is influenced by environmental elements such as temperature, drainage, rainfall, and others (Eigenberg *et al*., 2002). According to Arisha and Bradisi (1999), organic matter improves the physical characteristics of soil as well as moisture and nutrient retention. Without using manure, agriculture cannot be sustainable. Poultry manure is typically produced in areas where it is necessary to fertilize pastures and crops. In several places, Amanthus species are eaten as food. Amaranth is a low-cost, high-protein, and high-fiber food that contributes to a healthy vitamin and mineral consumption (IPGRI, 2003; Shukla *et al*., 2005). Rahman *et al*. (1990)

discovered, for instance, that *Amaranthus tricolor* had 629 mg/100 g of ascorbic acid, *Amaranthus gangeticus* contained 26.8 mg/100 g of total iron, and *Amaranthus gangeticus* contained 8 mg/100 g of -carotene. Along with being a large source of vitamins and minerals, amaranth also aids in the consumption of other phytochemicals such phenolic compounds (Ricardo, 1993).

Macronutrients are the most scarce nutrients in our soils because of continual cropping (Savant and Stangel, 1990). Excessive usage of inorganic fertilizers degrades the soil's physical qualities (Ogungbile and Olukosi, 1990). According to Aisha *et al*. (2007), certain inorganic fertilizers are volatile and others drain to lower horizons where roots cannot access them. Though organic manure can be utilized to create high-quality and quantitative yields of crops, including amaranth, rapid intervention is required due to the low quality and quantity of amaranth as well as its slow growth and development rate (Okalebo *et al*., 2002). Because it makes soil clump, producing aggregate, and enhancing soil structure, continuous application of organic fertilizer has an impact on soil structure. Naeem *et al*. (2006) claim that organic manures can therefore replace mineral fertilizers for improving soil structure (Dauda *et al*., 2008).

This study's primary goal is to evaluate amaranth growth, yield, and nutritional value by incorporating various organic manures and planting techniques. The specific objectives are to:

- determine the effects of different planting methods on the growth and yield of *A. cruentus*;
- evaluate the effects of different nutrient sources on growth and yield of *A. cruentus*;
- examine the effects of different nutrient sources on nutritive value of *A. cruentus*.

MATERIALS AND METHODS OF RESEARCH

The experiment was conducted at the Faculty of Agriculture, University of Abuja, Nigeria. The experimental site was located behind the faculty which is situated on Latitudes 9^{o}4'20''N and Longitudes 7^{o}29'28" E in the Northern Guinea Savanna zone of Nigeria with mean annual temperature ranging between 24^{o}C and 32^{o}C.

The seed of *Amaranthus cruentus* was obtained from a reliable and reputable seed vendor in Abuja.

The experimental field was prepared by clearing and removal of debris, the soil was ploughed, harrowed and prepared into sunken bed in order to retain moisture as the research was conducted during the dry season. The net plot size covered about 240m^2 and divided into three (3) blocks, each block was partitioned into ten (10) plots of 1.5m X 2m each with alley ways of 1m between blocks and plots respectively.

Poultry manure, goat manure and cow dung was sourced from reliable animal farm and NPK fertilizer was obtained from fertilizer vendor in Abuja. 1.5kg (5tonnes/ha) of each of the manure (poultry manure, cow dung and goat manure) were broadcasted and ploughed into the soil on assigned plots two weeks before planting. 0.3kg (1tonne/ha) of NPK fertilizer was also applied at planting and transplanting on assigned plot.

The direct sowing treatment was planted directly on the beds using drilling method and was later thinned to two plants/hole, while the seedlings of transplanted Amaranthus were raised in the nursery for 21days. The seedlings were planted in the experimental field using spacing of 20cm x 65cm which give a total of 30 plants per plot.

The experiment was laid in 2 x 5 factorial combinations in a Randomized Complete Block Design (RCBD). Consisting of two planting methods (direct sowing and transplanting) and four nutrient sources (poultry manure, goat manure, cow dung and NPK), the organic manures will be applied at same rate of application while NPK was applied at the rate of 0.3kg, replicated three times.

All agronomic practices were carried out as at when due. Weeding was done regularly using hoe to keep the field neat and free from weeds. Pests and diseases were controlled with the application of emulsified neem seed oil extract.

Growth parameters which include; plant height/plant (cm), number of leaves/plants, number of branches /plants, leaf area/plant (cm^2) and shoot girth (cm) were taken forth nightly

Also, the yield parameter which includes; Shoot yield/plot (kg), Cumulative yield/ Ha tons) were evaluated at harvest. The harvest index was calculated using the following equation:

$$\text{Harvest Index} = \frac{\text{Weight of edible part}}{\text{Total weight of plant}} \times 100$$

The quality of the Amaranthus was examined for proximate analysis to determine the nutritional content of the Amaranthus.

Data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated using Least Significant Differences (LSD) at 5% probability level.

RESULTS OF STUDY

Table 1 showed the result of soil and manure analysis. The result indicated that the soil in the experimental site is slightly acidic. The soil was also observed to have low essential nutrients (total N 0.16, available P 25.98 and exchangeable bases of 0.44). The result also show that goat manure is more acidic compared to poultry manure, likewise goat manure contain more total nitrogen as well as zinc. There were no observed differences between goat manure and cow dung in zinc content.

Table 1 – The Results of Soil and Manure Analysis

Sample Description	Soil	Poultry manure	Goat manure	Cow dung
pH (H_2O)	6.80	5.86	7.8	
Organic Carbon (%)	0.77	1.32		
Organic Matter (%)	1.33	1.42	468	
Total N (%)	0.16	3.14	20.22	1.68
Available P (ppm)	25.98	16.54	1980.10	0.14
Na ($cmolKg^{-1}$)	0.15	0.36	4315	0.82
Potassium ($cmolKg^{-1}$)	0.05	1.36	2005	4.89
Calcium ($cmolKg^{-1}$)	2.80	2.32	5 65	0.52
Magnesium ($cmolKg^{-1}$)	3.28	7.02	0.20	0.34
Exchangeable Acid ($CmolKg^{-1}$)	0.44	0.53	0.52	0.28
CEC ($CmolKg^{-1}$)	6.72	6.25	355.00	200.00
Sulphur (ppm)+			0.032	0.032
Zinc (ppm)		0.373	0.92	0.96
Sand (%)	84.4			
Silt (%)	6.36			
Clay (%)	9.24			
Texture	Loamy Sandy			

Table 2 showed the effect of different nutrient sources and planting methods on the *Amaranthus* plant. There was a significant difference in the plant height of *Amaranthus* at 2WAP/WAT. At 4, 6 and 8WAP/WAT, the effect of different nutrient sources and planting method was visible. There was no significant difference between poultry manure, goat manure and N.P.K at 5% probability level ($P<0.05$) while control (no amendment) had the least plant height with the mean average value of 34.33. Similarly, transplanted seedlings of *Amaranthus* had the highest mean value at 8WAP/WAT.

The result of number of branches is presented in the Table 3. The result showed that there were no significant differences at 5% probability level ($P<0.05$) between N.P.K, poultry manure and goat manure. N.P.K produced the highest number of branches; cow dung produced the least number of branches at 4, 6 and 8WAP/WAT. Similarly, there were significant different between the planting methods of *Amaranthus* at 5% probability level as transplanted seedlings produced the highest number of branches at 4, 6 and 8WAP/WAT.

Table 2 – Effect of Nutrient Sources and Planting Methods on the Plant Height of *Amaranthus cruentus* in 2022 Cropping Season

Plant Height (cm)				
	2WAP/WAT	4WAP/WAT	6 WAP/WAT	8 WAP/WAT
Nutrient Sources (N)				
Control	8.51a	15.10b	23.53b	34.33b
Poultry Manure	9.85a	23.30a	39.20a	51.76a
Cow Dung	6.72a	14.35b	25.33b	39.43b
Goat Manure	10.68a	22.10a	38.03a	52.60a
N.P.K	10.28a	24.23a	41.63a	59.43a
SE±	1.992	3.811	5.775	7.551
Planting Methods (P)				
Transplanting	11.47a	20.63a	35.31a	51.39a
Direct planting	6.95b	19.01a	31.79a	43.64ab
SE±	1.260	2.410	3.653	4.775
Interaction				
N × P	NS	NS	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant, SE = Standard error.

Table 3 – Effect of Nutrient Sources and Planting Method on the Number of Branches of *Amaranthus cruentus* in 2022 Cropping Season

Number of Branches			
	4 WAP/WAT	6 WAP/WAT	8 WAP/WAT
Nutrient Sources (N)			
Control	1.97b	5.97b	12.93ab
Poultry Manure	3.57a	9.67a	18.50a
Cow Dung	1.67b	4.63b	11.03b
Goat Manure	3.23a	8.38a	15.07a
N.P.K	4.63a	11.67a	19.77a
SE±	1.221	2.165	3.581
Planting Methods (P)			
Transplanting	4.73a	10.23a	18.44a
Direct Planting	1.29b	5.88b	12.48b
SE±	0.772	1.369	2.265
Interaction			
N × P	NS	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant, SE = Standard error.

Table 4 – Effect of Nutrient Sources and Planting Method on the Number of Leaves of *Amaranthus cruentus* in 2022 Cropping Season

Number of Leaves				
	2 WAP/WAT	4 WAP/WAT	6 WAP/WAT	8 WAP/WAT
Nutrient Sources (N)				
Control	10.10b	19.67b	35.17b	53.33b
Poultry Manure	11.80b	29.00a	55.80a	72.03ab
Cow Dung	8.00c	15.20bc	32.47b	46.23b
Goat Manure	11.90b	24.30ab	53.13ab	73.97a
N.P.K	18.00a	33.93a	87.40a	108.70a
SE±	2.432	5.224	16.377	17.452
Planting Methods (P)				
Transplanting	15.35a	29.60a	72.64a	93.27a
Direct planting	8.57b	19.24b	32.95b	48.44b
SE±	1.538	3.304	10.358	11.038
Interaction				
N × P	NS	NS	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant.

There were significant differences in the number of leaves at 2, 4, 6, and 8WAP/WAT between amaranths plants fertilized with N.P.K, Control (no fertilizer) and poultry manure. Amaranths fertilized with N.P.K and goat manure were found to have the highest number of leaves at 8WAP/WAT. There were no significant differences between plants fertilized with goat manure, poultry manure and control at 5% probability level (P<0.05) while cow dung produced the least number of leaves at 2WAP/WAT with the average mean number of 8.00. However, transplanting method of planting produced the highest numbers of leaves at 2, 4, 6 and 8WAP/WAT with the mean value of 13.35, 29.60, 72.64 and 93.27 respectively at 5% probability level in the 2022 cropping season of the southern guinea savannah ecological zone of Nigeria (Table 4).

In the 2022 cropping season in the southern guinea savannah ecological zone of Nigeria, Table 5 shows the effect of nutrient source(s) and planting methods on the leaf area of *Amaranthus*. The result reveal that there were no significant differences at 5% probability level (P<0.05) between the different soil amendments and the planting methods employed at 2, 4, 6 and 8WAP/WAT.

Table 5 – Effect of Nutrient Sources and Planting Method on the Leaf Area of *Amaranthus cruentus* in 2022 Cropping Season

Leaf Area (cm^2)				
	2 WAP/WAT	4 WAP/WAT	6 WAP/WAT	8 WAP/WAT
Nutrient Sources (N)				
Control	1.01a	2.20a	2.64a	3.45a
Poultry Manure	1.19a	3.37a	4.19a	5.93a
Cow Dung	0.53a	1.18a	2.00a	3.28a
Goat Manure	0.91a	2.06a	3.54a	5.19a
N.P.K	1.11a	3.14a	4.85a	6.49a
SE±	0.493	1.167	1.210	1.507
Planting Methods (P)				
Transplanting	1.29a	2.83a	3.80a	4.93a
Direct planting	0.61a	1.95a	3.09a	4.82a
SE±	0.312	0.738	0.765	0.953
Interaction				
N × P	NS	NS	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant.

Table 6 – Effect of Nutrient Sources and Planting Method on the Stem Girth of *Amaranthus cruentus* in 2022 Cropping Season

Stem Girth			
	4 WAP/WAT	6 WAP/WAT	8 WAP/WAT
Nutrient Sources (N)			
Control	1.63a	2.57b	3.49b
Poultry Manure	2.64a	3.93a	5.61a
Cow Dung	1.64a	2.49b	3.19ab
Goat Manure	2.18a	3.19a	4.26a
N.P.K	2.61a	3.71a	5.01a
SE±	0.394	0.551	0.898
Planting Methods (P)			
Transplanting	2.27a	3.27a	4.18a
Direct planting	2.02a	3.08a	4.44a
SE±	0.249	0.348	0.568
Interaction			
N × P	NS	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant.

Table 6 shows the effect of nutrient sources and planting method on stem girth. The result shows that there was no relationship between the planting methods at 4, 6 and 8WAP/WAT at 5% probability level (P<0.05). Similarly, there were no significant differences between the soil amendments at 2WAP/WAT but a significant difference was recorded at 6 and 8WAP/WAT as N.P.K had the thickest stem girth (cm) while control had the least thick stem girth.

The yield of *Amaranthus* was affected by different planting method and sources of nutrients in southern guinea savannah ecology of Nigeria as shown in Table 7. From the result, there were no significant differences (at 5% probability level) in the yield/ha of transplanted seedlings and directly sowed Amaranths produced a lower yield means value of 63.78. Similarly, there were no differences statistically a 5% probability level between N.P.K, poultry manure and goat manure in the yield/ha of Amaranthus but control (no amendment) had the lowest yield/ha while N.P.K produced the highest yield/ha. There was no statistical difference between N.P.K, goat manure, poultry manure, and cow dung but were significantly different from control (no amendment) as it produced the lowest harvest index.

Table 7 – Effect of Nutrient Sources and Planting Method on Yield Characteristics of *Amaranthus cruentus* in 2022 Cropping Season

Yield per Hectare		
	Yield/Ha (tons)	Harvest Index (%)
Nutrient Sources (N)		
Control	11.07b	59.15b
Poultry Manure	20.20a	64.41a
Cow Dung	11.50b	69.31a
Goat Manure	18.85a	66.80
N.P.K	25.14a	71.43a
SE±	6.438	5.108
Planting Methods (P)		
Transplanting	20.66a	68.78a
Direct Planting	14.05a	63.65b
SE±	4.072	3.231
Interaction		
N × P	NS	NS

Means followed with same letter(s) are not significantly different at 5% probability level using LSD, SE = Standard error, WAP = Weeks after Planting, WAT =Weeks after Transplanting, NS = Not significant.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha of poultry manure and direct planting produced 4.60 of moisture content,15.50 of Ash content,14.50 of fat content, 4.27 of protein content,10.28 of crude fiber, carbohydrate of 50.85, dry matter of 95.40 (Table 8).

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 0 tonnes/ha of transplanting and control supported 3.40 of moisture content, 17.00 of Ash content, 32.80 of fat content, 4.05 of protein content ,9.31 of crude fiber,33.44 0f carbohydrate, 96.60 of Dry matter.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 0 tonnes/ha of Direct planting and control supported 3.00 of moisture content,17.00 of Ash content, 7.00 of fat content,3.17 0f protein content,6.61 of crude fiber,63.22 of carbohydrate, Dry matter of 97.00.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha of Direct planting and goat manure supported 12.80 of moisture content,18.50 of Ash content,33.50 of fat content,6.68 of protein content,7.84 of crude fiber,20.68 of carbohydrate,87.20 of dry matter.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha of transplanting and poultry manure supported 5.40 of moisture content,17.50 of Ash content,5.00 of fat content,1.64 of protein content,6.62 0f crude fiber,63.84 of carbohydrate,94.60 of dry matter

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 1tone/ha of Direct planting and NPK supported 6.40of moisture content,17.00 of Ash content,23.80 of fat content,5.58 of protein content,8.45 of crude fiber,38.77 0f carbohydrate, Dry matter of 93.60.

Table 8 – Proximate Analysis on Dry Weight of Amaranthus g\100g

Sample	Moisture content	Ash content	Fat content	Protein content	Crude fiber	Carbohydrate	Total Dry matter
Direct planting poultry manure	4.60	15.50	14.50	4.27	10.28	50.85	95.40
Transplanting control	3.40	17.00	32.80	4.05	9.31	33.44	96.60
Direct planting control	3.00	17.00	7.0	3.17	6.61	63.22	97.00
Direct planting goat	12.80	18.50	33.50	6.68	7.84	20.68	87.20
Transplanting poultry manure	5.40	17.50	5.00	1.64	6.62	63.84	94.60
Direct planting NPK	6.40	17.00	23.80	5.58	8.45	38.77	93.60
Transplanting cow dung	3.60	19.00	24.50	1.20	8.53	42.67	96.40
Transplanting NPK	9.00	18.00	4.00	2.30	7.74	58.96	91.00
transplanting goat manure	4.00	15.50	31.80	1.86	9.00	37.84	96.00
Direct planting cow dung	3.20	16.00	33.00	3.17	5.49	39.14	96.80

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha of transplanting and cow dung supported 3.60 of moisture content,19.50 of Ash content,24.50 of fat content,1.20 of protein content,8.53 0f crude fiber,42.67 of carbohydrate,96.40 of Dry matter.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 1 tonnes/ha of transplanting and NPK supported 9.00 of moisture content,18.00 of Ash content,4.00 of fat content,2.30 of protein content, 7.74 of crude fiber, 58.96 of carbohydrate,91.00 of Dry matter.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha transplanting and goat manure supported 4.00 of moisture content,15.50 of Ash content,31.80 of fat content,1.86 of protein content,9.00 of crude fiber,37.84 of carbohydrate,96.00 of Dry matter.

Results obtained from the proximate analysis of *Amaranthus cruentus* based on the applied treatment indicates that the application of 5 tonnes/ha of direct planting and cow dung supported 3.20 of moisture content, 16.00 of Ash content,33.00 of fat content,3.17 of protein content,5.49 of crude fiber,39.14 of Carbohydrate,96.80 of Dry matter.

DISCUSSION OF RESULTS

An essential factor in determining plant growth is plant height. Plant height variations were present at a 5% probability level ($P < 0.05$). N.P.K.-fertilized amaranthus plants outgrew those grown with goat manure, chicken manure, cow dung, and control plants in terms of plant height. This is most likely a result of the release of nutrients that encouraged robust plant development through effective photosynthesis (Sanni, 2016). Due to the role that nitrogen plays in plant cell division and cell elongation, nitrogen fertilizer has a propensity to increase plant height (Mazumber *et al*., 2019). According to Ogunlela, *et al*. (2005), who observed that amaranth height rose with fertilizer treatment, the results of this study were consistent with their findings. This is also in accordance with the findings of Mondal, *et al*. (2016) who reported that an optimum plant height is claimed to be positively correlated with inorganic fertilizers applied on garlic plants.

According to the experiment's findings, the number of leaves produced by amaranth plants treated with various soil amendments varied significantly. The most leaves were detected on amaranths that had been fertilized with N.P.K. and goat dung. Given that the leaves are the plant's primary photosynthetic organ, changes in leaf count are certain to have an impact on amaranths' overall performance (Miah *et al*., 2013). The increased number of leaves in soil amended with NPK and other organic fertilizers could be attributed to the availability of necessary nutrients, which encouraged more leaves and leaf area during vegetative development and also assisted in maintaining functional leaf area during the growth period (Cox *et al*, 1995). The results of Sanni (2016), who stated that the application of N.P.K. and chicken manure improved plant height, leaf number, and area, are in agreement with this. This result is in line with the findings of Abdulmaliq, *et al*. (2017) who reported that poultry manure performed better than other organic soil amendment as it produced significantly higher growth and yield parameters. Also, these findings are in agreement with Xu, *et al*. (2015) who stated that the yield and quality of leafy vegetables grown with organic fertilizers produced significant higher growth and yield, which led to a higher total yield than those grown with synthetic fertilizers.

From the result, there were significant differences at 5% probability level in the yield. N.P.K fertilized crops was found to have the highest yield followed by poultry manure and goat manure. These results are comparable to those of Masarrirambi *et al*. (2010) who found that organic fertilizers not only increase yield but also preserve soil fertility even though amaranths were a low management crop and flourished in poor soils. These results are consistent with those of Abdulmaliq *et al*. (2019), who found that the only application of chicken manure significantly supported higher growth and yield parameters than the solo application of NPK fertilizer during tomato production.

Transplanted Amaranthus supported taller plant height, higher number of leaves, more branches at 4, 6 and 8WAT/WAP at 5% probability level. These could be due to the fact that seedlings were initially raised in the nursery for three weeks before been transplanted which the plants continue her growth from the point where it was taken from. This result is in accordance with the findings of Adesina *et al*. (2014) who reported that transplanted seedlings had a significantly higher morphological parameter than directly sown seeds.

The result showed that application of poultry manure and transplanting method have a profound effect on the overall performance of *Amaranthus cruentus*.

CONCLUSION AND RECOMMENDATIONS

Except for the stem girth and leaf area, transplanted Amaranthus supported significantly higher growth parameters and yield at 5% probability level ($P<0.05$) during the 2022 cropping season of the northern guinea savannah ecological zone of Nigeria.

This study showed that the application of poultry manure and NPK was not significantly different in the growth and yield parameters of *Amaranthus cruentus* in the Southern Guinea Savanna zone of Nigeria during the 2022 cropping season. There was no significant difference in the plant height, number of leaves, stem girth, number of branches and yield of *Amaranthus cruentus* at 2, 4, 6 and 8 weeks after planting and transplanting but NPK supported higher number of branches than poultry at 2 weeks after planting and transplanting.

Based on the findings from the study, the following recommendations were made:

- From the results of the study, application of poultry manure was not significantly different from NPK; therefore it is recommended that application of poultry manure should be adopted for the production of Amaranthus;
- Seeds of Amaranthus should be raised on the nursery bed and should be transplanted after 3 weeks for optimum yield of Amaranthus;
- For better performance of transplanted seedlings of Amaranthus, spacing of 20cm×65cm should be adopted.

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REFERENCES

1. Abdulmaliq, S.Y., Kumar, N., Bello, O.B., Nduka and Kareem I. (2019). Influence of poultry manure and NPK Fertilizer as amendment on the performance of Tomato

(Solanum lycoperscum L. Moench) varieties at Lapai, Southern Guinea Savannah. Annals of Biotechnology and Bioengineering, 1(1), 1003.
2. Abdulmaliq, S.Y., Gudugi, A.S., and Abubakar, A., Kumar, N., and Majin, N.S. (2017). Effects of Organic soil amendment types and rates on growth and yield of Amaranthus cruentus (L.) in Southern Guienea Savannah of Nigeria. Journal of Organic Agriculture and Environment, Vol. 5, No. 1, June, 2017.
3. Adesina, J. A., Akande, M. O. and Akanbi, W. B. (2014). Effect of organic root plus (Biostimulant) on nutrient content, growth and yield of tomato. Nigerian Journal of Soil Science, 15, 26-33.
4. Aisha, A.H., Rizk, F. A., Shaheen, A.M. and Abdel-Mouty, M. M. (2007).Onion plant growth, bulbs yield and its physical and chemical properties as affected by organic and natural fertilization. Research Journal of Agriculture and Biological Sciences, 3(5), 380-388.
5. Arisha, H.M. and A. Bradisi (1999). Effect of mineral fertilizers and organic fertilizers on growth, yield and quality of potato under sandy soil conditions. Zagazig Journal Agricultural Research, 30, 1875-1899.
6. Chang, L.C, and Palada, M.C (2003). Suggested cultural practices for vegetable amaranth. International Cooperators Guide, AVRDC Publishers; 03-552.
7. Cox, W.J., Kalonge, S., Cherney, D.J. and Reid, W.S., (1995). Growth Yield and Quality of Forage Maize under Different Nitrogen Management Practices. Agronomy Journal, 85(2): 341-347.
8. Dauda, S.N., Ajayi, F.A and Ndor, E. (2008). Growth and yield of water melon (Citrullus lanatus) as affected by poultry manure application. Journal of Agriculture and Social Science, 4: 121-124.
9. Eghball, B.,Wienhold, B. J.,Gilly, J. E., and Eigenberg, R.A.(2002).Mineralization of manure nutrients. Journal of Soil and Water Conservation, 57 (6),470-473.
10. Eliot, F. (2005). Organic Farming in Scotland. http://www.alfredhartemink.nl/fertilizer.htm.
11. Gupta, S., Lakshmi, J. A., Manjunath, M. N., and Prakash, J. (2005). Analysis of nutrient and antinutrient content of underutilized green leafy vegetables. LWT- Food Science and Technology, 38, 339-345. http://dx.doi.org/10.1016/j.lwt.2004.06.012.
12. IPGRI (2003). Rediscovering a forgotten treasure. IPGRI Public Awareness Forum. Nairobi, Kenya. IPGRI/National Museums of Kenya. http//ipgri-pa.grinfo.net/index.php?itemid=101.
13. Masarirambi, M.T., Mavuso, V., Shongwe, V.D., Nkambule, T.P., and Mhazo, N. (2010). Indigenous postharvest handling and processing of traditional vegetables in Swaziland. African Journal of Agricultural Research, 5(24), 333-3341.
14. Mazumder, N., Sultana, T., Paul, P., and Noor, M.M., (2019). Influence of NPK fertilizer and spacing on growth parameters of onion (Allium cepa L. Var. BARI piaz-1). Research in Agriculture, Livestock and Fisheries, 6(1): 19-25.
15. Miah, M.Y., Roy, P.K., Islam, M.S. and Fazal, K.I., (2013). Stem amaranth yield in response to organic manuring. Journal of Environmental Science and Natural Resources, 6 (2), 19 -23.
16. Mondal, M.M., Akter, M.B., Rahman, M.H. and Puteh, A.B., (2016). Influence of micronutrients and manures on growth and yield of garlic (Allium sativum L.) in sandy loam soil. International Journal of Plant & Soil Science, 13(4), 1-8.
17. Naeem, M., Iqbal, J. and Bakhsh, M.A.A. (2006).Comparative study of NPKs and quail manures on yield and yield components of mung bean (Vigna radiate L.).Journal of Agriculture and Social Science, 2, 227-229.
18. Ogungbile, A.O.and Olukosi, J. (1990). An overview of the problems of the resource poor farmers in Nigeria in Proceedings of the Nigerian National Farming Systems Research Network, Calabar, Nigeria, August 1990.
19. Ogunlela, V.B., Masarirambi, M.T., and Makuza, S.M. (2005). Effect of cattle manure application on pod yield and yield indices of okra (Abelmoschus esculentus L. Moench) in semi-arid and subtropical environment. Journal of Food Agricultural Environment; 3, 5-15.

20. Okalebo, J.R.K.W. Gathua and P.L. Woomer, (2002). Laboratory methods of soil and plant Analysis: A working Manual.2nd edition. TSBF-CIAT and Sacred Africa, Nairobi.
21. Rahman, M.M., Wahed, M.A. and Ali, M.A. (1990). β-carotene losses during different methods of cooking green leafy vegetables in Bangladesh. J. Food Comp. Anal. 3: 47-53.
22. Ricardo, B. (1993). Amaranth: In: Encyclopaedia of Food Technology and Nutrition. Vol. 1. Academic press, London. UK.
23. Sanni, K.O., (2016). Effect of compost, cow dung and NPK 15-15-15 fertilizer on growth and yield performance of Amaranth (Amaranthus hybridus). International Journal of Advanced Science Research, 2, 76-82.
24. Savant, N.K. and Stengel, P.J. (1990). Deep placement of urea super granules in transplanted rice. Principles and practice. Fert Res., 25, 1-18.
25. Shukla S., Bhargava, A., Chatterjee, A., Srivastava, A and Singh S.P. (2005). Estimates of genetic variability in vegetable amaranth (A. tricolor) over different cuttings. Hort. Sci. 32(3), 60-67.
26. Vorster, H.J., Stevens, J.B., and Steyn, G.J. (2008). Production systems of traditional leafy vegetables: Challenges for research and extension. South African Journal for Agricultural Extension, 37, 85- 96.