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Effect of Organic and Inorganic Fertilizer on Growth and Yield of *Amaranthus Caudatus* L. in Northern Guinea Savanna of Nigeria

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ABSTRACT [ENGLISH/ANGLAIS]

Two field trials were conducted during the wet seasons of 2009 and 2010 at the Research farm of Institute for Agricultural Research, Ahmadu Bello University Samara, Zaria (110 11' N, 070 38' E and 686 altitude) in the northern guinea savanna ecological zone to study the effect of organic and inorganic fertilizer on the growth and edible yield of local vegetable amaranth (*Amaranthus caudatus* L.). The treatments consisted of three levels of organic fertilizer (farmyard manure FYM) 0, 5 and 10 t ha⁻¹ and four levels of inorganic fertilizer (Compound fertilizer NPK 20:10:10) 0, 150, 300 and 450 Kg ha⁻¹ arranged in a randomized complete block design and replicated three times. The crop growth and vegetative yield parameters responded to NPK compound fertilizer significantly ($p > 0.05$) in the mean results. Most of the crop parameters were maximized with the application of 300 kg NPK ha⁻¹. The regression of edible yield per hectare to NPK level indicates a strong linear response up to 450kg NPK ha⁻¹, although the difference between this rate and 300 kg ha⁻¹ was not significant. The rate of 5 t ha⁻¹ FYM also significantly increased all the growth attributes. No significant interaction was observed between NPK and FYM, on almost all the characters accessed. Application of 300 kg ha⁻¹ NPK and 5 t ha⁻¹ FYM gave the best edible yield of vegetable amaranth.

Keywords: Vegetable amaranth, Organic fertilizer, inorganic fertilizer, yield, Savanna

RÉSUMÉ [FRANÇAIS/FRENCH]

Deux essais ont été effectués pendant les saisons pluvieuses de 2009 et 2010 à la ferme de recherche de l'Institut pour la recherche agricole, l'Université Ahmadu Bello Samara, Zaria (110 11 'N, 070 38' E et 686 d'altitude) dans la zone de savane du nord Guinée écologique pour étudier l'effet de la fumure organique et minérale sur la croissance et le rendement comestibles d'origine végétale locale amarante (*Amaranthus caudatus* L.). Les traitements consistaient en trois niveaux de fertilisation organique (fumier de ferme) 0, 5 et 10 t ha⁻¹ et quatre niveaux de fertilisation minérale (engrais composé NPK 20:10:10) 0, 150, 300 et 450 kg ha⁻¹ disposés dans un design en blocs aléatoires complets et répliqué trois fois. La croissance des cultures et les paramètres de rendement végétatives répondu à engrais NPK composé de façon significative ($p > 0,05$) dans les résultats moyens. La plupart des paramètres des récoltes ont été maximisés à l'application de 300 kg de NPK ha⁻¹. La régression du rendement comestible par hectare au niveau de NPK indique une forte réponse linéaire jusqu'à 450 kg NPK ha⁻¹, bien que la différence entre ce taux et 300 kg ha⁻¹ n'était pas significative. Le taux de 5 t ha⁻¹ FYM également augmenté de façon significative tous les attributs de croissance. Aucune interaction significative n'a été observée entre les NPK et FYM, sur presque tous les personnages accessibles. Demande de 300 kg ha⁻¹ NPK et 5 t ha⁻¹ FYM a donné le meilleur rendement de légumes comestibles amarante.

Mots-clés: Légumes amarante, engrais organique, engrais inorganiques, le rendement, Savanna

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INTRODUCTION

Optimum nutrient amounts reported for maximum amaranth growth by different researcher are

substantially different. Apart from the use of inorganic fertilizers, the level of organic manure in the soil is very essential in promoting crop growth. The complementary

use of organic manure and mineral fertilizer has been recommended for sustenance of long term cropping in the tropic [1]. Akambi and Togun reported that optimum N and P uptake by amaranth was obtained when 30t/ha compost was applied along with 30kgN/ha fertilizer while the best K uptake was obtained with plants treated with 1.5 t ha⁻¹ compost + 60kg N ha⁻¹[2]. In Kenya, Kipkosgel *et al*, [3] in their work on *Solanum villosum* reported that the addition of various rates of organic and inorganic fertilizers that were tested significantly improved vegetative growth and increased leaf yields of amaranth ($p > 0.05$).

Farmer's use of such input as inorganic fertilizer and manure are quite varied. In order to increase production substantially cropping may extend to the relatively poor upland soil. It is in view of this need that the study was proposed to determine the effect of organic fertilizer (FYM) and inorganic fertilizer (NPK) on growth and edible yield of vegetable amaranth and also to study whether or not there is significant interaction between organic and inorganic fertilizers on the crop yield.

MATERIALS AND METHODS

Two field trials were conducted during the rainy season of 2009 and 2010 at the Institute for Agricultural Research farm, Samaru (11° 11'N, 07° 38'E and 686 altitude) in the Northern Guinea Savanna ecological zone of Nigeria. The treatments consisted of four levels of NPK (20-10-10) compound fertilizer 0, 150, 300, 450 kg ha⁻¹ as inorganic fertilizer and three levels of farmyard manure 0, 5, 10 t ha⁻¹ as organic fertilizer. The treatments were factorially combined and arranged in a randomized complete block design (RCBD) and replicated three times.

Seeds of local amaranth cultivar, obtained at Samara, were sown in the nursery within an orchard of the Agronomy Department by drilling. The nursery bed was mulched after sowing and irrigated regularly. The mulch was removed immediately after germination and rearranged between drill-rows of the emerged seedlings. The experimental site was ploughed harrowed and prepared into slightly raised beds (plots) of 1.5 × 3.0 m dimension preparatory to transplanting the crop seedlings. The four-week old seedlings were transplanted on the open field at a stand spacing of 40 × 20 cm. Farmyard manure was incorporated according to treatment level to specific plots during land preparation. The inorganic fertilizer NPK of 20:10:10 grade was applied as per the treatment levels by side-dressing in two equal split doses. The first dose was applied at one week after transplanting and the remaining at two week

after in amount according to treatment. The field was weeded manually using a small hand hoe. A total of two weeding were adequate for weed control carried out at two and four weeks after transplanting. Amaranth is a vegetative crop that is harvested for use at various stages of growth. A sample of three plants was regularly harvested at 10-days interval beginning at 20 days after transplanting. The final harvest was done by removing only the leaves from the base of the petiole as the edible part at 45 days after transplanting when almost all plants had reached anthesis heralding the end of active vegetative growth.

The data collected at 10 days interval were Number of branches, Days to 50% anthesis, Shoot dry weight, and edible shoot yield per hectare

Data collected were subjected to analysis of variance and where the f-values were found to be significant the significant among treatment means were tested using the Duncan multiple range test [4].

Regression analysis of edible yield against NPK and FYM levels as well as simple correlation matrix among the growth and yield parameters are determined as described by Steel *et al*. [5].

RESULTS

Effect of Inorganic Fertilizer

All the yield and growth characters assessed with the exception of number of days to 50% anthesis that was not affected by inorganic fertilizer rates others showed positive response and was maximized up to NPK fertilizer rate of 450 kg ha⁻¹ but the difference between this rate and 300 kg NPK ha⁻¹ was non-significant for edible yield (Table 1).

The maximum 450 kg NPK ha⁻¹ applied in this study contain an equivalent of 90 kg N, 19.8 kg p and 37.4 kg K ha⁻¹ which tend to fit the ranges of individual N, P and K recommendations made for leafy amaranth as reported by earlier workers. The result of the response of amaranth to NPK is not unexpected. However, the results of this work is in agreement with the N-recommendation made by Bahrat *et al*. [6] for N-rate who observed an increase in leaf area and a linear increased in stem and leaf fresh weight with N-fertilization until 90 kg ha⁻¹, while for P and K rates, the results also is in line with the recommendation made by Rana *et al*. [7] who recommended 40 kg P₂O₅ and 40 kg K₂O ha⁻¹ respectively for enhanced growth and yield of amaranth. This supply 17.6 kg P and 33.2 kg K which is close to the rate that produced the best result in this work. Also reported that optimum levels of N needed to maximize yield in leafy

amaranth was in the range of 50 – 200 kg N ha⁻¹[8]. The regression of edible yield to NPK level which was strongly linear (Figure 1) indicates that the yield of the crop was still increasing up to the maximum N-fertilizer rate of application. The application of N-containing

fertilizer such as NPK is known to promote photosynthetic activities and vegetative growth. Thus, the satisfactory growth and yield of vegetable crop like amaranth depended on the amount of N-supplying fertilizer.

Table 1: This table shows effect of organic and inorganic fertilizer on growth characters and edible yield of vegetable amaranth in the mean result of the two years at Samaru.

Treatment	No of branche			Shoot dry wt g/Plant			Days to 50% anthesis	Edible yield kg ha ⁻¹
	20	30	40	20	30	40		
NPK-Fertilizer Kg ha⁻¹								
0	7.9b	10.9b	14.6b	2.4b	5.8b	10.5c	40.3	37c
150	8.7ab	15.7a	17.1a	3.2ab	9.2b	17.1b	38.3	59b
300	9.9a	14.2a	17.0a	3.6a	9.9b	22.2a	39.3	78a
450	10.0a	15.3a	18.3a	3.1ab	15.3a	19.8ab	39.3	86a
SE±	0.60	0.67	0.73	0.33	1.77	1.47	0.91	4.33
FYM t ha⁻¹								
0	7.2b	12.5b	15.4b	2.6b	6.5b	12.2c	41.0a	49b
5	9.8a	14.4a	17.5a	2.9ab	10.4ab	17.9b	38.8a	69a
10	10.3a	15.2a	17.3ab	3.7a	13.6a	22.2a	38.2b	78a
SE±	0.52	0.58	0.63	0.28	1.53	1.27	0.79	3.76
Interaction								
N×F	NS	NS	NS	NS	NS	NS	*	NS

Means within a treatment column followed by same letter(s) indicate that they are statistically similar (P>0.05) using DMRT.

* = SIGNIFICANT, NS = Not significant.

Table 2: This table shows nitrogen and FYM Interaction on days to 50% anthesis Per Plant of Vegetable Amaranth for the mean

NPK (kg ha ⁻¹)	Farmyard Manure (t ha ⁻¹)		
	0	5	10
0	44.3a	37.0c	39.7abc
150	41.0abc	36.7c	37.3c
300	38.3bc	42.7ab	37.0c
450	40.3abc	38.7bc	38.7bc
SE±	1.58		

Means followed by the same letter(s) indicate that they are statistically similar (P > 0. 05) using DMRT.

Effect of Organic Fertilizer (FYM)

All the growth and yield parameters of amaranths accessed were significantly increased in response to the application of farmyard manure at the highest rate of 10 t ha⁻¹ used, but the difference between this rate and 5 t ha⁻¹ was statistically non-significant (Table 1). This may be attributed to the fact that farmyard manure like other organic matter contains essential plant nutrients though in lower concentrations compared with inorganic fertilizer. It is therefore expected that additional supply

of nutrients from FYM contributed to the growth and yield of the crop. But due to the bulky nature and low concentration of nutrients a relatively higher quantity of organic manure was supplied which gave an appreciable level of nutrients. Thus, even at 10 t ha⁻¹ of FYM the growth and yield response were positive. The significant growth and yield response to increasing level of FYM may partly be due to the beneficial effect of organic manure. I.e. application of organic manure was useful not only in terms of nutrient supply. This is in line with the report of Ajakaiye [9] that organic manure also improves soil physical conditions. Also, the regression of marketable yield to FYM rates which was strongly linear (Figure 1), indicate that the yield of the crop was still increasing up to the maximum FYM rate of application. However, yield was higher in 2010 than in 2009 probably due to high organic matter content of the soil of the experimental site or due to slightly higher and even distribution of rainfall in 2010.

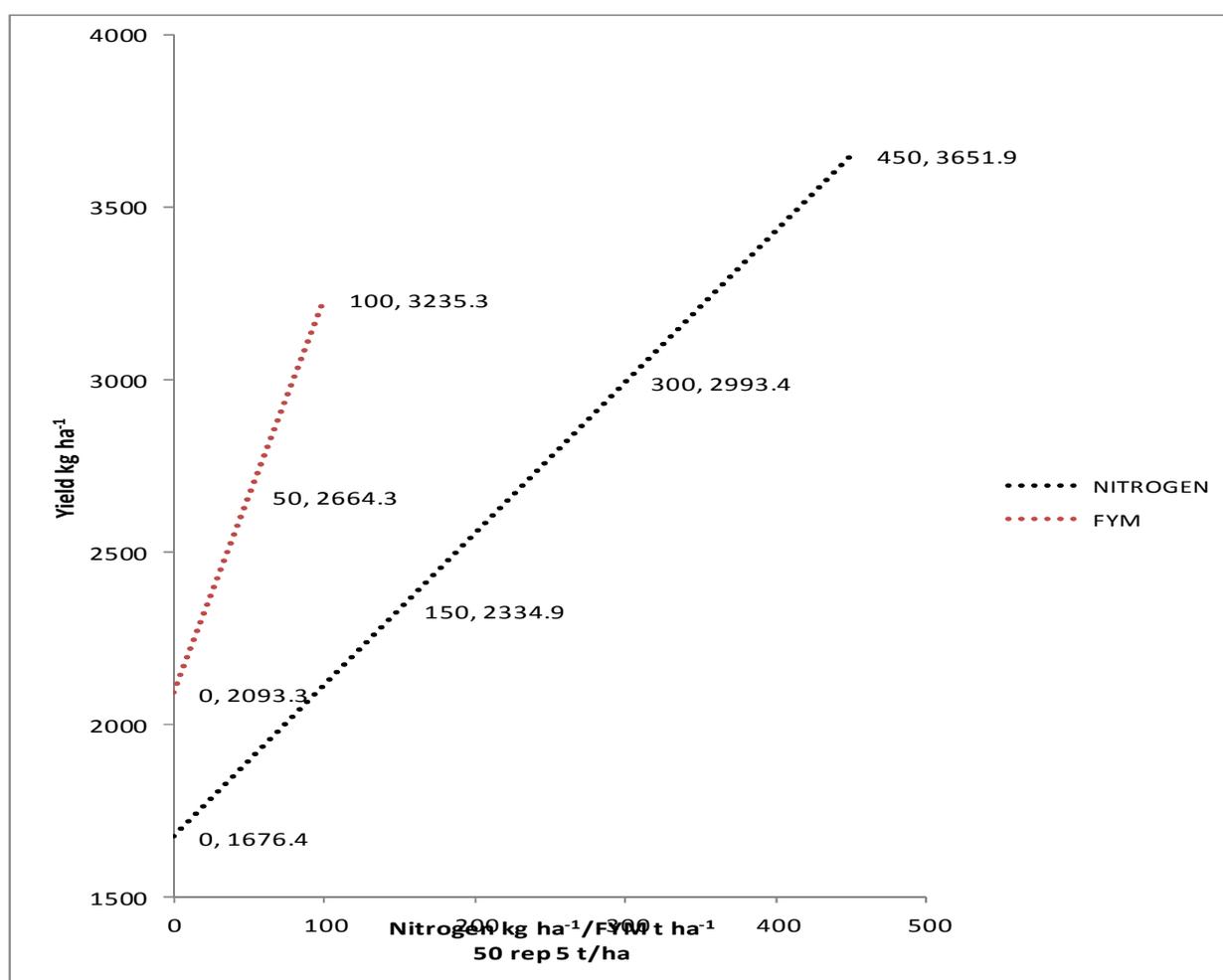
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Figure 1: This figure shows regression of the edible yield of amaranth against NPK fertilizer and farmyard manure in the mean.



Interaction of Organic and Inorganic Fertilizer

The interaction of organic (FYM) and inorganic (NPK) fertilizers on all the parameters accessed was not significant except number of days to 50% anthesis which was found to delay anthesis even in the absence of the two inputs (Table 2). This is indicative of the fact that

organic or inorganic fertilizer alone was capable of providing enough of the nutrient elements. This may be due to the fact that the soil of the experimental site was found to be rich in total N and organic carbon content. This is contrary to the work of Dennison [10] who had reported that full benefits of crop development are

achieved with a combination of organic manure and inorganic fertilizers.

CONCLUSION

In conclusion, results obtained from this study showed that application of organic fertilizer (FYM) at 5 t ha⁻² and inorganic fertilizer (NPK 20:10:10) at the rate of 300 kg ha⁻¹ is recommended for farmers on upland soil in the Samara area of the Northern Guinea Savanna ecological zones of Nigeria.

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CONFLICT OF INTEREST

No conflicts of interests were declared by authors

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