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Effects of Fertilizer Microdosing on Yield and Nitrogen Use Efficiency of Green Amaranth (*Amaranthusviridis)*

Kuye O. B. , Oyedele D. J. And Idowu M. K.

Abstract:- This study evaluated the effects of fertilizer rates on yield and nitrogen use efficiency (NUE) of green amaranth. This was with the view to establishing the best fertilizer rate for green amaranth production in Southwestern Nigeria.The experiment was carried out in two agroecological zones (rainforest and derived savanna). The experiment was laid out in Randomized Complete Block Design with four replicates. The treatments were: (i) 80 kg N/ha (farmers' practice) (ii) 40 kg N/ha (microdose) (iii) 0 kg N/ha (control). Soil samples were collected from each plot at 0-15 cm depth before and after the experiment for routine laboratory analyses. The above-ground biomass of green amaranth was harvested three times and tissue samples were taken for the determination of dry matter yield and total tissue nitrogen. Nitrogen use efficiency of green amaranth was estimated. The data collected were subjected to analysis of variance and differences in treatment means were separated using Tukey test at 5% level of probability.The results showed that soil in the derived savanna zone had higher organic carbon and available phosphorus than that of the rainforest zone. The farmers' practice of 80 kg N/ha and 40 kg N/ha (microdose) had dry matter yields and nitrogen uptake significantly higher than the Control in the two zones. The nitrogen use efficiency from farmers' practice and microdose were not significantly different from each other in rainforest but microdose had nitrogen use efficiency higher than farmers' practice in the derived savanna.It was concluded that fertilizer microdosing was best for optimum yield and Nitrogen use efficiency of green amaranth.

Keywords:- *Microdose, Farmers' practice, Nitrogen Use Efficiency.*

I. INTRODUCTION

In Nigeria, low crop yield is a major challenge facing farmers and this is largely due to inherent poor fertility status of our soils and imbalanced use of fertilizers (Shaheen*et al.,* 2010; Adepetu*et al.,* 2014). Improper farm management practices even where fertilizers are made available have been found to account for nutrient loss also leading to low crop yield.

Nutrients supply is an important factor required for plants' growth and survival. The soil supplies 13 of the 16 essential elements required for nutrition of higher plants while the rest are supplied by air and water. These elements must be available continuously and in balanced proportions to support photosynthesis and other metabolic processes of plants. If any one of these essential elements is missing, plant productivity will be limited, or the plant may cease to grow entirely. Nitrogen is widely considered the major nutrient limiting productivity in most agricultural systems. It is an essential nutrient which is a determining factor in crop production and is absorbed primarily in the form of nitrate (Tisdale and Nelson, 1990). It constitutes about 1.5 - 6% of the dry weight of many crops apart from being a constituent of many organic compounds, nucleic acids and protein compounds (Sanjuan*et al.,* 2003). Nitrogen plays a role in chlorophyll synthesis and hence the process of photosynthesis and carbon dioxide assimilation (Jasso-Chaverria*et al.,* 2005). Where nutrients supply is limited, fertilizer application is advised. Beneficial effect of adding mineral elements (such as plant ash or lime) to soils to improve plant growth has been known in agriculture for more than 2000 years. Nevertheless, even up till date it is still a matter of scientific controversy deciding the appropriate mineral fertilizers application rates and methods for optimum plant growth. However, fertilizer microdosing has been reported to increase crop productivity at low cost and at a very moderate risk to farmers. It also increases fertilizer use efficiency (Guo*et al*., 2012; Olatoberu, 2018) which consequently prevents wastages that may eventually pollute the surrounding water bodies causing alga bloom and several health challenges including methemoglobinaemia (blue baby syndrome) in babies.

Amaranthusviridis is an annual herb with nutritional, economical and health values. It contains all the classes of food and it is a source of income for farmers.*Amaranthusviridis* has high resistance to adverse weather conditions, fast growth rate and most importantly high nutrient responsiveness especially affecting the leaf growth, thereby making it the appropriate test crop for this experiment. The key constraints to its production are low moisture content, emergence of multiple nutrient deficiencies, low use and unbalanced use of fertilizers (Shaheen*et al.*, 2010). However, amaranthus can accumulate nitrates especially when soil fertility is very high (generally the result of adding nitrogen fertilizer) which when ingested may result to nitrate poisoning in human infants and some animals because they have bacteria in their digestive systems, which convert nitrates to nitrite.

The specific objective of the study was toevaluate the effects of fertilizer application rates on yield and nitrogen use efficiency (NUE) of green amaranth.

II. MATERIALS AND METHODS

This study was carried out at the Obafemi Awolowo University Teaching and Research Farm (OAUT&RF), Ile-Ife, Osun State (rainforest ecological zone of Southwestern Nigeriaof Latitudes between 7º 32´ 39´´ N and 7º 38´ 36´´ N

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and Longitudes between 4º 33´ 29´´ E and 4º 33´ 30´´ E) and National Biotechnological Development Agency (NABDA) station, Ogbomoso, Oyo State (derived savannah ecological zone of Southwestern Nigeria of Latitudes between 8º 6 ´35´´ N and 8º 6´ 46´´ N and Longitudes between 4º 18´ 41´´ E and 4º 18´ 42´´ E).

The experiment was laid out in Randomized Complete Block Design with four replicates. The treatments were: (i) 80 kg N/ha (farmers' practice) (ii) 40 kg N/ha (microdose) (iii) 0 kg N/ha (control).Seedlings of *Amaranthusviridis* were raised in the nursery and later transplanted into the main plots. Urea was applied two weeks after transplanting and subsequently applied immediately after each harvest according to design. Three cycles of harvest were carried out at each location before termination and harvesting was done by cutting the above ground biomass at about one centimeter from the ground surface.Soil samples were collected from each plot at 0 - 15 cm depth before and after the experiment. The samples were air-dried, gently crushed and passed through a 2 mm sieve for soil routine analyses. Plant tissue samples were also collected at each harvest, rinsed, weighed and oven dried at 65 ºC to constant weight and used for the determination of total nitrogen in plant tissue. The dry matter yield and nitrogen use efficiency were estimated using the formulae below:

$$\text{Dry matter yield (kg/ha)} = \frac{\text{dry matter weight (kg)}}{\text{area of harvested land (ha)}}$$

$$\text{NUE (kg/ha)} = \frac{(YN - YO)}{\text{Nr}}$$

Where,

Y_N = Dry matter yield with inorganic fertilizer
Y_O = Dry matter yield without inorganic fertilizer
N_r = Amount of inorganic fertilizer applied (Eivazi and Habibi, 2013)

Data collected were subjected to Analysis of Variance using the PROC GLM procedure in Statistical Analysis System (SAS) software version 9.0 (SAS institute, 2001) and where significant, means were separated using Tukey test.

III. RESULTS AND DISCUSSION

The dry matter yield obtained from 40 kg N/ha (microdose rate) and 80 kg N/ha (farmers' practice) were not signicantly different from each other but significantly different from the control in the two zones (Table 1). Higher yields were obtained in Ogbomoso (the derived savanna zone) which may can be attributed to higher antecedent total nitrogen as seen in Table 2.

In Ife (the rainforest), the 40 kg N/ha (microdose rate) had nitrogen use efficiency of green amaranth not significantly higher than 80 kg N/ha (farmers' practice)which was because the post-harvest nitrogen in this zone is more than the antecedent nitrogen while in derived savanna the antecedent was more than the post-harvest (Tables 2 and 3). On the contrary in the derived savanna, the microdose rate had nitrogen use efficiency of green amaranth significantly higher than 80 kg N/ha which corroborates the findings of Guo *et al.* (2012), and Olatoberu (2018). Halvorson *et al.* (2005) also reported that nitrogen use efficiency decrease with increasing levels of applied nitrogen.

	80 kg N/ha	40 kg N/ha	0kg N/ha	80 kg N/ha	40 kg N/ha	0kg N/ha
	←	Rainforest	→	←	Derived savanna	→
DMY(kg/ha)	1994a	1813a	1396b	2572a	2536a	1717b
NUE (kg/ha)	11.60a	15.30a	-	11.26b	23.08a	-

Table 1: Effects of fertilizer application rates on dry matter yield and nitrogen use efficiency of green amaranth in rainforest and derived savanna zones

Means in a row with similar letter(s) are not significantly different (p<0.05) according to Tukey test. Where TRT= treatments, DMY= dry matter yield, NUE= nitrogen use efficiency, NU = nitrogen uptake, NRE= nitrogen recovery efficiency.

	Ife	Ogbomoso
Sand (g/kg)	739	732
Silt (g/kg)	115	157
Clay (g/kg)	146	111
Textural class	Sandy loam	Sandy loam
pH ($CaCl_2$)	5.6	5.7
Organic carbon (g/kg)	4.7	14
Total nitrogen (%)	4.2	11
Available phosphorus (mg/kg)	7.0	14
Exchangeable calcium (cmol/kg)	1.2	1.4
Exchangeable magnesium (cmol/kg)	0.90	0.43
Exchangeable potassium (cmol/kg)	0.16	0.14
Exchangeable sodium (cmol/kg)	0.037	0.031

Table 2: Antecedent physical and chemical properties of soils (0-15cm) in the two locations

	Ife	Ogbomoso
pH ($CaCl_2$)	5.9	5.6
Organic carbon (g/kg)	6.7	8.4
Total nitrogen (%)	5.8	7.1
Exchangeable calcium (cmol/kg)	1.8	2.1
Exchangeable magnesium (cmol/kg)	0.32	0.37
Exchangeable potassium (cmol/kg)	0.15	0.14
Exchangeable sodium (cmol/kg)	0.037	0.038

Table 3: Post-harvest chemical properties of soils (0-15cm) in the two locations

IV. CONCLUSION AND RECOMMENDATION

In conclusion, application of 40 kg N/ha (fertilizer microdosing) is optimum for green amaranth’s production and should be recommended to farmers because it reduces cost of production and prevents both leaching and surface runoff of nitrogen into water bodies as well as reduces luxurious consumption and accumulation of nitrate in the vegetable all of which are harmful to both human health and environment.

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