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**Research Article**

# Effects of Sole and Combined Application of Goat Manure and Urea Fertilizer on the Performance of Amaranth *(Amaranthus cruentus,L.)*

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## Abstract

*A field experiment was carried out at Federal College of Agriculture, Akure, Ondo State (Latitude 7108'N and Longitude 5015'E) Nigeria in 2015, to determine the effects of sole and combined application of goat manure and urea fertilizer on the performance of amaranth. The treatments applied were: Sole 6ton/ha goat manure, 6ton/ha goat manure + 50kg/ha urea fertilizer, 6ton/ha goat manure + 100kg/ha urea fertilizer, 6ton/ha goat manure + 150kg/ha urea fertilizer, sole 200kg/ha urea fertilizer and control (no treatment). Application of sole 6ton/ha goat manure, 6ton/ha goat manure + 50kg/ha urea, 6ton/ha goat manure + 100kg/ha urea and 6ton/ha goat manure + 150kg/ha urea compared with control increased marketable yield of amaranth by 43, 57.9, 58 and 60.8% respectively. The use of goat manure at 6ton/ha with urea fertilizer reduces requirement mineral fertilizer to about 25%.*

**Keywords:** Goat manure; amaranth; combined application; urea fertilizer; shoot yield.

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## Introduction

In most parts of Africa, including Nigeria, the problem of land tenure system has been affecting the availability of land for agricultural purposes. Also the traditional method of maintaining soil fertility and productivity has been bush-fallow system where the arable land is allowed to regain the lost nutrients after 3 – 4 years of continuous cultivation (Usman *et al.*, 2015). However, in order to accommodate the high demand

for food by the ever increase population and other socio-economic pressures, the fallow period has been reduced to almost no fallow.

The use of fertilizers is highly needed to replenish nutrients taken out of the soil through crop harvest and to supplement more nutrients to boost yield (Olatunji and Ayuba, 2012). There are many research works that showed the use of several organic materials, especially cow dung, poultry droppings and farm yard manure as soil amendments suitable for increasing crop production, particularly among subsistent farmers in West Africa (Asadu and Unagwu, 2012). The application of organic fertilizer to manage the current trend of soil physical, chemical and biological degradation has been recommended by Chukwu *et al.* (2012). Organic fertilizers release nutrient slowly. This implies that crops can suffer initial starvation from nutrient immobilization prior to mineralization. While inorganic fertilizers ensure quick release of nutrients to crops, but have residual effect which may cause environmental pollution if not judiciously applied. This can also affect the intake of some essential nutrients in the soil by plant (Okigbo, 2000). The high cost coupled with non availability when needed can never be over emphasized.

The integration of organic and inorganic fertilizers in crop production has been advocated and supported by some research findings. Ayeni *et al*. (2015) stated that total dependence on inorganic fertilizers for crop production is not sustainable in tropical agriculture. Organic fertilizer can be used to improve soil characteristics and obtain high crop yields in addition with inorganic fertilizer (Chukwu *et al*., 2012). In his greenhouse experiment, Olowoake (2014) found that organomineral fertilizer increased amaranth performance significantly. He made use of products of fertilizer companies; Sunshine and Aleshinloye in Ondo and Oyo state respectively. Hence, there is scarce research information on the use of goat manure and urea fertilizers in crop production, in particular in short life span crops such as amaranth. The vegetable production in Nigeria still lies in the hand of the peasant farmers. It is therefore necessary to combine goat manure, which is readily available with the reduced urea fertilizer requirement and be tested under field condition to improve vegetable production.

Thus, a field experiment was carried out to determine the effects of application of sole goat manure and its combination with urea fertilizer (25, 50, 75%) and sole urea fertilizer on the performance of amaranth.

## Materials and Methods

Site Description

Description of the experimental site.

A field trial was conducted at Federal College of Agriculture, Akure, South-west zone of Nigeria. The annual rainfall ranges between 1100mm to 1,300mm for about six to seven months of the year in a bimodal pattern. The temperature ranges between 24-35$^{o}$C with constant sunshine. The relative humidity is high during the wet season. The existing vegetation was a mixture of grass and broad leaves. The dominant grass was guinea grass (*Panicum maximum* ) while the broad leaves were Siam weed (*Chromoleana odorata*) and Tridax (*Tridax procumbens*). The experiment was conducted between June and September, 2015.

Nursery Establishment

Two weeks before the commencement of the experiment, nursery beds were made. Amaranth seeds were broadcasted on the beds and covered thinly with soil. Watering was done twice daily; morning and evening as a result of cessation of rain.

Site Clearing and Input Acquisition

The site was cleared manually using cutlass. The thrashes were packed and divided into blocks and plots. Each plot measured one meter by four meters with discard of one meter between blocks and plots respectively. Amaranth seeds were sourced from Horticulture Section, Federal College of Agriculture, Akure. Goat manure was procured from a manger at Ilesa garage, Akure. Urea fertilizer was purchased from an agrochemical store in Akure metropolis.

Experimental Design and Treatment Definition

The experiment was laid out in a Randomized Complete Block Design with three replications. The experiment compared 200kgha$^{-}$ Urea fertilizer (UF) with sole 6tonha$^{-}$ goat manure (GM) and its combination with reduced levels of urea fertilizer, which were: 50kgha$^{-}$ Urea fertilizer + 6tonha$^{-}$ Goat Manure (GM), 100kgha$^{-}$ Urea fertilizer + 6tonha$^{-}$ Goat Manure (GM) and 150kgha$^{-}$ Urea fertilizer + 6tonha$^{-}$ Goat Manure (GM).

Soil Physico-chemical Properties Determination

Prior to the commencement of the experiment, six soil samples were taken randomly from the experimental site at the depth of 0-15cm with soil auger. The samples were bulked together; air dried and sieved with a 2mm sieve for chemical analysis following the laboratory procedures described by Carter (1993). The soil pH was determined in

water using a glass electrode pH meter. Soil organic carbon was determined by oxidizing soil sample with dichromate solution and later titrated with ferrous sulphate solution (Walkley and Black, 1934).The total nitrogen was determined using micro-kjeldahl method (AOAC 1995), while the available phosphorus was determined by the Bray P-1 method. The exchangeable cations were extracted using ammonia acetate at pH7. The K in the leachate was determined with a flame spectrophotometer while calcium and magnesium were determined with an atomic absorption spectrophotometer.

Growth Parameters

Three plants were selected at the centre from each plot at two weeks after treatment application. Data were collected weekly until the amaranth seeded. Plant height was measured from ground level to the tip of the shoot. Stem girth was measured with thread round the stem and stretch on ruler (cm). The number of leaves and shoots per plant were determined by counting respectively. Graphical method was used to determine the leaf area ($cm^2$).

Yield Parameters

Immediately after harvesting, fresh leaf and stem weight were determined using a triple stand scale respectively. These samples were oven dried at 85$^oC$ for 72hours or to constant weight and reweighed and calculation done as explained by Brandy and Weil (1999) for dry matter content determination.

Statistical analysis

The data collected were analyzed using the analysis of variance to determine the treatment effects. Duncan Multiple Range Test was used for mean separation at 5% level of significance.

## Results

Table 1 shows the chemical properties of the soil at the site of the experiment before the application of treatments. The pH (6.3) indicates slight acidity. The nitrogen was (0.12%) low.

The value of available Phosphorus was 0.93mg/kg, while the exchangeable cations; K,Ca Mg were 0.1, 0.78 and 0.9Cmol/kg respectively. These values indicate low fertility of the soil.

**Table1: Physico-chemical properties of soil in the experimental site before the commencement of the experiment**

| Soil Properties | Values |
|---|---|
| Sand(%) | 56 |
| Silt(%) | 22 |
| Clay(%) | 22 |
| Bulk density | 1.60 |
| pH (water)1:1 | 6.30 |
| Organic matter(g/kg) | 0.52 |
| Total N (g/kg) | 0.12 |
| Available Phosphorus(mg/kg) | 9.30 |
| Exchangeable K(Cmol/kg) | 0.10 |
| Exchangeable Ca(Cmol/kg) | 1.78 |
| Exchangeable Mg(Cmol/kg) | 0.90 |

Growth of amaranth as influenced by goat manure and urea fertilizer.
At the first harvest, data on growth of amaranth as influenced by urea, sole and combined application of goat manure are shown in Table 2. Urea fertilizer increased number of leaves per plant significantly. It also increased plant height, but not significantly taller than its combination with half and above levels.

Table 3 shows the growth parameters of amaranth as affected by the application of urea, sole and combined application of goat manure at second harvest. 6ton/ha goat manure + 150kg/ha urea produced the highest number of shoots, but not significantly higher than plots treated with sole urea and 6ton/ha goat manure + 1000kg/ha urea respectively. Sole application of urea increased number of leaves per plant and plant height significantly. Application of sole urea, 6ton/ha goat manure + 100kg/ha urea and 6ton/ha goat manure + 150kg/ha urea increased stem girth and leaf area significantly. Sole application of urea fertilizer significantly increased total number of leaves per plants followed by 6ton/ha goat manure + 150kg/ha urea. Sole goat manure application and 6ton/ha goat manure + 50k/ha urea were not significantly different compared with control (no treatment)

**Table 2. Effect of combined use of goat manure and Urea fertilizer on the growth of amaranths at first harvest**

| Treatment | Number of leaves/plant | Plant height | Stem girth | Leaf area |
|---|---|---|---|---|
| Control | 109.13$^{b}$ | 46.56$^{b}$ | 4.56$^{a}$ | 143.63$^{a}$ |
| 6 ton\ha GM | 84.10$^{c}$ | 50.96$^{b}$ | 5.06$^{a}$ | 132.66$^{a}$ |
| 6 ton/ha GM+50kgha urea | 115.00$^{b}$ | 51.23$^{b}$ | 5.63$^{a}$ | 152.96$^{a}$ |
| 6 ton/ha GM+100kg/ha urea | 141.00$^{b}$ | 73.30$^{a}$ | 5.56$^{a}$ | 190.63$^{a}$ |
| 6ton/ha GM+150kg/ha urea | 107.76$^{b}$ | 74.26$^{a}$ | 6.26$^{a}$ | 192.16a |
| 200kg/ha urea | 164.56$^{a}$ | 69.30$^{a}$ | 6.53$^{a}$ | 191.23$^{a}$ |

**Table 3. Effect of combined use of goat manure and Urea fertilizer on the growth of amaranths at second harvest**

| Treatment | Number of Shoot | Number of leaves/plant | Plant height | Stem girth | Leaf area |
|---|---|---|---|---|---|
| Control | 2.20$^{a}$ | 84.00$^{d}$ | 42.80$^{c}$ | 2.20$^{b}$ | 26.40$^{c}$ |
| 6 ton\ha GM | 2.50$^{cb}$ | 89.30$^{d}$ | 42.40$^{c}$ | 2.60$^{b}$ | 31.90$^{c}$ |
| 6 ton/ha GM+50kgha urea | 3.2$^{cb}$ | 112.00$^{c}$ | 40.00$^{c}$ | 2.50$^{b}$ | 35.30$^{cb}$ |
| 6 ton/ha GM+100kg/ha urea | 4.60$^{ba}$ | 143.10$^{c}$ | 65.20$^{b}$ | 4.60$^{b}$ | 44.00$^{ba}$ |
| 6ton/ha GM+150kg/ha urea | 6.50$^{a}$ | 216.40$^{b}$ | 61.30$^{b}$ | 5.10$^{a}$ | 47.00$^{a}$ |
| 200kg/ha urea | 5.60$^{a}$ | 299.70$^{a}$ | 72.00$^{a}$ | 5.00$^{a}$ | 50.30$^{a}$ |

Figure 1 indicates that the sole application of urea significantly increased marketable weight compared with sole goat manure and no treatment. The combined treatments were not significantly different from one another in the first harvest,s but 6ton/ha goat manure + 150kg/ha urea was significantly increased in the second harvest. Sole urea

produced highest fresh yield, but not significantly higher than 6ton/ha goat manure + 150kg/ha urea. All the combined treatments were not significantly different from one another. Nevertheless, sole goat manure significantly increased total marketable yield of amaranth compared with no treatment (figure 2). In figure 3, the dry matter yield was highest in the plot treated with 6t/ha goat manure + 150kg/ha urea but not significantly higher than sole urea treatment. The dry matter obtained from control was significantly lower than any of the combined treatments.

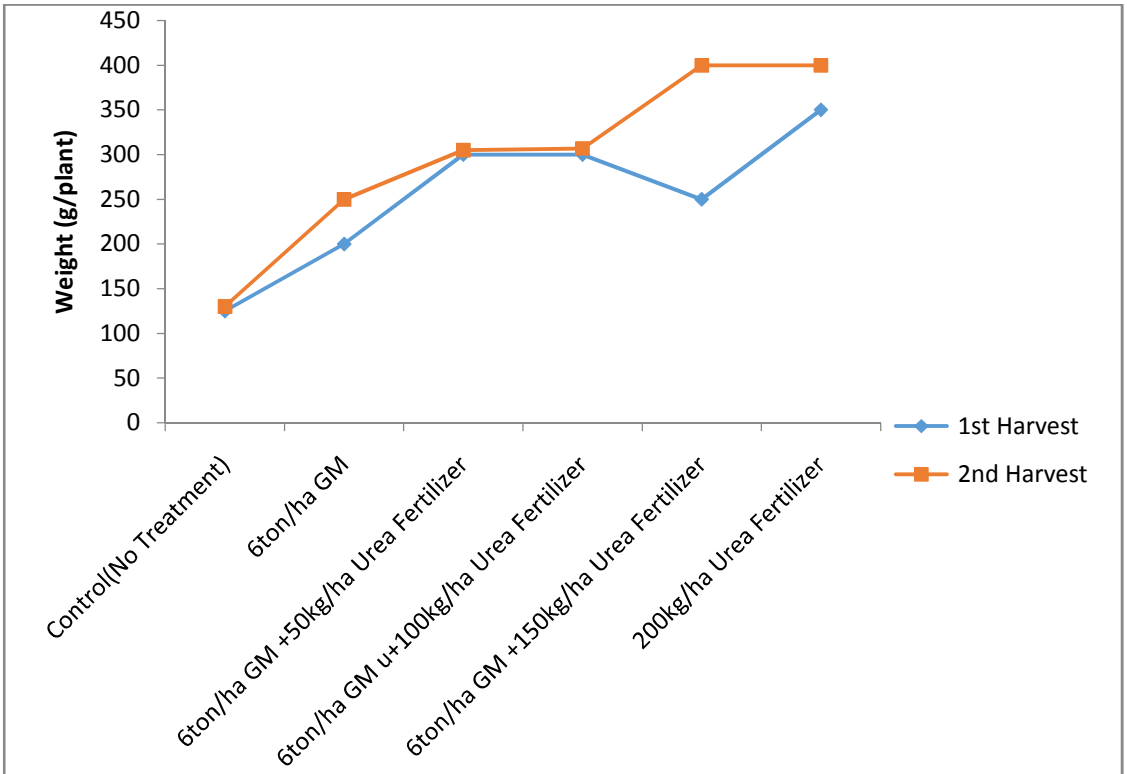


Figure 1. Effect of combined application of goat manure and urea fertilizer on the marketable weight of amaranth

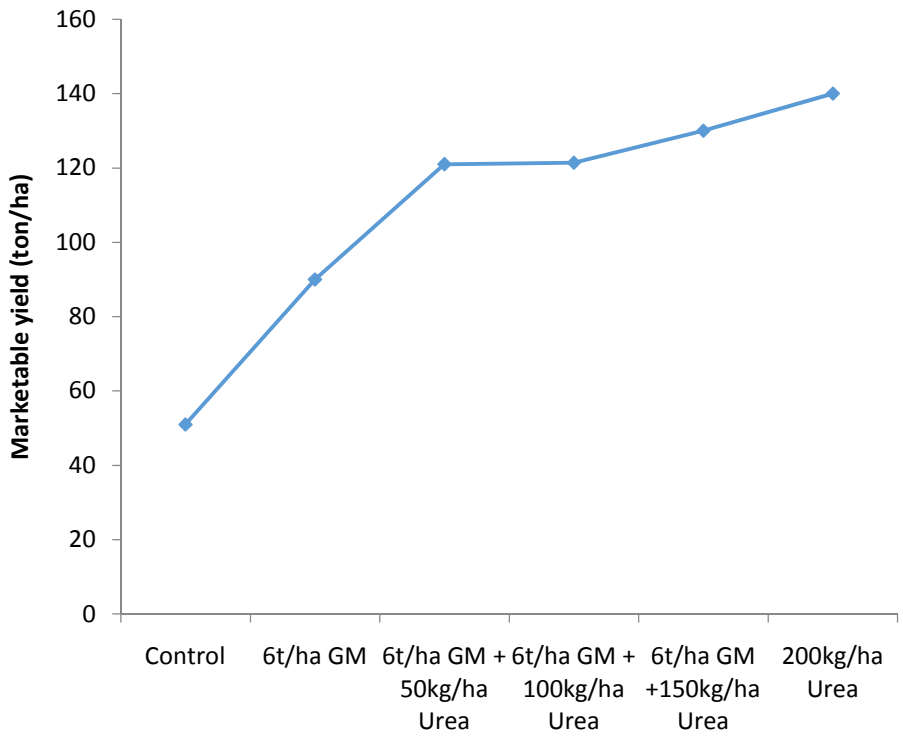


Figure 2. Total marketable yield of amaranth as influenced by the combined application of goat manure and urea fertilizer

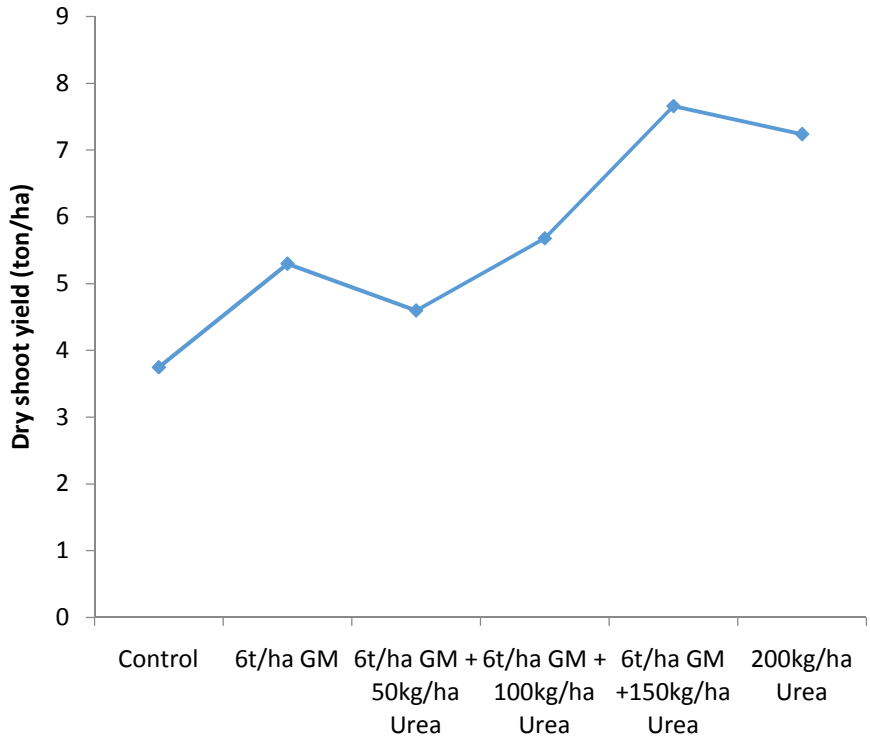


Figure 3. Dry shoot yield of Amaranth as influenced by the combined use of goat manure and urea fertilizer

## Discussion

The significantly less number of leaves obtained in the plot treated with sole goat manure compared with control in the first harvest can be adduced to the fact that part of nutrients present in the soil has been used by soil microbes as substrate for decomposition of goat manure. But the increase in the number of leaves from sole goat manure in the second harvest, although not significantly more than control shows that plant has started benefiting from the nutrients released after mineralization.

The combined application of goat manure and mineral fertilizer that increase the performance of amaranth compared with sole application of animal manure indicates that the presence of mineral fertilizer on the treatment was not only adding more nutrients to the soil but serves as substrate which increase the rate of decomposition of

animal manure. This is in consonance with a previous work in yam production where the growth performance and nutrient uptake of yam were increased significantly by combining animal waste to reduce levels of NPK fertilizer requirement to 25% (Arotolu *et al.*, 2015). The economic component of amaranth is the shoot. Sole application of urea fertilizer increased fresh shoot yield the most compared with either sole goat manure or its combination and control. This might be for the quick release of nitrogen in abundance to the soil for plant use for leaf production which promotes photosynthesis and shoot development. But in contrast to the observation of Ogunlade *et al.* (2011) as cited by Olowoake, 2014 that the combinations of organic and mineral fertilizer perform better on crop yield than when each of them is solely used. The effectiveness of any fertilizer may depend on the type of fertilizer and crop.

## Conclusion

The application of sole goat manure and its combination with urea fertilizer and sole urea fertilizer improved the performance of amaranth.

Application of 6ton/ha goat manure, 6ton/ha goat manure + 50kg/ha urea, 6ton/ha goat manure + 100kg/ha urea, 6ton/ha goat manure + 150kg/ha urea and 200kg/ha urea compared with control increased fresh yield of amaranth by 43, 57.9, 58, 60.8 and 66% respectively. It is concluded that animal waste such as goat manure can be used to improve vegetable performance. It can be used solely or in combination with the reduced rate of recommended mineral fertilizer. This will reduce the negative attributes associated with the sole use of mineral fertilizer.

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