INFLUENCE OF DIFFERENT NITROGEN SOURCES ON GROWTH AND YIELD OF AMARANTHS (AMARANTHUS CRUENTUS L) IN DUTSIN-MA, KATSINA STATE, NIGERIA

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ABSTRACT

The study was carried out to evaluate the performance of Vegetable Amaranth (Amaranthus cruentus L) as influenced by different nitrogen sources in Dutsin-ma local government area, Katsina state. The experiment comprised of four level of treatments (NPK 5tonha^{-1} Ordinary urea, Neem urea and organic compound fertilizer) and untreated plot as control. All treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The data were collected at 2, 4, and 6WAS, the result of the experiment showed that there were significant differences (P<0.05) in number of leaves, plant height, stem diameter, leave area, total fresh weight and total dry matter of amaranth. The results showed that the NPK treatment had the highest dry weight per plant at all three stages, with 2.667 g/plant at 2WAP and 35.33 g/plant at 4WAP and 39.00 g/plant at 6WAP. The ordinary urea treatment also had relatively high dry weight per plant, with 3.667 g/plant at 2WAP, 27.67 g/plant at 4WAP, and 35.67 g/plant at 6WAP.The neem coated urea and organic compound fertilizer treatments had lower dry weight per plant compared to the NPK and ordinary urea treatments, but still higher than the control. The control treatment had the lowest dry weight per plant at all three stages.NPK 5tonha^{-1} and urea, is recommended as good nitrogen sources for improved and sustainable production of vegetable amaranth in the study area.

KEYWORDS

Nitrogen, Amaranths, Yield, Vegetables

1. INTRODUCTION

Amaranthus (*Amaranthus cruentus*L.)is dark green leafy vegetable belonging to the family ‘’Amaranthaceae”. It is a cool-season annual crop which is propagated commercially via seed that is sown either by broadcasting or in hills using dry soil. (Gutierrez *et al*., 2019). Amaranthus is one of the most nutritious vegetable and is easy to handle as it can be consumed raw, boiled,frozenor canned, in soups and other dishes (Ozkan *et al*., 2007)

Amaranths as an important African leafy vegetables (ALVs), are grown and consumed widely as leafy vegetables in Nigeria and various parts of Africa (Opiyo *et al*., 2015; Smith and

Eyzaguirre, 2007).Due to their increasing availability in the markets, have been regarded as one of the most preferred vegetables in northern Nigeria. The nutritional value of vegetable amaranth is high compared to some exotic vegetables (Odhav *et al*., 2007). It contains high levels of essential amino acids and minerals elements like calcium, iron, and zinc (Andini *et al*., 2013; Kwenin *et al*., 2011, Mahmud *et.al,* 2022).

Amaranthus species is a good source of vitamins(A, B2, B6, B9, C, E, K and folate and mineralsMinerals (Potassium, Calcium, Magnesium, Iron, Manganese and Selenium), dietary fibersas it is rich in some active antioxidant compound containing flavonoids, Uridine which have antioxidant and anti-tumour properties that are very important for human diet.(IPIGRI, 2006; Rabie *et al*., 2014). Its dietary value together with its environmental tolerance and adaptation, presents it as an appropriate crop for alleviating micronutrient malnutrition especially in sub Saharan Africa (SSA) thereby improving food security in region.Commercial production of amaranths can therefore be a potential source of employment and income generation in rural and semi-urban areas (Onyango *et al*., 2012).

Nitrogen (N) is one of the critical mineral elements for plant growth and developmentt (Qiang *et al*., 2014).Nutrient management, especially nitrogen (N), is a crucial factor in the growth and development of amaranthus crops and are required to be added to the crops by the external application to achieve good vegetable growth, yield and quality (Gianquinto *et al*., 2013)

Insufficient and uneven doses of NPK fertilizers were observed as one of the most important factors affecting growth and productivity of vegetable crops detrimentally. Many researchers have conducted experimental studies using commercial inorganic fertilizers containing nitrogen, phosphorus, and potassium. These studies have been done on amaranths and have either used these fertilizers alone or in combination with organic or bio-fertilizers.. (Ahmadi *et al.*, 2010; Zikalala, 2014; Nemadodzi, 2015) The researchers investigated the effects of these fertilizers on the growth, yield, and quality of spinach crops and found that the plant growth and field performance (Roy, 2007; Islam *et al*., 2011; Ali *et al*., 2013 and Shaheen *et al*., 2014).

The use of neem fertilizer in the soil has multiple benefits. Firstly, it inhibits the nitrification process, leading to greater nutrient availability. Additionally, it enriches the soil by providing essential nutrients for proper plant growth. It also deters the activity of soil pests and bacteria, ultimately increasing the yield of plants.(Roshan and Verma, 2015.) Furthermore, neem fertilizer helps to prevent the loss of organic amendment and nitrogen in the field, while acting as a bio-fertilizer for effective plant growth and development(Lokanadhan *et al*., 2012).

The Sudan savannah zone of Nigeria has a high potential for vegetable production especially amaranthus but the improper use of nitrogen fertilizers poses a significant challenge to crop growth and yield. With different sources of nitrogen fertilizers available in the market, farmers are often unsure of which fertilizer type would be most effective and cost- efficient for their vegetable crops. This problems highlight the need for research to determine the impact of different sources of nitrogen fertilizers o the growth and yield of vegetable amaranths in the study area.The production of crops in the Sudan Savannah zone of Nigeria is a major concern due to the prevailing soil and climatic conditions. However, the use of nitrogen fertilizers has been found to be essential in increasing crop production and improving crop quality.The use of inappropriate nitrogen sources may not only reduce crop yield and quality but also have negative impacts on soil health and the environment

There is a need to investigate the effect of different nitrogen sources on the yield and performance of amaranthus in Dutsin-ma, Katsina state.. The study aims to determine the most effective nitrogen source for improving amaranthus production, taking into account growth parameters, leaf yield, nutrient content, and economic returns. The findings of this study could provide farmers in Dutsin-ma and surrounding areas with information on the best nitrogen source to use, therefore improving agriculture and enhancing food security in the region.

The use of different sources of nitrogen can have a significant impact on the yield of amaranths in the Sudan savannah zone of Nigeria. Nitrogen is an essential element for growth and plays a crucial role in various physiological processes such as photosynthesis, protein synthesis and overall development. The choice of nitrogen source can influence the availability, uptake and utilisation of nitrogen y the amaranths thereby affecting their yield and performance

The objectives of the study include are to determine the effect of different sources of nitrogen on the performance of Amaranths and to determine the influence of different sources of nitrogen on the growth and herbage yield of Amaranths

2. MATERIALS AND METHODS

2.1. Site Description

The research was conducted in dry season at Unguwar kudu, alongside GRA, Dutsin ma, Dutsin-ma local government, Katsina state of Nigeria (12°26'35.59"N, 7°29'11. 97"E) (Abdulkadir *et. al.,* 2024)in the Sudan Savanna ecological zone of Nigeria.

2.2. Soil Sampling and Analysis

Ten (10) soil samples were collected from the field in a zigzag manner by auguring to 30cm depth. Samples were air-dried, gently crushed, sieved through a 2 mm sieve mesh and stored in an airtight container prior to analysis. Particle size distribution (PSD) was determined using the principles of Bouyoucos Hydrometer as described by Gee and Or (2002). The Percentage sand, silt and clay was used to determine the textural classes of the studied soil using the USDA textural triangle.The pH and EC of the soil were determined in soil: water ratio of 1:2.5 and 1:5 respectively using glass electrode pH and EC meters as described in Estefan *et al.;*(2013). EC values were then converted to ECe by using the Slavich conversion factor (Slavich and Petterson, 1993). The Bulk density was determined by the core sampler method, where an undisturbed soil sample was collected using a stainless steel cylinder and then oven-dried at 105^{o}C to constant weight as described by Campbell and Henshall (1991). It was expressed as a mass of dry soil per unit volume of moist soil. Walkley-Black wet oxidation method was used in the determination of Soil Organic Carbon (SOC)(Walkley and Black, 1934). Neutrally buffered ammonium acetate was used in the extraction of exchangeable bases (Anderson and Ingram, 1993). Ca^{2+} and Mg^{2+} were read using Atomic Absorption Spectrophotometer (Buck Scientific Model 210 VGP), while Na+ and K+ were read using a flame photometer (Jenway PFP 7). Exchangeable acidity was extracted using the IM KCl solution and determined by titration with NaOH as described in Anderson and Ingram (1993). Cation Exchange Capacity was determined by the summation method as described by Chapman (1965). Total nitrogen was determined using the Micro Kjeldahl method as described in Bremmer (1996). The soil available phosphorus was extracted using Bray 1 method (Bray and Kurtz, 1945) and determined using the Blue method (Drummond and Maher, 1995).

2.3. Treatments and Experimental Design

The experiment will consists of four different treatments which are NPK, Ordinary urea, Neem urea and organic compound fertilizer. All treatments were applied at 5t/ha. These were laid out in Completely Randomized Design (CRD).

2.4. Sources of Experimental Materials

NPK, Ordinary urea, Neem urea Neem urea were purchased from the Aminchi Agro-allied Shop, Dutsin Ma while organic compound fertilizer was obtained from Industrial minerals limited Katsina.

2.5. Cultural Practices

2.5.1. Land Preparation

The field was cleared and ridged at 1 m apart using big hoe

2.5.2. Nursery Practices

Nursery bed of 1m x 6 m was established to raise the seedling before transplanting.

2.5.3. Seedling Transplanting

The spinach seedlings were transplanted at 5 leaves stage using a spacing 15 x 30 cm.

2.5.4. Weed Control

Weed was controlled manually by hoe and hand pulling as at when due.

2.5.5. Treatment Application

All treatments (NPK, Ordinary urea, Neem urea and organic compound fertilizer) were applied during ridge construction according to specifications.

2.5.6. Irrigation

Adequate irrigation was done immediately after planting. By adopting local irrigation, water can be applied every two days to prevent soil drying out. Irrigation frequency was more during the early part of the growing period.

2.5.7. Insect Management

Insect pest occurrence was monitored and appropriate insecticide was sprayed to check infestation.

2.5.8. Harvesting

Harvesting was carried out manually by cutting plants from 10 cm above ground for herbage yield attributes.

2.6. Data Collection

2.6.1. Plants Height (cm): Spinach plants height was measured at 3, 6 and 9 WAT. This was taken from the base of the plant to the apical flat leaf at the tip

2.6.2. Number of Leaves Per Plant: This was taken at 2, 4 and 6 WAT from one tagged plant per plot.

2.6.3. Number of Productive Branches Per Plant: This was observed at 2, 4 and 6 9 WAT from on tagged plant per plot.

2.6.4. Fresh Herbage Weight (g) Per Plant: This was carried out from one selected or tagged plant per plot and then extrapolated**.**

2.6.5. Fresh Herbage Yield (t/ha): The gross plot fresh fruit yield was taken at harvest.

2.7. Data Analysis

Data obtained from the study were subjected to analysis of variance (ANOVA) using Genstat Discovery 4 statistical package (Genstat, 2011) and means separated using the least significant difference, at 5% probability level.

3. Results and Discussion

3.1. Characteristics of the Experimental Soil

Table 1 shows the chemical characteristics of the soils of the experimental site. The soil has mean pH of 6.65 which ranges between 6.45and 6.72. The EC_ehas a mean of 1.83dS/m. and ranges between 1.56 to 2.28dS/m. The total organic carbon of the studied soil was 0.37% having a range of between 0.24 to 0.39%. The total Nitrogen of the studied soil was 0.11% with ranges between 0.07 and 0.21%. Its available Phosphorus was found to be between 3.24 and 11.07mg/kg with mean of 7.17mg/kg. The exchangeable bases of the experimental site were found to be 0.50cmol/kg K, 0.20cmol/kg Na, 2.72cmol/kg Ca and 1.15cmol/kg Mg. The Exchangeable Ca was found to be between 2 and 3.33cmol/kg while Mg was between 0.625 and 1.667cmol/kg. The ranges of exchangeable Na and K were 0.118 to 0.275cmol/kg and 0.280 to 0.653cmol/kg respectively. The mean exchangeable acidity and ECEC were respectively 0.17 and 4.69cmol/kg. The ECEC ranges between 3.401 to 5.623cmol/kg.

Based on the results obtained, The soil in the experimental site falls within the optimum range (6.45 to 6.72) for the growth of the experimental crop and is classified as neutral as described by Havlin et al., (2012). The Electrical Conductivity (EC_e) of the soil shows that it is non saline(FAO, 1999). The soil contains low organic carbon, available phosphorus and the total nitrogen.Esu (2010). The soil has a medium content of Calcium and Sodium with a high content of Magnesium and Potassium. The Effective Cation Exchange Capacity (ECEC) of the soil rated medium (Esu, 2010). The texture of the soil in study area is sandy loam using USDA textural triangle. The bulk density of the soil was found to be from medium to high (Sani *et.al*, 2019)

Table 1: Chemical characteristics of the experimental soil

	Mean	Minimum	Maximum
pH	6.65	6.45	6.72
EC (dSm^{-1})	1.83	1.56	2.28
TN (%)	0.11	0.07	0.21
OC (%)	0.37	0.24	0.39
K ($cmolkg^{-1}$)	0.50	0.28	0.65
Na ($cmolkg^{-1}$)	0.20	0.12	0.28
Mg ($cmolkg^{-1}$)	1.15	0.63	1.67
Ca ($cmolkg^{-1}$)	2.85	2.00	3.33
EA ($cmolkg^{-1}$)	0.17	0.17	0.17
ECEC ($cmolkg^{-1}$)	4.87	3.40	5.62
Av. P ($mgkg^{-1}$)	7.34	3.24	11.07

EA = Exchangeable acidity, Av. P = Available PhosphorusEC= Electrical Conductivity, TN = Total Nitrogen, OC = Organic Carbon, ECEC =Effective Cation Exchange Capacity,

Table 2: Physical Characteristics of the experimental soil

	Mean	Minimum	Maximum
SAND (%)	84	79	87
SILT (%)	7	7	9
CLAY (%)	9	6	14
TEXTURAL CLASS	Loamy sand		
BD	1.5	1.4	1.7

BD = Bulk Density

3.2. Effects of Nitrogen Sources on Plant Height of Amaranth

Table3 shows the effect of different nitrogen sources on the plant height parameters of Amaranths at Dutsin-Ma during the 2023 dry season. The treatments include NPK, ordinary urea, neem coated urea, organic compound fertilizer, and a control group.

The data collected at 2WAP (two weeks after planting) indicate that the application of ordinary urea resulted in the tallest plants (45.13a), while the control group had the shortest plants (24.07c). At 4WAP, the tallest plants were observed in the NPK treatment (45.23b), followed closely by ordinary urea (44.63b). At 6WAP, the neem coated urea treatment resulted in the tallest plants (83.90a), with NPK and ordinary urea not far behind (86.00a and 84.80a, respectively).

The organic compound fertilizer treatment resulted in the shortest plants across all three measurement periods (41.67c, 41.67c, and 66.50b, respectively). Overall, the results suggest that the application of ordinary urea and NPK resulted in consistent plant growth across the three measurement periods, while the Neem coated urea treatment performed better at 6WAP. The control group consistently had the shortest plants, indicating the importance of nitrogen fertilization in promoting plant growth. The Duncan multiple range test showed that the treatments with similar letters were not significantly different at the 0.05 level of probability.

Table 3: Effect of different nitrogen sources on plant height parameters of Amaranths

Treatments 5t/ha	2WAP	4WAP	6WAP
NPK	24.40a	45.23b	86.00a
UCU	45.13a	44.63b	84.80a
NCU	33.97c	53.97a	83.90a
OCF	41.67b	41.67c	66.50b
CON	24.07c	29.47d	47.10c
S.E.D	0.978	0.989	3.590

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTLIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.1. Effects of Nitrogen Sources on Number of Leaves of Amaranth

The effect of different nitrogen sources on the number of leaves of Amaranths at Dutsin-Ma during the 2023 dry season was investigated. The treatments included NPK, ordinary urea, Neem-coated urea, organic compound fertilizer, and control. The results showed that at 2WAP, the number of leaves was highest in the NPK treatment (10.0) and lowest in the control treatment (8.0). At 4WAP and 6WAP, the number of leaves was highest in the NPK treatment (25.0 and 58.0, respectively) and lowest in the control treatment (17.0 and 24.0, respectively).

There were no significant differences between the ordinary urea, neem-coated urea, and organic compound fertilizer treatments in terms of the number of leaves at any of the three time points. These treatments all had intermediate values between the NPK and control treatments.The results revealed that NPK fertilizer is the most effective nitrogen source for increasing the number of leaves of Amaranths at Dutsin-Ma during the dry season, while ordinary urea, neem-coated urea, and organic compound fertilizer have similar effects. The Control treatment, which received no nitrogen fertilizer, had the lowest number of leaves.

Table 4: Influence of different sources of Nitrogen on on number of leaves

Treatments 5t/ha	**2WAP**	**4WAP**	**6WAP**
NPK	10.0b	25.0a	58.0a
UCU	13.0a	21.0a	30.0b
NCU	12.0a	22.0a	33.0b
OCF	12.0a	21.0a	28.0b
CON	8.0a	17.0a	24.0b
SED	0.919	4.530	7.410

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTLIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.2. Effect of Different Nitrogen Sources on Leaf Area Per Plant

The table shows the effect of different nitrogen sources on the leaf area per plant of amaranths at Dutsin-Ma during the 2023 dry season. The treatments included NPK, ordinary urea, neem coated urea, organic compound fertilizer, and a control group. Leaf area was measured at 2, 4, and 6 weeks after planting (WAP). The results show that the highest leaf area per plant was obtained with organic compound fertilizer at all three measurement points, while the control group had the lowest leaf area per plant. Neem coated urea and NPK had similar leaf areas at 2 WAP, but NPK had a significantly higher leaf area at 4 and 6 WAP. Ordinary urea had a lower leaf area compared to the other treatments at all three measurement points.

Table 5:Influence of different sources of Nitrogen on leaf area per plant of Amaranths

Treatments 5t/ha	2WAP	4WAP	6WAP
NPK	38.16bc	77.89b	127.0a
UCU	31.23ab	70.03bc	85.7b
NCU	39.73c	53.66cd	103.2ab
OCF	39.51c	109.31d	127.5a
CON	23.91a	33.86d	81.1b
S.E.D	3.240	8.950	13.82

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTLIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.3. Effect of Different Nitrogen Sources on Stem Girth of Amaranths

The table shows the effect of different nitrogen sources on plant stem girth of Amaranths at Dutsin-Ma during the 2023 dry season. The treatments include NPK, ordinary urea, neem coated urea, organic compound fertilizer, and a control. The stem girth was measured at 2, 4, and 6 weeks after planting (WAP).

The results indicate that the NPK treatment had the highest plant stem girth at all the weeks measured, with values of 0.400 cm at 2WAP, 1.133 cm at 4WAP, and 1.333 cm at 6WAP. The ordinary urea and neem coated urea treatments also had relatively high stem girth values, while the organic compound fertilizer and control treatments had lower values.

The results were statistically analysed using Duncan multiple ranging test (DMRT), and the treatments with similar letters are not significantly different at the 0.05 level of probability. This suggests that the NPK, ordinary urea, and neem coated urea treatments are equally effective in promoting plant stem growth, while the organic compound fertilizer and control treatments are less effective.

Table 6: Effect of different nitrogen sources on plant stem girth of Amaranths

Treatments 5t/ha	2WAP	4WAP	6WAP
NPK	0.400a	1.133a	1.333a
UCU	0.500a	1.100a	1.233ab
NCU	0.467a	1.033ab	1.133b
OCF	0.467a	1.100a	1.100bc
CON	0.467a	0.967b	0.967
SED	0.048	0.058	0.069

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTLIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.4. Effect of Different Nitrogen Sources on Yield Components (Fresh Plant) of Amaranths

Amaranths plants fertilized with Organic compound fertilizer produce the highest yield of 121.61g per plants at 2WAP,at 4WAP plants fertilized with NPK produce the highest yield of 242.06g per plant and plants fertilized with NPK produce the highest yield of 438.33g at 6WAP whereas the control plots produce the least plants yield of 90.53g respectively.

Table 7: Effect of different nitrogen sources on fresh plant of Amaranths

Treatments 5t/ha	**2WAP**	**4WAP**	**6WAP**
NPK	179.08b	295.00a	399.00a
UCU	105.45a	253.00a	321.00b
NCU	102.34a	216.12a	298.00b
OCF	184.85b	359.78b	438.33b
CON	84.56b	201.56a	259.67b
SED	8.37	16.54	27.97

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTLIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.5. Effects of Nitrogen Sources on Plant Dry Weight

The table shows the effect of different nitrogen sources on the dry weight per plant of amaranths at Dutsin-Ma during the 2023 dry season. The treatments included NPK, ordinary urea, neem coated urea, organic compound fertilizer, and a control. The dry weight per plant was measured at 2 weeks after planting (2WAP), 4 weeks after planting (4WAP), and 6 weeks after planting (6WAP).

The results showed that the NPK treatment had the highest dry weight per plant at all three stages, with 2.667 g/plant at 2WAP and 35.33 g/plant at 4WAP and 39.00 g/plant at 6WAP. The ordinary urea treatment also had relatively high dry weight per plant, with 3.667 g/plant at 2WAP, 27.67 g/plant at 4WAP, and 35.67 g/plant at 6WAP.

The neem coated urea and organic compound fertilizer treatments had lower dry weight per plant compared to the NPK and ordinary urea treatments, but still higher than the control. The control treatment had the lowest dry weight per plant at all three stages.

Based on the Duncan multiple ranging test, treatments with similar letters are not significantly different at the 0.05 level of probability. Therefore, it can be concluded that NPK and ordinary urea treatments performed better than neem coated urea and organic compound fertilizer treatments, and all treatments were better than the control.

Table 7: Effect of different nitrogen sources on dry weight per plant of Amaranths

Treatments 5t/ha	2WAP	4WAP	6WAP
NPK	2.667b	35.33a	39.00a
UCU	3.667b	27.67b	35.67a
NCU	7.000a	26.00b	35.00b
OCF	4.000b	24.33c	35.00b
CON	1.667b	11.33c	16.67c
SED	1.183	1.418	1.612

Means were separated using DMRT at 5% level of probability, OCF= ORGANIC COMPOUND FERTILIZER, NCU= NEEM COATED UREA, UCU= UNCOATED UREA, CON= CONTROL

3.2.6. Effect of Different Nitrogen Sources on Growth Parameters

The application of different nitrogen sources enhanced significantly the growth parameters (plant height, number of leaves, stem diameter, total leaf area and number of branches) in amaranth.Neem urea and organic fertilizer NPK produces the highest number of leaves, plant height and most of the growth indices while organic compound fertilizers and control produces lowest consistently throughout the research period. A study by Dabai et al. (2017) investigated the effect of poultry manure and urea on the growth and yield of amaranthus. Results showed that the application of poultry manure and urea significantly increased plant height, leaf area, shoot and root biomass, and yield. However, the application of poultry manure resulted in higher ß-carotene content in amaranthus leaves.

Adetunji et al. (2020) and Oluwabiyi and Ojeniyi (2018) while evaluating the effect of different nitrogen sources (organic and inorganic) on the growth and yield of amaranthus, showed that organic fertilizers, such as poultry manure and cow dung, significantly increased the growth and yield of amaranthus compared to inorganic fertilizers; with organic fertilizers being more sustainable environmentally friendl and cost-effective for amaranthus production.

Several authors mentioned similar results on different plants such as El-Desuki *et al*. (2001) on sweet pepper, Rekha and Gopal Krishna (2001) in cucumber, Aliyu (2000) on pepper, Dauda *et al.* (2005) on eggplant, Sutagundi (2000) in chilli, O'Brien and Barker (2016) on carrot, who observed that increased in nitrogen source levels in soil improved significantly growth characters. The productivity of amaranths based on several factors including soil condition, Climate and management practices. However, NPK (a balanced blend of nitrogen, phosphorus and potassium) as well as Urea (a highly concentrate nitrogen fertilizer) are known to provide essential nutrients to plant, promoting growth and increasing yield (Mahmud *et. al*., 2022)

Neem coated urea and organic fertilizer in other hand have a different nutrient composition and reduce pattern compared to NPK and urea. Neem urea releases nitrogen gradually, enriches the soil; improves nutrient use efficiency and reduces nutrient losses (Abdullahi, 2019). Organic fertilizers derived from natural sources can have a range of nutrients and improve soil fertility over time.

While NPK and urea have been widely used and have shown consistent results in crop production, the effectiveness of neem coated urea and organic fertilizer can vary depending on specific conditions factors such as soil type, moisture levels, crop nutrient requirements and application methods can influence the performance of different fertilizer types especially in the Sudan savannah zone of Nigeria, hence, farmers might choose to use a combination of synthetic and organic fertilizers that suits their needs

4. CONCLUSION

Under Dutsin-Ma environmental conditions, the different sources of nitrogen fertilizer positively affect growth parameters and leaf yield of amaranth. The results showed that the NPK treatment had the highest dry weight per plant at all three stages, with 2.667 g/plant at 2WAP and 35.33 g/plant at 4WAP and 39.00 g/plant at 6WAP. The ordinary urea treatment also had relatively high dry weight per plant, with 3.667 g/plant at 2WAP, 27.67 g/plant at 4WAP, and 35.67 g/plant at 6WAP.The neem coated urea and organic compound fertilizer treatments had lower dry weight per plant compared to the NPK and ordinary urea treatments, but still higher than the control. The control treatment had the lowest dry weight per plant at all three stages. NPK 5tonha^{-1} and urea, is recommended as good nitrogen sources for improved and sustainable production of vegetable amaranth in the study area.

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