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Evaluation of the Effect of Different Organic Fertilizer and Synthetic Fertilizer on the Vegetative Growth of *Amaranthus Cruentus* for Organic Vegetation Gardening

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ABSTRACT

This research was conducted to evaluate the effects organic and inorganic fertilizers on growth of *amaranth* in Jalingo metropolis. The experiment site was laid out in a randomized complete block design (RCBD) with four replications and a control block. Treatment was replicated four times on the RCBD. The treatments were; Treatment1 T_1 Control (0), Treatment2 T Cow dung, Treatment3 T_3 Poultry dropping, Treatment4 T_4 Decomposed leaves and Treatment5 T_5 NPK. ANOVA was used to analyze variation. The result shows that treatment consisting of Decomposed leaves had the tallest plant height (48.31cm). The result revealed that *Amaranthus* treated with decomposed leaves attained the highest plant node of 22.20 cm and those that received normal soil, cow dung, poultry dropping and inorganic manure treatment reached a maximum plant node of 14.40 cm, 16.85 cm, 16.65 cm and 16.28 cm respectively. The study shows variations in growth and development between *amaranth cruentus* treated with organic and inorganic fertilizers. It was recommended that the used of organic fertilizer be intensified in the cultivation of *amaranth cruentus.*

1. Introduction

The severe fear of the residues of pollutants in food, especially in the sixties during the agricultural revolution and the increase of chemicals used in agricultural production and food processing, and to reduce this problem prompted specialists to introduce new farming systems, the organic farming which aim to reduce the use of chemicals (Jayanta et al, 2023). Organic farming, also known as ecological farming or biological farming, is an agricultural system that uses fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. It prioritizes sustainable practices by avoiding synthetic fertilizers and agrochemicals, focusing on renewable resources, and promoting biodiversity and soil health. The methods of organic farming include the use of organic fertilizers, crop rotations, symbiotic associations, cover crops, inter-cropping, and minimum tillage to maintain soil fertility and structure (Pawa, 2014). This agricultural production endeavours to uphold and enhance the innate equilibrium of the environment. In alternative terms, this method of agriculture relies on the utilization of fertilizers that are derived from wholly natural sources known as organic fertilizers.

Though the method of farming is not new to Africa and Nigeria in particular, over the years with the introductions of chemicals, synthetic fertilizer, pesticides etc, African farmers have abandoned organic farming. But with the issue of residues of agrochemicals in food and the fear of contamination of agricultural produce, attentions have been drawn back to organic farming. The most important crops cultivated through organic farming are organically grown vegetables such as *Amaranthus cruentus*, potatoes, onions, garlic, beans, peppers, cucumbers, cantaloupe, strawberries, tomatoes, carrots, pea and squash. Fruit such as

apricots, peaches, apples, dates. Field crops, fiber (cotton, peanuts and sesame) and also medicinal and aromatic herbs were cultivated organically, Tripathi et al, (2023).

Amaranths cruentus is an important vegetable in human diet as a source of nutrients such as vitamin, minerals, sugar, water, protein and fibre needed for healthy body growth and sustenance. They are grown as soup vegetables or for boiled salad greens (Ainika and Amans, 2011). *Amaranths* species is a leafy vegetable in the tropical region of world and formed a high percentage of daily intake of leafy vegetables. It is grown for its leaves and is among the highly prized leaf vegetables in Nigeria, due to their high nutritional and commercial significance. It has been one of the most important vegetables of Amaranthaceae family. Amaranth has been naturalized in central parts of Asia and possibly Iran, (Nyankanga et'al, 2012) and has cultivation history of more than 2000 years Daneshvar (2000).

Bulks of vegetables consumed in Nigeria were supplied by subsistence farmers. The supply of vegetable to areas of high demand has remained low and seasonal as the subsistence farmers continue to rely on natural rainfall. Today, high demand for vegetables in the cities and towns has stimulated the growth of market gardening along perennial rivers and streams. This is a common sight at Jalingo, Wukari, Yola, Onitsha, Lagos, Port Harcourt, Warri, Sapele, Agbor, Jos, Ibadan, Kaduna, Sokoto and some other towns, (Oyedeji, Animasaun, Bello and Agboola 2014).

A common misconception is that organic fertilizers are safer for plants and the environment than inorganic (chemical) products. Improper *organic* fertilizer application can also contribute to surface and ground water pollution, may induce a plant nutrient deficiency or toxicity. If properly used, both organic and inorganic fertilizers are safe for plants and the environment (Law-Ogbomo and Ajayi, 2009). Hence, it is necessary to compare the growth of *Amaranthus cruentus* using organic and synthetic fertilizer.

2. Methodology

The method used in this study is an experimental research method. An experimental farm was acquired at Nukkai area of Jalingo metropolis. Nursery bed was prepared at the Taraba State University farm site were the *amaranth* nursery was prepared before transplanting it to the experimental farm in March 31, 2023.

2.1 Data used

The data used for this study are basically agromonic data that has to do with plant growth and development and they includes:

1. Plant Height (cm):
2. Number of Nodes per Plant:
3. Plant Root Length (cm):
4. Leave Area:
5. Stem Girth:

The fertilizers used for this study are outlined and explained below:

i. **Poultry manure:** The poultry manure was collected at the TallCam Farm at Mallum a suburb of Jalingo, Taraba State. By sweeping and gathering and packing into a sack then carried to the site of experiment.

ii. **Cow dung:** Cow dung was collected at the Taraba State University Farm in Jalingo Taraba State. By hand picking then packed into a sack and transported to the site of experiment.

iii. **Decomposed Leave:** Decomposed leaf was collected at the Taraba State University Farm in Jalingo Taraba State. By hand picking and carried to the site of experiment. The leaves comprises of *mangifera indica* and *mallena aborae*.

iv. **NPK**: The NPK was bought from agro-chemical store and transported to the site of experiment.

2.2 Experimental site

The experiment was conducted at the Teaching and Research Farm of Taraba State Polytechnic, Jalingo Campus during the 2023 growing seasons. The sites were not used for any cropping activities for period of twenty five (25) years and there was no record of fertilizer usage, the soil was well drained and gentle slope. The experiment site is located at an elevation of about 189 meters above sea level and lies between latitude $7^0$51 N' to $7^0$85'N and longitude $9^0$46'E to 9°78 E' of the Greenwich meridian; it has mean annual rainy days of 200 to 220 days. Rain fall intensity in the area varies from 1000-1150mm, with an average minimum temperature of 27°C while average maximum temperature is 37°C, Zemba, Abbas and Asa (2019). The study area falls within the southern Guinea Savannah Agro-ecological zone of Nigeria, with a distinct dry season from November to April while rainfall is usually from May to November.

2.3 Experimental design and treatment

The experiment site was laid out in a randomized complete block design (RCBD) with four replications as described by Olowoake and Ojo (2014). Treatment was replicated four times in a randomized complete block design (RCBD). Total of one hundred (100) polythene bag of treatments were used and a distance of 1m between replications. The treatments were as follows:

I. Treatment1 T_1 Control (0)
II. Treatment2 T. Cow dung 2g per pollen bag
III. Treatment3 T_3. Poultry dropping 2g per pollen bag
IV. Treatment4 T_4 Decomposed leaves 2g per pollen bag
V. Treatment5 T_5 NPK at1g per pollen bag.

2.4 Nursery bed preparation

Land was cleared manually with simple farm tools. Layout was then designed and pegged using measurement tape and ruler, after which beds were raised and irrigated using watering can. Seed were sown by means of broadcasting method on the prepared irrigated nursery bed on the 31st March 2023. The bed was watered regularly using watering can and checked for seed emergence and later thinned to 20 stands per pollen bag after germination making a number of 100 pollen bags for all treatments with a spacing of 50cm between pollen bags. Trans-planting of seedlings into their respective pollen bags in the field took place in two weeks after sowing on the 31st March 2023.

Seedlings were trans-planted at two weeks after treatment consisting of four manure types and a control of normal soil. The fertilizers were applied 1cm close to each plant stand 2g per pollen bag. The experimental plot was divided into five blocks each containing twenty (20) pollen bags per treatment. The organic fertilizer (poultry manure) was incorporated into the soil one week before trans-planting of the seedlings, while inorganic fertilizer (NPK) was applied to the plant the day of trans-planting.

Weeding was done manually with hoe to control weed while the pollen bags were weeded by hand picking when there was need throughout the period the experiment was carried out. Collection of data commenced from one week after trans-planting and was done weekly till the fourth week.

3.0 DATA COLLECTION

The Data collected for the purpose of this research were data on growth and development of the *Amaranthus cruentus*. The parameters include;

1. **Plant Height (cm):** A plant stand was randomly selected from each pollen bag of each treatment, meter rule was used to measure the stem height from the base to the apex of the uprooted plant in each pollen bag at one-week regular interval starting from 1, 2, 3, and 4 weeks, the result obtained was all recorded.
2. **Number of Nodes per Plant:** Number of Nodes per Plant was obtained by counting the nodes of the uprooted plants at 1, 2, 3, and 4 weeks after emergence and the average was calculated and recorded.
3. **Plant Root Length (cm):** The root of the uprooted plant was measured using thread and rule at week 1, 2, 3, and 4 after emergence and the average was calculated.
4. **Leave Lenght:** The leaves from the uprooted stand of plant were measured (length) sum together at 1, 2, 3 and 4 weeks after emergence and the average was calculated recorded.
5. **Stem Girth:** The stand of plant uprooted from the plot in the field, the stem girth is taken by using a thread tied round the stem, marked and then place the rope on a meter rule to know the measurement at 1, 2, 3, and 4 weeks after emergence, the average was calculated and recorded.

3.1 Data analysis

The data collected were analyzed using statistical tool the SPSS. Analysis of Variance (ANOVA) from the SPSS was used to assess the fertilizer that gives maximum yield. The ANOVA was tested at 5 percent (%) level of significant (P= 0.05) while the significance difference among treatments means were evaluated using Duncan Multiple Range Test. Correlation coefficient was used To determine the effect of different types of organic and synthetic fertilizer on the vegetative growth of *Amaranthus cruentus.*

4.0 RESULTS AND DISCUSSION

4.1 Effect of the Different Organic and Inorganic Fertilizers

The effects of the different organic and inorganic fertilizers used in this research on the *Amaranthus cruetus* was analyzed on weekly basis for four (4) weeks and the result is presented and discussed as following:

4.1.1 Effects of Different Organic and Inorganic Fertilizers on Amaranth height

The effects of the different organic and inorganic fertilizers used in this research on the height of *Amaranthus cruetus* was analyzed on weekly basis for four (4) weeks and the result is presented in tale 1 and figure 1;

Table: 1 Effect of different organic and inorganic fertilizers on plant height (cm)

Treatment	Weeks			
	1st	2nd	3rd	4th
Normal Soil	6.95 ± 1.3771[a]	9.17 ± 0.5108[a]	21.59 ± 0.5040[ba]	40.51 ± 0.8580[a]
Cow Dung	5.72 ± 1.0213[a]	9.20 ± 1.2776[a]	22.61 ± 1.1733[b]	41.03 ± 0.6628[a]
Poultry Dropping	6.08 ± 0.9116[a]	10.02 ± 0.4403[ab]	21.12 ± 0.0661[a]	41.19 ± 0.5050[a]
Decomposed leaves	5.77 ± 0.8133[a]	11.68 ± 0.9183[c]	21.44 ± 0.1949[a]	48.31 ± 0.6161[b]
Inorganic Fertilizer	6.29 ± 0.7273[a]	10.91 ± 0.7177[bc]	20.87 ± 0.4152[a]	45.76 ± 3.7987[b]

Mean ± Standard Deviation. Means in column with different superscript alphabet are significantly different ($p<0.05$)

The result as presented in table 1 above and figure 1 below shows that different organic manure rates had a significant effect ($P\leq0.05$) on the plant height at 2 weeks after sowing (Table 1). Treatment consisting of Decomposed leaves had the tallest plant height (11.68cm), while treatment consisting of Normal soil had shortest plant height of (9.17cm) which is not significantly ($P\geq0.05$) different from treatment consisting of Cow dung and Poultry dropping. There was also a significant effect ($P\leq0.05$) of different organic manure on plant height at 3 weeks after sowing with Decomposed leaves having the tallest plant height (24.44cm), while the shortest height (20.87cm) was obtained in inorganicfertilizer. Similarly, at 4 weeks after sowing, the different organic manure effect had significant ($P\leq0.05$) on plant height. The tallest plant height (48.31cm) was obtained with Decomposed leaves, though, not significantly different ($P\geq0.05$) from Inorganic Fertilizer used, while the shortest plant height was recorded in control (Normal soil). This finding agreed with earlier report of Adeyemi, Fakore and Edema, (1999) who observed that adequacy of manure decreased the number of days from planting to first harvesting, and it increased the plant height of *Amaranthus*. Also, Tindall (1975) reported that *Amaranthus* require soils with high organic content, and adequate mineral nutrients favoured the production of higher plant height *Amaranthus*.

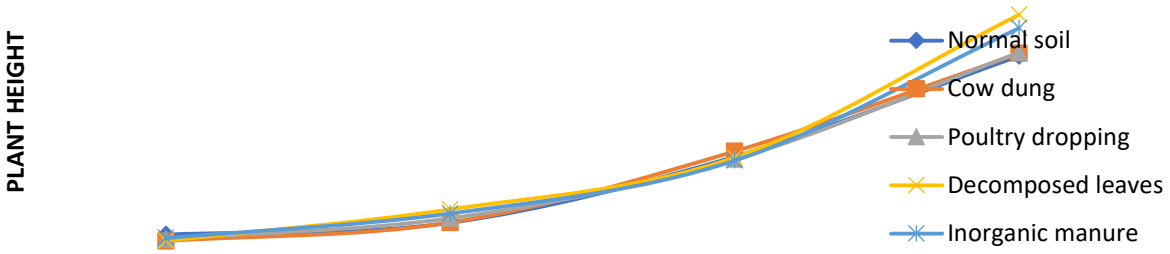

Figure: 1 shows variations in plant height by different treatments

4.1.2 Effects of Different Organic and Inorganic Fertilizers on Amaranth Node

The plant nodes in centimeter (cm) of *Amaranthus* as treated with various organic and inorganic fertilizers for the period of study was analyzed, the result is presented in table 2 below.

Table: 2 Plant nodes (cm) of *Amaranthus* treated with various organic and inorganic fertilizers

	Weeks			
Treatment	1st	2nd	3rd	4th
Normal Soil	5.35 ± 0.5000[a]	6.85 ± 0.5000[a]	10.90 ± 0.3464[a]	14.40 ± 0.2309[a]
Cow Dung	5.25 ± 0.6191[a]	7.25 ± 0.5745[a]	10.70 ± 0.4163[a]	16.85 ± 0.4726[b]
Poultry Dropping	5.16 ± 0.7701[a]	7.70 ± 0.7746[ab]	10.95 ± 0.2517[a]	16.65 ± 0.5972[b]
Decomposed leaves	5.30 ± 0.7746[a]	9.60 ± 0.5888[c]	11.60 ± 0.2828[b]	22.20 ± 0.8485[c]
Inorganic Fertilizer	5.20 ± 0.5888[a]	8.50 ± 0.3464[b]	10.65 ± 0.6608[a]	16.28 ± 2.2441[b]

Mean ± Standard Deviation. Means in column with different superscript alphabet are significantly different ($p<0.05$)

The result as presented in table 2 above and figure 2 below shows plant nodes were observed to increase with plant age (Table 2). At 1 week after planting (WAP), there were no significant differences in plant nodes of *Amaranthus* treated with the various organic manures. However, between 2 and 4 WAP, significant differences in plant nodes were observed among different organic manure. The highest plant node was recorded for organic manure treatment unit of decomposed leaves (Table 2). The result revealed that *Amaranthus* treated with decomposed leaves attained the highest plant node of 22.20 cm and those that received normal soil, cow dung, poultry dropping and inorganic manure treatment reached a maximum plant node of 14.40 cm, 16.85 cm, 16.65 cm and 16.28 cm respectively.

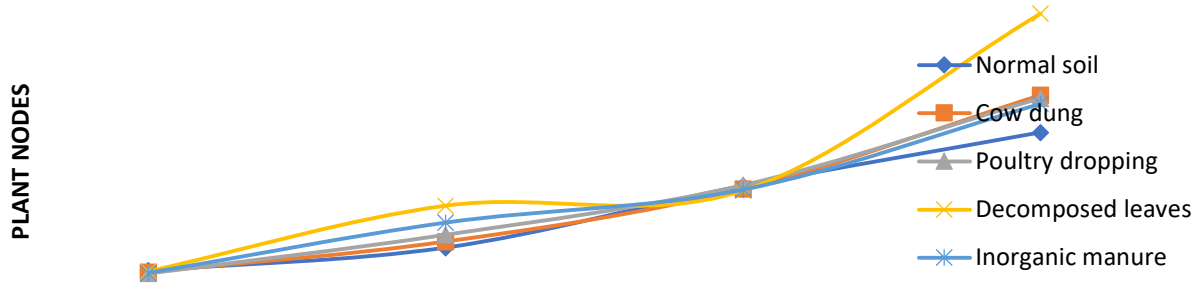

Figure 2: Graph of plant node variations Using Different Treatment

4.1.3 Effects of Different Organic and Inorganic Fertilizers on amaranth Stem

Analysis of the effects of different organic and inorganic fertilizers on plant stems on weekly basis throughout the period of study as treated with was carried out and the result is presented in table 3 below.

Table 3: Plant stem (cm) of *Amaranthus* treated with various organic and inorganic fertilizers

	Weeks			
Treatment	1st	2nd	3rd	4th
Normal Soil	0.79 ± 0.0823^{a}	1.17 ± 0.1204^{b}	1.25 ± 0.0987^{c}	3.34 ± 0.3213^{a}
Cow Dung	0.63 ± 0.1228^{a}	0.74 ± 0.0589^{a}	0.92 ± 0.0915^{a}	3.22 ± 0.0252^{a}
Poultry Dropping	0.69 ± 0.0806^{a}	0.79 ± 0.1025^{a}	1.03 ± 0.0945^{ab}	3.29 ± 0.0823^{a}
Decomposed leaves	0.72 ± 0.2406^{a}	0.95 ± 0.2402^{a}	1.16 ± 0.2209^{bc}	3.55 ± 0.0597^{a}
Inorganic Fertilizer	0.56 ± 0.2450^{a}	0.85 ± 0.0841^{a}	2.20 ± 0.0283^{d}	3.38 ± 0.4852^{a}

Mean ± Standard Deviation. Means in column with different superscript alphabet are significantly different ($p<0.05$)

Table 3 above and figure 3 presents the results of the effect of different organic fertilizers on Plant Stem. It shows the response of stem girth of Amaranths to application of organic manure. All manures applied were found to increase the stem girth of Amaranths when compared with control (normal soil). At 1, 2 and 4 week after planting (WAP) stem girth of Amaranths were not significantly different ($p>0.05$). At 4 weeks after sowing, decomposed leaves had the highest average stem girth of 3.55 cm, though; it was not significantly different ($P\geq0.05$) from other treatments.

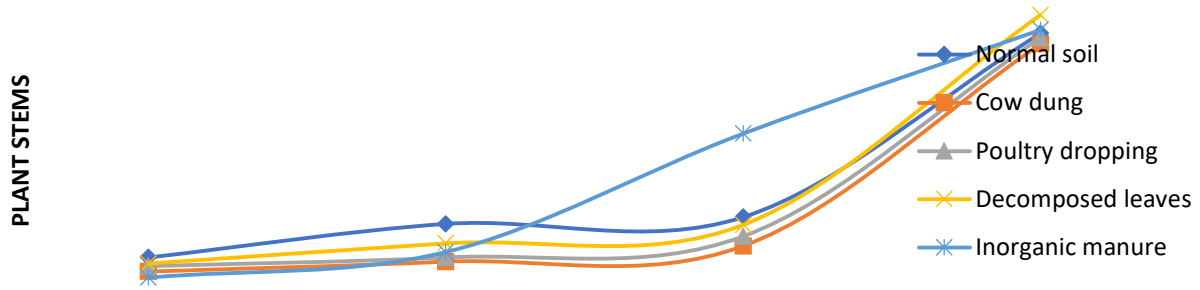

Figure: 4 shows variations of Plant Stem using different treatments

4.1.4 Effects of different organic and inorganic fertilizers on Plant roots

The analysis of the effects of the different fertilizers (organic and inorganic) on the roots of amaranth in the study area for the period of the study was carried out and the result is presented in table 4 below.

Table: 4 Plant root (cm) of *Amaranthus* treated with various organic and inorganic fertilizers

	Weeks			
Treatment	1st	2nd	3rd	4th
Normal Soil	2.02 ± 0.0993^{a}	2.58 ± 0.4674^{ab}	3.88 ± 0.4796^{a}	6.46 ± 0.7935^{a}
Cow Dung	2.16 ± 0.2315^{ab}	3.01 ± 0.3026^{ab}	5.27 ± 0.3087^{c}	8.14 ± 1.4004^{a}
Poultry Dropping	1.89 ± 0.3018^{a}	2.43 ± 0.4889^{a}	3.92 ± 0.2317^{a}	9.30 ± 5.1489^{a}
Decomposed leaves	2.68 ± 0.1939^{c}	4.06 ± 0.5295^{c}	5.17 ± 0.5201^{c}	15.79 ± 3.1036^{b}
Inorganic Manure	2.47 ± 0.2357^{bc}	3.26 ± 0.3927^{b}	4.57 ± 0.3800^{b}	14.17 ± 1.5109^{b}

Mean ± Standard Deviation. Means in column with different superscript alphabet are significantly different ($p<0.05$)

The results as presented in table 4 above and figure 4 below revealed that, *Amaranthus cruentus* treated with the various treatment (normal soil, cow dung, poultry dropping, decomposed roots and inorganic manure) show significant difference in number of roots at 1 WAP while at 2, 3 and 4 WAP. The plant that received decomposed roots as treatment produced the highest average root length of 2.68 cm, 4.06 cm, and 15.79 cm at 1, 2, and 4 WAP (Table 4). The least average root length of 6.46 cm was produced by *Amaranthus* that received normal soil (control) during the period under study. The result showed that the higher the quantity of decomposed roots applied, the higher the root length. Tindall (1975) reported that *Amaranthus* require soils with high organic content and such soils favoured the production of leaf area. Similar results were reported by Wright et al. (2012), who observed that maximum root growth and rooting depth of barley crop were higher in treatments, which received organic and inorganic fertilizer relative to where manure was not applied.

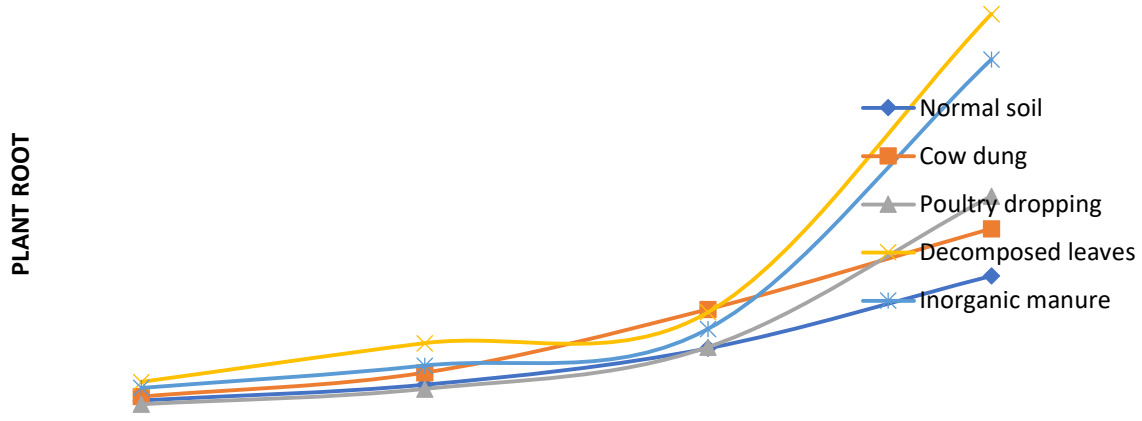

Figure 4 Variations of Plant Root Using Different Treatments

4.1.5 Effects of Different Organic and Inorganic Fertilizers on Number of Leaves

Effects of different fertilizers on number of leaves of amaranth in the study area was analyzed and the result is presented below in table 5

Table 5: Effect of different organic and inorganic fertilizers on number of leaves

	Weeks			
Treatment	1st	2nd	3rd	4th
Normal Soil	2.23 ± 0.1936[a]	3.43 ± 0.4107[a]	4.66 ± 0.7819[a]	11.59 ± 0.0931[a]
Cow Dung	2.43 ± 0.2511[ab]	3.37 ± 0.3388[a]	4.73 ± 0.5162[a]	11.38 ± 0.1479[a]
Poultry Dropping	2.30 ± 0.1700[ab]	3.58 ± 0.4984[a]	4.88 ± 0.6501[a]	11.08 ± 0.3691[a]
Decomposed leaves	2.64 ± 0.3544[b]	3.71 ± 0.5625[a]	5.28 ± 0.6831[a]	12.61 ± 2.0377[a]
Inorganic Manure	2.40 ± 0.1100[ab]	3.34 ± 0.2110[a]	7.26 ± 0.1746[b]	11.35 ± 0.5105[a]

Mean ± Standard Deviation. Means in column with different superscript alphabet are significantly different ($p<0.05$)

The effects of different organic manure on number of leaves of amaranth was not significantly different as the result is $P \geq 0.05$ at 2 weeks, 3 weeks and 4 weeks after sowing as shown in table 5 and figure 5.

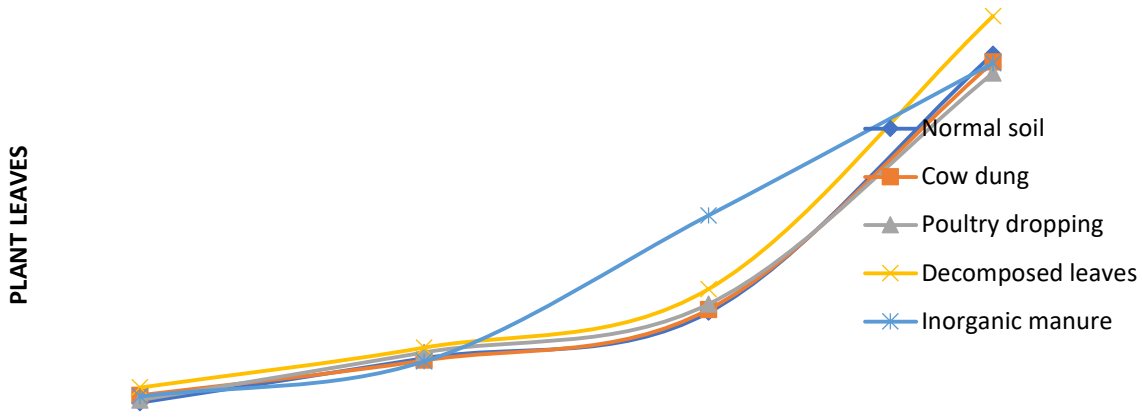

Figure 5 Variations of Plant leaves Using Different Treatments

The result indicates that Plants in Decomposed leaves had more numbers of leaves of (2.64, 3.71, and 12.61) at 1, 2 and 4 weeks after sowing, respectively, while Control (Normal soil) recorded the fewest numbers of leaves (2.23) at 1 weeks after sowing although, this was not significantly different (P≥0.05) from what was obtained in Poultry dropping. Poultry dropping treatment also recorded the fewest number of (11.08) leaves at 4 weeks after sowing, respectively, though, number of leaves recorded in poultry dropping treatment at week 4 was not significantly different (P≥0.05) from other treatments. Tindall (1975) reported that *Amaranthus* require soils with high organic content and such soils favoured the production of leaf number and leaf area. Olufolaji et al. (1985) stated that the lowest fertilizer of 60 t/ha gave the least leaf number and leaf area per plant when compared to other higher level of fertilizer application in *Amaranthus.*

5.0 CONCLUSION

From the result obtained in this study, it can be concluded that the use of organic and inorganic fertilizer in *Amaranthus* production is desirable as it has various impacts on the parameters assessed in the experiment. The fertilizers was found consistently to have affected the plant heights, numbers of node, stem girth, leave length and root length of *Amaranthus*.

6.0 RECOMMENDATION

Base on the results of the study the following recommendations were made;

i. That the used of organic manure should be intensified due to its low cost, availability and environmental friendly

ii. Cultivators of amaranth should avoid the use of chemical (synthetic) fertilizers

iii. Further research should be carry out on how organic and inorganic fertilizers affect the nutrient content of *Amaranthus*

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Conflicts of Interest: The authors declare no conflict of interest

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