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Effect of cow dung and urea on some soil properties and growth of Amaranthus in Bennubyen flood plain in Wukari

Waizah Yakub[1+]
Onwu Clement Alex[2]

[1,2]*Department of Soil Science and Land Resources Management, Federal University Wukari, Nigeria.*
[1]*Email: waizahyakub@gmail.com*
[2]*Email: clementonwu@gmail.com*

(+ Corresponding author)

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ABSTRACT

A field trail was conducted in Bennubyen flood plain of Wukari, Taraba State, Nigeria to evaluate the effect of cow dung and urea on some soil properties and growth of *Amarathus hybridus*, The experiment was laid out in a Randomized complete block design (RCBD), with seven treatments replicated three times, T_1 receives 30 t/ha, T_2 received 150 kg/ha, T_3 received 75kg/ha + 30 t/ha, T_4 received 15 t/ha + 150 kg/ha, T_5 received 15 t/ha T_6 received 75 kg/ha, and T_7 received no treatment and serve as the control. The pre cropping soil analysis when compared with post cropping soil analysis showed that, application of organic and inorganic fertilizers improved soil OC, OM, N %, ECEC, and available P, while decrease was observed on the pH, Zn, Cu, Mn and Fe. The results on the growth parameters and yield of *Amarathus hybridus* were significantly ($p<0.05$) improved by the applications of urea and cow dung, the highest increase was observed on the treatment with cow dung (30 t/ha), urea (150 Kg/ha) and cow dung 15 t/ha combined with urea (75kg/ha). The use of urea and cow dung is therefore essential in increasing *Amaranthus hybridus* yield. Since no significant difference was found at 30 t /ha of cow dung, 150kg/ha of urea and 15t/ha of cow dung and 75kg /ha of urea combined, use of cow dung at the rate of 30t/ha is recommended.

Contribution/Originality: The findings from this research contributes to the knowledge of the use of cow dung as a source of fertilizer in the production of amaranth in Northern Nigeria.

1. INTRODUCTION

Amaranth, a vegetable plant commonly grown in Nigeria, is widely utilized in Nigerian cuisine for various dishes such as soups, stews, salads, porridge, and side dishes (Shehu et al., 2019). This long-stemmed annual plant has a short life cycle of two to three months and is extensively cultivated in different Savannah climates. Its popularity is increasing, with over 60 species being cultivated in Asia, Australia, North and South America, Europe, and Africa (Spetter & Thompson, 2007).The genus Amaranthus comprises nearly 60 cultivated species, while others are considered as weeds. Among these species, Amaranthus hybridus is particularly prevalent as a green leafy vegetable widely cultivated throughout Nigeria. It is a robust plant with heavy branching, capable of reaching a height of one meter or more if allowed. The leaves are broad, ovate, and densely packed on the primary stem and branches, making it a common choice for leafy vegetable consumption (Maseko et al., 2017). Amaranthus is known as a low-maintenance crop that can thrive in poor soil conditions. However, studies have shown that its yield can be improved through the application of fertilizers (Maseko et al., 2017). In Wukari, where amaranthus is a staple food, there has been a decrease in market supply due to low yields. This is primarily attributed to the prevalence of

subsistence farmers in the area. To enhance productivity, urea is commonly applied to amaranthus as nitrogen has been identified as the primary limiting factor in leafy vegetable production (Olowoake & Ojo, 2014). Unfortunately, most Nigerian soils are deficient in nitrogen (Yakub, Saddiq, Solomon, Bawa, & Abdullahi, 2022), and the scarcity and high cost of nitrogen fertilizer sources pose challenges for subsistence farmers. As a result, alternative sources of fertilizer, such as organic manure (cow dung), are being considered in the study area.

2. MATERIAL AND METHODS

This study was conducted at Bennubyen floodplain, Wukari local Government area of Taraba State, Nigeria. The study area is located between longitude 9^0 08 and 10^0 23East of the meridian and latitude 7^0 35and 8^0 15 North of the equator. It lies in the Southern part of the Guinea Savannah Zone. The experiment was laid in a Randomized complete block design (RCBD), with 7 treatments replicated three times. The treatments were, cow dung (CD) 30t/ha, urea 150kg/ha, cow dung (CD) 30t/ha + urea 75t/ha, cow dung (CD) 15t/ha + urea 150kg/ha, urea 75kg/ha, cow dung (CD) 15t/ha and the control. The amaranth was raised on a nursery bed and transplanted to 2m × 3m bed at 10cm ×10cm spacing three week after planting. The treatments were applied by broadcasting method two weeks after transplanting, and weeding was done manually. Soil samples (0-20cm) were collected at the beginning and at the end of the experiment, and were air dried and prepared for Laboratory analysis. Soil samples were analyzed using standard laboratory procedures. The pH was determined using digital pH meter with glass electrode in soil water at 1:1 ratio. Organic carbon (OC) was measured by chromic acid wet oxidation procedure as described by Jackson (1962). Available P was extracted using Bray-1 solution (Bray & Kurtz, 1945) and the phosphate in the extract was analysed calorimetrically by the molybdenum blue colour method as described by Murphy and Riley (1962). Exchangeable bases were extracted using 1 N neutral ammonium acetate solution. Ca and Mg content of the solution were determined volumetrically by EDTA titration while K and Na were determined by flame photometry. Total Nitrogen of the soil was determined by Micro- Kjedhal procedure as described by Jackson (1962) and the exchangeable acidity was determined by the KCl extraction and titration method of McLean (1965). Five plants were selected from each plot and data on plant height, stem girth, number of leaves and leaf area of amaranth were collected biweekly. The pooled data were subjected to analysis of variance (ANOVA) and we used Duncan multiple range test (DMRT) to separate the means at 5% probability level (P= 0.005).

Table 1. Some properties of soil of the study area before experiment.

Parameter	Soil test value
Sand (%)	76.4
Silt (%)	15.4
Clay (%)	8.2
Tex. (US)	LS
pH (H20)	5.7
Organic. C (gkg-1)	6.0
Total N (gkg-1)	1.7
Available P (mg/kg)	2.94
Exch Ca (cmol/kg)	0.57
Exch Mg (cmol/kg)	0.41
Exch Na (cmol/kg)	0.91
Exch K (cmol/kg)	0.27
ECEC (cmol/kg)	3.76

3. RESULT

Some physico-chemical properties of the soil in the study area before the start of the experiment is presented in Table 1. The soil is loamy sand (LS) with moderate compaction. The soil is moderately acidic with pH value of 5.7

(Usman, 2005). The organic carbon and available phosphorous were low with their values as 6.0 gkg-1 and 2.94 mgkg-1 while the total nitrogen was medium with value of 1.7gkg-1 (Aduayi, Chude, Adebusuyi, & Olayiwola, 2002). The Exchangeable cations were generally low except exchangeable Na (0.91 cmol kg^{-1}), the effective cation exchange capacity was lower than the minimum limit (4 cmol kg^{-1}) required by most plant (FAO, 2006).

The effect of the treatments on the chemical properties of the soil of the study area is presented in Table 2. The pH of the soil was moderately acidic in all the treatments with the mean values of 5.3, 5.6 for Cow dung (C D) 30t/ha and urea 150kg/ha, 5.5 for 30t/ha +75kg/ha and 15t/ha +150kg/ha while 15t/ha, 75kg/ha and the control had pH of 5.7.

The plot treated with 30 t/ha cow dung, 30 t/ha cow dung + 75 kg/ha urea and 15 t/ha cow dung had the highest organic carbon content which were 1.96 %, 1.99 % and 1.98% respectively, while the mean values for the plots treated with 75 kg/ha urea and the control was significantly low. The plots treated with different combinations of urea and cow dung exhibited varying levels of total nitrogen, phosphorus, potassium, sodium, and effective cation exchange capacity (ECEC).

The total nitrogen content was significantly higher in the plots treated with 150kg/ha urea, 30t/ha cow dung + 75 kg/ha urea, and 15t/ha cow dung +150 kg/ha urea, with mean values of 0.23%, 0.21%, and 0.22% respectively. In contrast, the control plot and the plot treated with 15 t/ha cow dung had significantly lower mean values of 0.12% and 0.13% respectively. The available phosphorus content was found to be high in the plot treated with 30 t/ha cow dung, 30 t/ha cow dung + 75 kg/ha urea, and 15 t/ha cow dung +150 kg/ha urea.

Furthermore, the plots treated with 30 t/ha cow dung, 150kg/ha urea, 30 t/ha +75kg/ha urea, and 15 t/ha cow dung +150kg/ha urea exhibited significantly higher levels of exchangeable potassium and sodium. The mean values for potassium were 2.4 Cmol/kg, 4.4 Cmol/kg, 1.5 Cmol/kg, and 1.8 Cmol/kg respectively, while the mean values for sodium were 1.9 Cmol/kg, 2.8 Cmol/kg, 1.4 Cmol/kg, and 2.7 Cmol/kg respectively.

Interestingly, the effective cation exchange capacity (ECEC) of the soil increased in all treatments except for the control plot. The plot treated with 30 t/ha cow dung showed a significant increase in ECEC, reaching 10.60 cmol/kg. The plots treated with 30 t/ha cow dung + 75 kg/ha urea, 15t/ha cow dung +150 kg/ha urea, and 15t/ha cow dung had ECEC values of 7.5 cmol/kg, 6.9 cmol/kg, and 7.4 cmol/kg respectively.

The findings indicated that the height of the plants increased as they aged across all the experimental conditions. Specifically, the plot that was treated with 30 t/ha of cow dung exhibited the greatest plant height, measuring 32.30, 40.03, 50.67, 63.77, and 76.80 cm at 3, 4, 5, 6, and 7 weeks after planting, respectively. On the other hand, the Amaranthus hybridus plants that did not receive any fertilizer displayed the lowest average plant height, measuring 25.10, 32.10, 37.80, 48.30, and 49.47 cm at 3, 4, 5, 6, and 7 weeks after planting, respectively (Table 3). Notably, there were no significant differences in the height of the Amaranthus hybridus plants treated with 30 t/ha cow dung, 30 t/ha cow dung +75 kg/ha urea, and 15 t/ha cow dung +150 kg/ha urea at 5, 6, and 7 weeks after planting. However, all the plots that received cow dung and urea treatments outperformed the plot that did not receive any treatment (Table 3).

Table 4 showed the effect of cow dung and urea on leaf area. The result showed that plots treated with 30t/ha and 150 kg/ha of urea had the highest leaf area at week 7 after planting with values of 62.17 cm^3 and 61.73 cm^3 and not significantly different from the plots treated with 30 t/ha cow dung + 75 kg/ha urea and 15 t/ha cow dung + 150 kg/ha urea with their mean values of 58.07 cm^3 and 57.23 cm^3 respectively, the lowest leaf area was recorded on the plot that had no treatment.

Table 5 showed the effect of cow dung and urea on stem girth of amaranth plant. The result showed that the plot that received cow dung at 30 t/ha and urea 150 kg/ha are statistically not different from each other and had the highest stem diameter with the mean values of 2.9, 3.7, 5.6, 6.7 and 8.30 cm and 2.83, 3.7, 6.17, 7.3 and 8.97 for 3, 4, 5, 6, and 7 weeks after planting.

Table 2. Effect of treatments on physico-chemical properties of the soils of the study area.

Parameters	Sand	Silt	Clay	Txt	pH	OC	N	Av.P	K	Na	Ca	Mg	ECEC
	----------%----------							Mg/kg	----------Cmol/kg----------				
CD 30t/ha	71.15^{c}	18.62^{a}	10.23^{a}	LS	5.3^{b}	1.96^{a}	0.19^{bc}	14.9^{a}	2.4^{a}	4.4^{a}	0.62	0.51	10.6^{a}
Urea 150kg/ha	75.45^{abc}	15.72^{ab}	8.83^{abc}	LS	5.6^{ab}	1.76^{a}	0.23^{a}	8.6^{b}	1.5^{abc}	1.8^{c}	0.65	0.51	5.7b^{c}
CD 30t/ha +Urea 75kg/ha	72.65^{c}	17.63^{ab}	9.73^{ab}	LS	5.5^{ab}	1.99^{a}	0.21^{a}	15.8^{a}	1.9^{ab}	2.8^{b}	0.67	0.54	7.5^{b}
CD15t/ha+ Urea 150kg/ha	75.15^{abc}	15.12^{abc}	9.73^{ab}	LS	5.5^{ab}	1.98^{a}	0.22^{a}	15.5^{a}	1.4^{bc}	2.7^{b}	0.64	0.51	6.9^{b}
Urea 75kg/ha	75.95^{ab}	15.22^{abc}	8.83^{abc}	LS	5.7^{a}	1.04^{b}	0.19^{bc}	5.7^{b}	0.5^{c}	0.8^{d}	0.62	0.50	3.9^{c}
CD 15t/ha	72.15^{bc}	17.62^{ab}	10.23^{a}	LS	5.7^{a}	1.90^{a}	0.18^{c}	6.9^{b}	0.4^{cd}	0.9^{d}	0.63	0.57	7.4^{b}
Control	78.20^{ab}	12.^{bc}	9.23^{b}	SL	5.7^{a}	0.52^{c}	0.12^{c}	5.7^{b}	0.2^{d}	0.9^{d}	0.67	0.53	3.8^{bc}

Note: Mean in column with the same letter show not significant different at $p<0.05$ by Duncan multiple range test.

The lowest stem girth was observed in the plot that received no treatment with the mean values of 1.27, 2.76, 3.40, 3.70 and 4.30 cm for weeks 3, 4, 5, 6 and 7 respectively. All the treatments affected the stem diameter positively. The effect of cow dung and urea on number of leaves of Amaranth is shown in Table 6. The result shows that all the treatments performed significantly better than the control, the effect on the number of leaves at 4 weeks after planting (WAP) are statistically the same except for the control, the plot that received 30 t/ha cow dung +75 kg/ha had the highest mean value of 19.23.

Table 3. Effect of the treatment on plant height (CM).

Parameter	Weeks after planting				
	3	4	6	6	7
CD 30t/ha	32.30^{a}	40.03^{ab}	50.67^{a}	63.77^{a}	76.80^{a}
Urea 150kg/ha	33.00^{a}	41.87^{a}	49.47^{a}	61.70^{ab}	73.90^{b}
CD 30t/ha + Urea 75kg/ha	31.17a^{b}	38.83^{b}	45.33^{b}	57.00^{d}	75.10^{a}
CD15t/ha + Urea 150kg/ha	32.63^{a}	42.90^{a}	50.20^{a}	64.87^{a}	76.10^{a}
Urea 75kg/ha	30.00^{b}	38.63^{b}	46.20^{b}	59.73^{bc}	72.70^{b}
CD 15t/ha	30.80^{b}	36.40^{c}	43.20^{c}	56.57^{d}	70.70^{c}
Control	25.10^{c}	32.10^{d}	37.80^{d}	48.30^{d}	49.47^{d}

Note: Mean in the column with the same letter show not significant different at p<0.05 and the mean in the column with different letter show significant different at p<0.05 by Duncan multiple range test.

Table 4. Effect of the treatments on leaf area (CM).

Parameter	Weeks after planting				
	3	4	5	6	7
CD 30t/ha	29.53^{a}	38.73^{a}	47.73^{ab}	55.07^{ab}	62.17^{abc}
Urea 150kg/ha	26.07^{ab}	35.80^{a}	44.00a^{bc}	51..70^{b}	61.73^{ab}
CD 30t/ha +Urea 75kg/ha	29.93^{a}	36.07^{a}	44.20^{abc}	50.73^{b}	58.07^{bc}
CD15t/ha+Urea 150kg/ha	25.03^{ab}	34.03^{a}	41.03^{bc}	50.03^{b}	57.23^{bc}
Urea 75kg/ha	24.33^{ab}1	33.87^{a}	39.90^{c}	47.10^{b}	54.47^{c}
CD 15t/ha	24.97^{ab}	34.83^{a}	42.53^{bc}	48.57^{b}	55.50b^{c}
Control	19.87^{b}	25.01^{b}	30.90^{d}	37.30^{c}	43.43^{d}

Note: Mean in the column with the same letter show not significant different at p<0.05 and the mean in the column with different letter show significant different at p<0.05 by Duncan multiple range test.

Table 5. Effect of the treatments on girth (CM).

Parameter	Weeks after planting				
	3	4	5	6	7
CD 30t/ha	2.90^{a}	3.70^{a}	5.60^{ab}	6.70^{a}	8.30^{a}
Urea 150kg/ha	2.83^{ab}	3.70^{a}	6.17^{a}	7.30^{a}	8.97^{a}
CD 30t/ha +Urea 75kg/ha	2.90^{a}	3.90^{a}	5.97^{ab}	6.09^{a}	8.40^{a}
CD15t/ha+Urea 150kg/ha	2.67^{b}	3.50^{b}	5.00^{c}	5.66^{bc}	6.77^{b}
Urea 75kg/ha	2.47^{b}	3.60^{ab}	4.57^{c}	5.13^{c}	6.30^{bc}
CD 15t/ha	2.07^{c}	3.63^{ab}	4.6^{c}	4.93^{c}	5.47^{c}
Control	1.27^{d}	2.76^{c}	3.40^{d}	3.70^{d}	4.30^{d}

Note: Mean in the column with the same letter show not significant different at p<0.05 and the mean in the column with different letter show significant different at p<0.05 by Duncan multiple range test.

Table 6. Effect of the treatments on number of leaves (CM).

Parameter	Week after transplanting				
	3	4	5	6	7
CD 30t/ha	12.56^{a}	18.87^{a}	23.14^{b}	26.87^{ab}	32.87^{ab}
Urea 150kg/ha	12.63^{a}	18.90^{a}	23.66^{b}	28.33^{a}	34.27^{a}
CD 30t/ha +Urea 75kg/ha	12.13^{a}	19.23^{a}	25.73^{a}	29.87^{a}	35.87^{a}
CD15t/ha+Urea 150kg/ha	12.13^{a}	18.47^{a}	22.73^{a}	26.63^{ab}	31.53^{ab}
Urea 75kg/ha	11.60^{ab}	18.57^{a}	23.23^{b}	26.90^{ab}	30.67^{ab}
CD 15t/ha	12.43^{a}	18.77^{a}	23.33^{b}	26.77^{ab}	30.97^{ab}
Control	10.43^{b}	16.37^{b}	20.3^{c}	22.57^{c}	25.27^{c}

Note: Means in the column with the same letter show not significant different at p<0.05 and the mean in the same column with different letter show significant different at p<0.05 by Duncan multiple range test.

4. DISCUSSION

Effect of the Treatments on physicochemical properties of the soil, the soil was slightly acidic in all the treatments. The organic carbon, total nitrogen available phosphorous and potassium increased significantly in all the treatments except the control which had no soil amendment, the improvement in the major soil nutrients may be as a result of addition of the cow dung and urea. The total exchangeable bases improved greatly over the pretreatment soil and the control which reflected on the significant increase in the effective cation exchange capacity which may be as result of the soil amendment added. Application of both cow dung and inorganic fertilizers has been shown to increase plant high from three week after planting to seven week after planting. The highest level of cow dung (30t/ha) and Cow dung (30t/ha) + urea (150 kg/ ha) applied produced the tallest plants at week seven (76.80 cm and 76.10 cm) and the shortest plants were those of the control 49.4 cm. Similar result was observed by Shehu et al. (2019) who reported increased height in amaranth plant at higher nitrogen application rate. Olowoake and Ojo (2014) also reported that amaranth require soils with high organic content, and adequate mineral nutrients favoured the production of higher plant height in amaranthus. This positive effect of cow dung on the growth of amaranth may be due to the release of the balanced nutrients contained in the organic fertilizer. The largest leaf area was produced by the plant that received 30 t/ha cow dung which was statistically the same with the treatment that received 150 kg/ha urea and the least was observed in the control. The amaranth treated with 30 t/ha cow dung, 150kg/ha urea, 30t/ha cow dung + 150 kg/ha urea and 30 t/ha cow dung +75 kg/ha urea did not show any significant difference on leaf area at seven weeks after planting. The result showed that the nitrogen in urea and cow dung tend to create lush or soft growth resulting in larger leaves and darker green plants (Sanni, 2016). The utilization of cow dung and urea significantly enhanced the average number of leaves in all treatment treatments, except for the control treatment. The control treatment, which did not receive any cow dung or urea, exhibited the lowest average number of leaves at 10.43, 16.37, 20.30, 22.57, and 25.27 per plant during weeks 3, 4, 5, 6, and 7 after planting, respectively. This study reaffirms the role of fertilizers in promoting the growth of leafy vegetables, as evidenced by the increased number of leaves observed under the application of cow dung and urea (Tijani-Eniola, Nwagwu, & Aiyelari, 2000). The changes in leaf number resulting from the application of cow dung and urea are expected to have a significant impact on the overall performance of the plant, as leaves serve as photosynthetic organs responsible for assimilate production. The application of cow dung and urea also led to an increase in stem girth in Amaranthus hybridus. This increase can be attributed to the improved availability of nutrients in the soil due to the treatments, as well as the uptake of these nutrients by the amaranth plants. The enhanced stem girth subsequently facilitated the retention of a substantial amount of assimilates in the stem, which contributed to the production of nodes and leaves (Ayalew, 2013).

5. CONCLUSION AND RECOMMENDATION

The results of this study indicate that the application of urea and cow dung to the soil had a positive impact on the growth and yield of Amaranthus hybridus. Additionally, it was found that the physico-chemical properties of the soil were improved as a result. Based on these findings, it is recommended that farmers use either 30 t/ha of cow dung or 30 t/ha of cow dung combined with 75 kg/ha of urea, as these treatments showed comparable results to the highest dose of urea.

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