EFFECTS OF BIOAMENDMENTS APPLICATION ON GROWTH AND YIELD OF *Amaranthus hybridus*

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Abstract

Amaranthus hybridus is an indigenous vegetable grown in Nigeria and is ranked among the top ten priority indigenous vegetables in terms of production and consumption. Production of this vegetable is affected by many factors, with the source of nitrogen fertilizer being among the most important. This study aimed at investigating the effect of bioamendments application on the growth and yield of *Amaranthus hybridus*. The soil of the experimental site was sandy loam. 20 g of Amaranthus hybridus seeds were planted into 16 beds of 3 m x 3 m each using the drilling method. The experiment was laid out in a Complete Randomized Design (CRD) with four treatments (bioamendments applications): T1: 3 kg Rabbit droppings, T2: 3 kg Rabbit droppings + 160 g NPK 15:15:15, T3: 5 kg Rabbit droppings and T4: 10 kg Rabbit droppings. The plant height and yield of T2 were significantly higher ($P<0.05$) than others due to the abundant supply of nitrogen from the combination of rabbit droppings and NPK 15:15:15. More importantly, the application of rabbit droppings at increased dose also resulted in better plant performance. Therefore, the study suggests that rabbit droppings can serve as an alternative to inorganic fertilizers.

Keywords: *Amaranthus hybridus*, biofertilizer application method, plant height, yield, Rabbit droppings

Introduction

Vegetables are important for both domestic and export markets. Almost all households in Nigeria include vegetables in their diets. Nutritionally, vegetables are good sources of vitamins, fat, proteins, minerals and fibres (Tosi et al., 2001). Vegetables produced in Ogbomoso include leafy vegetables such as Amaranthus, spinach, cochorus, okra, tomatoes and pepper among others. *Amaranthus cruentus* belong to the family of vegetable called Amaranthaceous and it is known as a vegetable in West Africa and especially in Nigeria. Amaranthus species which contains proteins and minerals with 15-22% protein, 3.0–11.5% fat and 9.16% dietary fibre depending on cultivation technique and environmental effects (Tosi et al., 2001). The green leaves of *Amaranthus* have also been reported to be rich in water, energy, fats, proteins, minerals, amino acid and carotenoids Ziada et al. (2008).

Producing early maturing vegetables in commercial quantities in Nigeria required among other factors fertilizer application (both organic and inorganic) in sufficient quantities. The use of soil amendments is mainly to improve crop yields while improved yields result from improved nutrient status in soil and other soil properties such as organic matter (Mungai et al., 2009). Rabbit manure is one of the available organic fertilizers that farmers can apply to vegetables. Rabbit droppings are a rich source of inorganic nitrogen, phosphorus, cellulose, and lignin (Franco, 1991, Kumar and Ayyapan, 1998). 3-1.5-0.3 of N-P-K (McCrosckey, 2001) and according to (Lebas et al., 1996), rabbit manure is much richer in nutrients than ordinary farm manure which typically contains 0.4% to 0.6 % nitrogen while rabbit dung contains up to 2.4 % nitrogen. The response of *Amaranthus hybridus* to fertilizer application has received less attention, especially in the tropics (Ong et al., 2008). Therefore this study was conducted to ascertain the response of *Amaranths hybridus* to various types of amendments application.

Materials and Methods

The experiment was carried out at the Indigenous Vegetables Unit, Bioresources Development Centre, Ogbomoso, Oyo State Nigeria. Ogbomoso is on latitude 8" 10N and longitude 4"10E with 420 meters above sea level. It has a bimodal rainfall pattern (1,150mm – 1,250mm per year) with a peak in July and September and a short rainfall break in August while the dry season last from November to March. It has a minimum temperature of 28 0C and a maximum temperature of about 74 0C all year round except in January when the dry winds blow from the North.

A piece of land 14 m x 14 m was used for this study. The land was manually cleared of weeds, and stumps and then divided into four plots of 3 m x 3 m with 0.5 m spacing in between the plots. Dried Rabbit droppings used for this study was collected from the rabbitary unit of Bioresources Development Centre Ogbomoso, Oyo state. NPK fertilizer (15: 15: 15) was sourced from a commercial vendor in Ogbomoso, Oyo state. Vegetable beds of 18 cm in height were made with hoe. The soil of the experimental site was sandy loam (Ewetola et al., 2015). 20 g of Amaranthus

hybridus seeds were planted into the beds using the drilling method. The experiment was laid out in a Complete Randomize Design (CRD) with four treatments (fertilizer applications): T1: 3 kg Rabbit droppings, T2: 3 kg Rabbit droppings + 160 g NPK 15:15:15, T3: 5 kg Rabbit droppings and T4: 10 kg Rabbit droppings. Hand weeding was carried out every week and no herbicides were applied. The experiment was rain-fed and terminated at the end of eight week. Data were collected on plant height using measuring tape every week for 2 months and the total yield of *Amaranthus hybridus* at the termination of the experiment using a weighing machine. Data obtained were analyzed with the General Linear Model of SAS (2008) and the Duncan New Multiple Range Test option of SAS (2008) was used to detect significant differences among means.

Results and Discussion

Table 1 shows the effects of the application of rabbit droppings and NPK fertilizer on plant heights of *Amaranthus hybridus* from week 1 to week 8. There was an increase in the plant heights from week 1 to week 6 for all the treatments. The results of our study showed a consistent increase in plant height with an increase in the application of manures. At weeks 4-6, T2 plant heights were higher than that of others. Plants treated with T2 had a consistent increase in plant height from week 4 to week 7. The increased plant heights recorded for T2 in this study were due to the abundance of nitrogen in the treatment. The Nitrogen content required for optimal growth of any plant varies and even depends on the plant species, stage of development and organs (Marschner. 1998). An increase in the nitrogen supply had been reported in the literature to stimulate growth. Our observations corroborate the finding of the Food and Agricultural Organisation (2007) that defined fertilizer as any natural or manufactured material having at least 5% of the primary nutrients (N, P and K) and with a high presence of these nutrients in the soil, crops will grow better and produce high yields. At the end of week 6, harvesting was carried out resulting in a decrease in plant heights at weeks 7 and 8 for all the treatments while, T2 still maintained the highest plant heights compared with others.

The Analysis of Variance (ANOVA) results of the application of fertilizers at different rates on plant heights of *Amaranthus hybridus* is presented in table 2 below. From weeks 1 to 3, there was no significant difference ($P>0.05$) in plant heights of *Amaranthus hybridus*. There was no application of fertilizers at this stage showing that the plants are subjected to the same soil nutrient profile without bias. The plant height of T1 was significantly ($p<0.05$) lower than that of T2, T3 and T4 at weeks 4-6. However, at weeks 7 and 8, the plant height of T2 was significantly ($p<0.05$) higher than that of others due to the higher nitrogen content the treatment was subjected to. The study agreed with Hommels et al. (1989) who reported that plants consume a large amount of nutrients and even use them efficiently at high nutrient availability.

A similar result was also reported by Agele et al. (2011). The authors found that the combination of livestock manure, plant residue and organic fertilizers applied at different rates enhanced leaf area development, yield and fruit concentrations of huckleberry. Chanda et al. (2011) also reported that Farm Yard Manure (FYM) supplemented with chemical fertilizer at different rates produced a better yield. The result of this study is also in agreement with the application of 20 tonnes FYM ha-1 along with a full dose of

Table 1: Weekly effect of different amendments on plant height (cm) of Amaranthus hybridus

Week	Treatment			
	T1	T2	T3	T4
Week 1	1.43	1.39	1.57	1.72
Week 2	6.81	7.57	7.55	7.79
Week 3	17.29	17.05	17.78	16.43
Week 4	19.30	25.60	23.00	23.43
Week 5	25.00	37.75	32.80	30.60
Week 6	32.43	52.95	38.70	40.20
Week 7	19.70	28.05	22.05	22.08
Week 8	19.70	28.05	22.05	22.08

Source: Field, 2019

T1: 3 kg Rabbit droppings

T2: 3 kg Rabbit droppings + 160 g NPK 15:15:15

T3: 5 kg Rabbit droppings

T4: 10 kg Rabbit droppings

Table 2: ANOVA result of the weekly effect of different amendments on plant height (cm) of Amaranthus hybridus

Week	Treatment				
	T1	T2	T3	T4	Probability
Week 1	1.43±0.10^{a}	1.39±0.16^{a}	1.57±0.11^{a}	1.72±0.15^{a}	0.28
Week 2	6.81±0.53^{a}	7.57±0.43^{a}	7.55±0.36^{a}	7.79±0.48^{a}	0.48
Week 3	17.29±1.14^{a}	17.05±0.84^{a}	17.78±1.18^{a}	16.43±0.77^{a}	0.81
Week 4	19.30±1.41^{b}	25.60±1.24^{a}	23.00±1.88^{ab}	23.43±0.99^{ab}	0.02
Week 5	25.00±2.08^{c}	37.75±1.50^{a}	32.80±3.23^{ab}	30.60±1.01^{bc}	0.001
Week 6	32.43±2.65^{c}	52.95±2.28^{a}	38.70±3.44^{bc}	40.20±1.68^{b}	<.0001
Week 7	19.70±0.84^{b}	28.05±1.53^{a}	22.05±0.89^{b}	22.08±1.18^{b}	<.0001
Week 8	19.70±0.84^{b}	28.05±1.53^{a}	22.05±0.89^{b}	22.08±1.18^{b}	<.0001

a, b, c: Means within each row with different superscript are significantly different (p<0.05)
Source: Field, 2019
T1: 3 kg Rabbit droppings
T2: 3 kg Rabbit droppings + 160 g NPK 15:15:15
T3: 5 kg Rabbit droppings
T4: 10 kg Rabbit droppings

recommended NPK at 150:60:60 kg ha-1 and concluded that integration of both organic manures and inorganic fertilizers is important for obtaining higher fruit yield in huckleberry.

Table 3 shows the ANOVA result of the effect of different fertilizers on the mean plant height and total yield/bed of *Amaranthus hybridus*. There was a significant difference (p<0.05) in the mean plant height (cm) of Amaranthus hybridus treated with different fertilizers. The mean plant height (24.80 cm) of T2 was significantly higher than that of others (p<0.05). The result obtained for T2 can be due to the higher nitrogen available for the utilization of the plants from the combination of rabbit droppings and NP

Conclusion

The combination of livestock manure and inorganic fertilizers applied at different rates increases the plant and yield of vegetables by increasing the nitrogen content available for plant utilization. Application of fertilizer (3kg rabbit droppings and NPK 15:15:15) to *Amaranthus hybridus* resulted in higher plant heights and total yield/bed (kg).

Recommendation

In this phase of food insecurity, higher cost of food, unemployment, low income and nutrient deficiency, there

Table 3: *ANOVA result of the effect of different fertilizers on the mean height per plant (cm), total yield/bed (kg) and number of branches per plant of Amaranthus hybridus*

	Treatment				
Parameter	T1	T2	T3	T4	Probability
Mean plant height (cm)	17.71±0.88^{b}	24.80±1.30^{a}	20.69±1.11^{b}	20.54±0.97^{b}	<0.0001
Total yield/bed (kg)	1.05±0.55^{a}	2.45±0.42^{a}	1.73±0.68^{a}	1.58±0.47^{a}	0.37

a, b, c: Means within each row with different superscript are significantly different (p<0.05)
Source: Field, 2019
T1: 3 kg Rabbit droppings
T2: 3 kg Rabbit droppings + 160 g NPK 15:15:15
T3: 5 kg Rabbit droppings
T4: 10 kg Rabbit droppings

plants from the combination of rabbit droppings and NPK.
There was no significant difference (p>0.05) in the total yield/bed (kg) of *Amaranthus hybridus* treated with the different amendments. T2 had the highest total yield/bed (kg) (2.45) compared to (1.73), (1.58) and (1.05) for T3, T4 and T1, respectively.

is a need to improve the yield of *Amaranthus hybridus*.

Declaration of interests

The authors have no relevant financial or non-financial interests to disclose.

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