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EFFECTS OF ANIMAL MANURES AND UREA FERTTILIZER AS NITROGEN SOURCES FOR *Amaranthus* GROWTH AND YIELD IN A RAINFOREST ULTISOL IN NIGERIA.

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ABSTRACT: Field experiment was conducted to determine the effects of animal manures and urea fertilizer on growth parameters and yield of *Amaranthus* for two years. The experiment was laid out in a randomized complete block design with three replications. Five sources of nitrogen (cattle manure, goat manure, poultry manure, pig manure and urea fertilizer) applied at a rate of 90kg N/ha and a control (no manure, no fertilizer) were used in the study. The results showed that *Amaranthus* height was significantly ($P < 0.05$) increased by cattle manure while the number of leaves per *Amaranthus* plant was significantly increased by urea fertilizer. The highest fresh yield of 35.15 t/ha was obtained by applying pig manure source of N although not significantly different ($P > 0.05$) from 33.67 t/ha obtained by using urea source of N, but it was significantly ($P < 0.05$) higher than the yield obtained from other sources of N and the control. Given its superior responses, pig manure could be a good N-fertilizer alternative where inorganic fertilizer is not readily available, particularly for annual crops with short growth cycle such as *Amaranthus.* However, applications of the five sources of nitrogen could immensely improve yield of vegetables as there were remarkable increases in growth and yield of *Amaranthus* when compared with the control.

INTRODUCTION

Amaranthus also called African spinach, bush green, green leaf, Amaranths in different parts of the world belongs to the family Amaranthaceae. They are the most commonly grown leafy vegetable of the lowland tropics in Asia and Africa. Leafy vegetables require more nitrogen than other vegetable crops hence the need for adequate nitrogen fertilization.

The need for nitrogen is evident from the fact that plants require protein for their metabolism. According to Tandon (1991), nitrogen is to a plant what petrol is to a car. Nitrogen is a vitally important plant nutrient, the supply of which can be controlled by man. It is absorbed by plants in the form of nitrates (NO_3^-) and also in the form of ammonium (NH_4^+). It can also be absorbed in the form of urea and even as ammonia (Tisdale and Nelson, 1975). Amaranths appreciate nitrogen and high levels of nitrogen will delay the onset of flowering, allowing a considerably higher yield (Messiaen, 1992; Edmond *et al*., 1993 and Schippers, 2000). Despite the relatively large amounts of available nitrogen made by soil organisms, only in exceptional cases are the quantities sufficient for the satisfactory growth of crop plants.

Most African farmers do not have easy access to inorganic fertilizer because of its high cost and inadequate supply and distribution. There is need to investigate on the organic sources of nitrogen for enhanced productivity of *Amaranthus*. This work investigated the effects of some organic manures and urea fertilizer as nitrogen sources for *Amaranthus* growth and yield in a rainforest ultisol in Nigeria.

MATERIALS AND METHOD

The experiment was carried out at the Research Farm of Michael Okpara University of Agriculture, Umudike to investigate the effectiveness of various sources of nitrogen for *Amaranthus* production for two years. Umudike is located on latitude 05^0 29' N, longitude 07^0 33' E, with an altitude of 122 m above sea level.

The nitrogen sources used were; cattle, goat, poultry, pig manures and urea fertilizer. The organic manures were obtained from the animal farm unit of Michael Okpara University of Agriculture, Umudike while urea fertilizer was purchased from the Agricultural Development Project (ADP) office at Calabar, Cross River State, Nigeria. The organic manures were dried to hinder decomposition and later analyzed for total N, total P, total K, organic carbon, C: N ratio, Ca and Mg following standard procedures (Juo, 1979). The *Amaranthus* seeds were obtained from the National Root Crops Research Institute (NRCRI), Umudike.

The experimental area was mechanically ploughed and harrowed. The field was manually marked out with pegs and flat beds were also manually made using the spade. Plot size was 3 m x 1.5 m. An alley of 1.2 m was left between blocks and 0.6 m between plots.

The five sources of nitrogen were applied at a rate of 90 kg N/ha. Additional treatment plot was prepared to serve as the control, where neither manure nor urea was applied. The treatments were replicated four times giving a total of 24 plots, using a randomized complete block design. The organic manure treatments were spread and incorporated into the soil on specified plots, the soil was kept moist and left for 2 weeks before planting. Urea fertilizer was applied to specified plots 2 weeks after planting using the band placement method. Banding of the fertilizer was about 3.75 cm away from the plant on one side of the seed row and about 5 cm deep.

The *Amaranthus* seeds were mixed with dried river sand first before sowing so as to ensure that the seeds were not planted too close together for proper management of the seed rate desired. The mixture was about 70 % sand and 30 % *Amaranthus* seeds. These were evenly distributed directly on drills at a distance of 10 cm between each row. The seedlings were later thinned down to one plant per stand few days after emergence at a spacing of 10 cm between plants. Therefore, the planting distance was 10 cm x 10 cm giving a plant population of 450 plants per bed (450/4.5 m^2) and 1,000,000 plants per hectare. The plots were kept weed free throughout the crop growing period by hand pulling because of the closeness of the plants. Plots were irrigated manually using watering cans before planting and immediately after planting to ensure and enhance sprouting. Watering was done 2 times a day (morning and evening) at the initial stage of development, this was reduced to once (evening only) every day. During this time there was a good canopy development that shaded the ground and reduced soil moisture loss.

Agronomic parameters measured were plant height (cm), number of leaves per plant, stem girth and fresh yield (kg/ha). Plant height was measured with a meter rule as the height from the base of the crop (ground level) to the tip of twenty tagged plants, while the number of leaves was taken from the fully opened leaves per plant. These measurements commenced 3 weeks after planting (3 WAP) and continued at weekly interval until the end of the experiment. Harvesting was done at 5 WAP by uprooting the entire plant. Yield data was taken at the time of harvest, where the weight of the uprooted plants were determined plot by plot after rinsing the roots free of sand. Stem girth was measured at harvest.

RESULTS AND DISCUSSION

The chemical compositions of the animal manures used in the experiment are as shown in Table 1 while the effects of nitrogen sources on plant height are presented in Table 2. Cattle manure produced the highest plant height at 3 and 4 WAP and was significantly ($P < 0.05$) higher than the other N sources, but taller plants were produced by pig manure source of N at 5 WAP though not significantly higher than the height obtained with cattle manure, poultry manure and urea fertilizer. Generally, the trend was; cattle manure > poultry manure > pig

manure > urea > goat manure > control at 3 WAP. At 4 WAP, the trend was; cattle manure > pig manure > poultry manure > urea > goat manure > control, while at 5 WAP, the trend was; pig manure > cattle manure > urea > poultry manure > goat manure > control. The insignificant effect of goat manure on *Amaranthus* height at the initial stage of growth (3 and 4 WAP) can be related to the relatively high C: N of goat manure. The high C: N ratio implies lower rate of decomposition of the manure and slow N mineralization. Goat manure also contained a large portion of organic N which needs to be mineralized to inorganic N before they are made available to the plants (Eghball *et al*., 2002). Therefore, goat manure requires a longer time for its organic N content to be mineralized for plant uptake. This is true by the significant effect obtained with goat manure at 5 WAP when compared with the control. However, the mean levels of plant height (Table 2) for the control, goat manure, poultry manure, urea fertilizer, pig manure and cattle manure were 25.94, 29.94, 34.88, 35.13, 36.59 and 37.38 cm, respectively. On this basis, cattle manure produced the tallest set of plants followed by pig manure, urea, poultry and goat manure. The superiority of organic manures in increasing *Amaranthus* height could be attributed to its slow nutrient release factor, its ability to enhance the desirable soil physical conditions for plant growth and its ability to buffer the soil pH against undesirable fluctuations. The mineralized N in urea fertilizer might have been subjected to leaching loss and or volatilization (Adediran *et al*., 1995).

Table 1: Chemical composition of the animal manures used in the study

Parameter	Animal manure			
	Cattle	Goat	Poultry	Pig
Org. C (%)	15.42	27.42	28.04	30.29
Org. matter (%)	26.58	47.27	48.34	52.22
Total N (%)	1.33	2.45	2.59	2.87
C: N ratio	11.59	11.19	10.82	10.55
Total P (%)	0.07	0.11	0.19	0.21
Total K (%)	0.90	1.39	1.50	1.80
Ca (%)	1.7	1.7	4.0	4.0
Mg (%)	0.7	0.9	2.0	1.8

Table 2: Effect of nitrogen sources on *Amaranthus* height

	Plant height (cm)			
Nitrogen source	3 WAP	4 WAP	5 WAP	Mean
Cattle	14.04	38.60	59.50	37.38
Goat	10.73	29.90	49.20	29.94
Pig	12.17	37.30	60.30	36.59
Poultry	12.45	36.40	55.80	34.88
Urea	11.29	35.90	58.20	35.13
Control	9.33	26.90	41.60	25.94
LSD (0.05)	1.18	3.69	5.29	

The effects of nitrogen sources on number of leaves per *Amaranthus* plant are recorded in Table 3. More number of leaves per plant was produced from urea treatment at all stages of growth. When compared with the control (unfertilized plots), the treatments irrespective of source significantly ($P < 0.05$) increased the number of leaves per *Amaranthus* plant at all stages of growth. The highest value of 39.79 leaves per plant obtained at 5 WAP with urea treatment was not significantly ($P < 0.05$) higher than 38.62 leaves per plant obtained with pig manure treatment but was higher than the values of 36.91, 36.44, 34.66 and 34.18 obtained by poultry manure, cattle manure, goat manure and control, respectively. The overall mean of the number of leaves per *Amaranthus* plant for the control, goat manure, cattle manure, pig manure, poultry manure and urea were 23.09, 23.78, 24.49, 24.63, 24.91 and 26.26 leaves per plant, respectively.

Table 3: Effect of nitrogen sources on number of leaves per *Amaranthus* plant

	Number of leaves per plant			
Nitrogen source	3 WAP	4 WAP	5 WAP	Mean
Cattle	13.68	23.34	36.44	24.49
Goat	13.51	23.18	34.66	23.78
Pig	13.51	24.39	38.62	24.63
Poultry	13.66	24.15	36.91	24.91
Urea	14.03	24.97	39.79	26.26
Control	12.59	22.49	34.18	23.09
LSD (0.05)	0.64	0.21	1.29	

All the treatments increased stem girth of *Amaranthus* more than the control (Table 4). The highest mean stem girth value of 17.03 was obtained from pig manure and was significantly ($P < 0.05$) different from the other nitrogen sources except urea fertilizer which recorded stem girth value of 14.90.

Table 4: Effect of nitrogen sources on *Amaranthus* stem girth

Nitrogen source	Stem girth
Cattle	13.73
Goat	13.83
Pig	17.03
Poultry	14.35
Urea	14.90
Control	9.58
LSD (0.05)	2.57

Table 5 shows the effects of nitrogen sources on the fresh yield of *Amaranthus*. Pig manure recorded the highest fresh yield of 35.15 t/ha and was not significantly ($P > 0.05$) higher than 33.67 t/ha obtained with urea treatment, but was higher than the yield obtained from the other nitrogen sources. The highest yield obtained with pig manure in this study is in line with the findings of Onweremadu *et al.* (2003) and Mbagwu *et al*. (1994) who recorded increase in soil productivity as a result of using pig manure. Also, the narrow C: N ratio of pig manure enhances faster mineralization, thereby making the nutrients readily available for plant uptake compared to other organic manure sources.

Comparison of the five sources of N indicates that pig manure gave the highest response followed by urea and then poultry. This could possibly be due to higher content of total N, P and K in pig manure compared to the other manure types. Though urea contains a higher total N, its low P and K content may be a limiting factor, also its N content might have been easily mineralized and subjected to leaching loses. Generally, yields were significantly ($P< 0.05$)

increased by the application of the different nitrogen sources when compared with the control. The yields obtained from all the treatments except goat manure and the control fell within the 25 t/ha reported by Messiaen (1992) and Tandon (1991), and that of 30 t/ha recorded by Schippers (2000).

Table 5: Effect of nitrogen sources on *Amaranthus* fresh yield

Nitrogen sources	Fresh yield (t/ha)
Cattle	27.25
Goat	21.23
Pig	35.15
Poultry	28.59
Urea	33.67
Control	18.78
LSD (0.05)	4.28

CONCLUSION

The applications of the five sources of nitrogen could immensely improve yield of vegetables as there were remarkable increases in growth and yield of *Amaranthus* when compared with the control. It would therefore be economical for farmers that cultivate in the rainforest Ultisol where nutrient contents in soil are low and access to and affordability of inorganic fertilizers are major problems to use animal manures. The use of animal manures especially pig manure as organic fertilizer on farms, particularly for annual crops with short growing cycle such as *Amaranthus* is advantageous..

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