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INFLUENCE OF PIG MANURE, UREA AND COMBINATIONS OF THEIR REDUCED LEVELS ON THE PERFORMANCE OF *AMARANTHUS CRUENTUS* IN A RAIN0FOREST *ULTISOL*

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ABSTRACT
The influence of sole and combined application of pig manure and urea on the performance of Amaranthus cruentus at Umudike in a rainforest Ultisol was investigated for two years. The study was laid out in a randomized complete block design with four replications. There were six treatments consisting of pig manure applied at 90 kg N/ha (full dose of manure), urea applied at 60 kg N/ha (full dose of urea), ½ dose of manure (45 kg N/ha) + ½ dose of urea (30 kg N/ha), ¼ dose of manure (22.5 kg N/ha) + ¾ dose of dose of dose of urea (45 kg N/ha), ¾dose of manure (67.5 kg N/ha) + ¼ dose of urea (15 kg N/ha), and control (no manure, no urea). Amaranthus height was not significantly affected by the treatments when compared with the control, though the tallest plant height of 76.30 cm was obtained from the combination of ½ manure + ½ urea treatments. The overall results showed that the combination, ½ manure + ½ urea (i.e. 45 kg N/ha of pig manure + 30 kg N/ha of urea) gave significant (P < 0.05) increases in stem girth (17.42), number of leaves per plant (44.76), fresh yield (41.51 t/ha) and in the dry matter yield (3.49 t/ha) of Amaranthus than sole application of either of them, and is therefore recommended as the best for optimum production of Amaranthus in the study area.

Keywords: *Amaranthus*, pig manure, urea, *Ultisol.*

INTRODUCTION

The maintenance of soil fertility is essential in achieving and sustaining high crop yields over a period of time. Use of inorganic fertilizers has proven to be more convenient and impactful than the use of organic fertilizers, but the resulting soil physical degradation, increased soil acidity and soil nutrient imbalance have drawn the attention of researchers back to the use of organic manure. Application of organic materials as fertilizers provides growth-regulating substances and improves the physical, chemical and microbial properties of the soil (Belay *et al.*, 2001). Sole use of organic fertilizers to sustain cropping has, however, been reported to be inadequate, as they are required in rather large quantities to meet crops' nutrient requirements because of their relatively low nutrient content (Palm *et al*., 1997).

It has been reported by several researchers (Satyanarayana *et al.*, 2002; Adeniyan and Ojeniyi, 2005; Obasi *et al*., 2006) that high and sustainable crop yields are only possible with integrated use of inorganic fertilizers with organic manure. Complementary application of inorganic and organic fertilizers increases nutrient availability and reduces losses by converting inorganic nitrogen into organic forms (Chand *et al*., 2006; Chen, 2008). It enhances the efficiency of the fertilizers and also reduces environmental problems that may arise from their use (Zublena *et al*., 1996; Hoffman *et al*., 2001).

This research was therefore, conducted to determine the combined effects of inorganic and organic fertilizers on the performance of *Amaranthus* and also to know the best combination of inorganic and organic fertilizers for *Amaranthus* production in a rainforest ultisol.

MATERIALS AND METHODS

The experiments were conducted at the Research Farm of Michael Okpara University of Agriculture, Umudike to determine the combined effects of organic and inorganic fertilizers on the performance of *Amaranthus* and also to establish the best combination of

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organic and inorganic fertilizers for *Amaranthus* production for two consecutive years.

There were six treatments with four replications, giving a total of 24 plots. The treatments were pig manure applied at 90 kg N/ha (full dose of manure), urea applied at 60 kg N/ha (full dose of urea), ½ manure (45 kg N/ha) + ½ urea (30 kg N/ha), ¼ manure (22.5 kg N/ha) + ¾ urea (45 kg N/ha), ¾ manure (67.5 kg N/ha) + ¼ urea (15 kg N/ha), and control (no manure, no urea).

The experimental design used was a randomized complete block design. The experimental area in each cropping season was slashed manually, ploughed and harrowed mechanically while the field was manually marked out with pegs. Flat beds were also manually made using a spade. Each plot measured 3 m x 1.5 m (4.5 m^2). An alley of 1.2 m was left between blocks and 0.6 m between plots.

The various rates of pig manure were applied one week before planting (1 WBP) by broadcast with incorporation method, while urea fertilizer treatments were applied two weeks after planting (2 WAP) by band placement method. *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, and was reduced to once (evening only) every day at the later stage. During this time there was a good canopy development that shaded the ground and reduced soil moisture loss.

Agronomic parameters measured included plant height (cm), number of leaves per plant, stem girth, fresh yield and dry matter 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 ten tagged plants, while the number of leaves was taken by counting the fully opened leaves per plant. These measurements commenced 3 WAP and continued at weekly interval until the end of the experiment. Harvesting was done at 5 WAP by uprooting the entire plant from an area of 100 cm x 100 cm per plot and the fresh yield determined after rinsing the roots free of sand. For dry matter determination, the ten tagged plants were uprooted, rinsed, and oven-dried at 65^0 C to constant weight (Maerere *et al.*, 2001) and the weight determined. Stem girth was measured at harvest using a venier calliper.

The data collected were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedures of the Statistical Analysis Systems programme (SAS, 1989) to determine treatment effects. Means were separated using the Fisher's Least Significant Difference (FLSD) at 5 % level of probability.

RESULTS AND DISCUSSION

Chemical composition of pig manure

The analyses of the pig manure used for the study gave 2.87 % N, 0.21 % P, 1.80 % K, 30.29 % O.C., 52.22 % O. M., 10.55 C: N ratio, 4.0 % Ca and 1.8 % Mg.

Growth parameters

Plant height of *Amaranthus* was not significantly affected by the sole and combined use of pig manure and urea in the first and second cropping seasons as indicated in Table 1, although the tallest plant of 76.30 cm (5 WAP) was obtained from the ½ manure + ½ urea treatment .

Table 1: Effects of sole and combined use of pig manure and urea on plant height in the 1st and 2nd cropping seasons

Treatment	Plant height (cm)								
	3WAP			4WAP			5WAP		
	1st	2nd	Mean	1st	2nd	Mean	1st	2nd	Mean
Control	12.25	12.30	12.28	24.35	23.45	23.90	56.60	55.75	56.18
Manure	15.85	14.20	15.03	32.45	29.45	30.95	70.80	63.65	67.23
Urea	18.10	16.60	17.35	37.65	36.20	18.46	78.35	72.80	75.58
½ m + ½ u	16.95	17.00	16.98	39.28	39.30	39.29	76.23	76.36	76.30
¾ m + ¼ u	17.75	16.40	17.08	35.65	32.50	34.08	73.40	68.90	71.15
¼ m + ¾ u	19.00	15.90	17.45	38.45	35.10	36.78	77.45	70.25	73.85
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Manure = 90 kg N/ha of pig manure (full dose of manure)
Urea = 60 kg N/ha of urea (full dose of urea)
m = manure
u = urea

Table 2: Effects of sole and combined use of pig manure and urea on number of leaves per plant in the 1st and 2nd cropping seasons

Treatment	Number of leaves per plant								
	3WAP			4WAP			5WAP		
	1st	2nd	Mean	1st	2nd	Mean	1st	2nd	Mean
Control	13.27	12.05	12.66	23.45	21.37	22.41	35.40	35.43	35.42
Manure	14.40	14.10	14.25	26.44	26.43	26.44	43.80	41.80	42.80
Urea	15.95	14.55	15.25	26.63	26.08	26.36	43.18	41.75	42.47
½ m + ½ u	15.60	14.48	15.04	27.00	28.30	27.65	44.78	44.75	44.77
¾ m + ¼ u	14.30	14.20	14.25	26.08	24.43	25.26	42.75	40.85	41.80
¼ m + ¾ u	15.38	14.46	14.92	27.15	26.33	26.74	44.82	44.55	44.69
LSD(0.05)	NS	NS	1.06	2.19	2.81	1.91	3.65	5.04	2.85

There was no significant difference in the number of leaves per plant at 3 WAP from either the sole or combined use of the treatments in the first and second cropping seasons as presented in Table 2, but the treatments significantly increased the number of leaves per plant relative to the control at 4 and 5 WAP. The highest number of leaves per plant was obtained from the ½ manure + ½ urea treatment combinations. The highest stem girth value of 17.42 was also obtained from the ½ manure + ½ urea treatment (Table 3). Generally, the best result was obtained from combined use of organic and inorganic fertilizers. This supports the findings of Akande *et al.* (1998) and Adediran *et al.* (2005) indicating a better effect of organic materials on *Amaranthus* when applied in combination with inorganic fertilizer.

Fresh and dry matter yields of *Amaranthus*

The highest fresh yield of *Amaranthus* of 42.80 t/ha obtained by the ¼ manure + ¾ urea treatment in the first cropping season was significant when compared with the sole manure treatment and the control, while the highest yield of 41.01 t/ha obtained from the ½ manure + ½ urea treatment in the second cropping season was significant relative to the control (Table 4). The mean data for the two years indicated that the ½ manure + ½ urea treatment recorded the highest fresh yield of 41.51 t/ha, followed by the ¼ manure + ¾ urea which recorded 41.40 t/ha while the least yield of 22.75 t/ha was obtained from the control. The highest dry matter yield (3.49 t/ha) was also obtained from the ½ manure + ½ urea combination.

Generally the fresh yields obtained from all the treatments except the control in both the first and second cropping seasons were higher than the 25 t/ha reported by Tandon (1991) and Messiaen (1992) and that of 30 t/ha reported by Schippers (2000). This showed that *Amaranthus* responded positively to the soil amendments used.

It is evident from the present study that balanced fertilization using both organic and inorganic fertilizers enhanced optimum growth and yield of *Amaranthus* than sole application of either of them. This view has also been reported by several researchers (Palm *et al.*, 1997; Adeniyan and Ojeniyi, 2005 Chen 2008). The combination of 45 kg N/ha of pig manure (½ manure) and 30 kg N/ha of urea (½ urea), though not significantly different from the combination of 22.5 kg N/ha of pig manure (¼ manure) and 45 kg N/ha of urea (¾ urea), gave significant improvement in the performance of *Amaranthus* and is therefore recommended as the best for optimum production of *Amaranthus* in regions with similar environmental and climatic conditions as the study site.

Table 3: Effects of sole and combined use of pig manure and urea on *Amaranthus* stem girth in the 1st and 2nd cropping seasons

	Stem girth		
Treatment	1st cropping	2nd cropping	Mean
Control	9.98	9.58	9.77
Manure	14.20	17.03	13.96
Urea	16.60	13.83	15.47
½ m + ½ u	17.83	13.73	17.42
¾ m + ¼ u	15.25	14.90	14.54
¼ m + ¾ u	16.53	14.35	15.71
LSD(0.05)	2.98	2.57	1.86

Table 4: Effects of sole and combined use of pig manure and urea on *Amaranthus* fresh and dry matter yield in the 1st and 2nd cropping seasons

Treatment	Fresh yield (t/ha)			Dry matter yield (t/ha)		
	1st cropping	2nd cropping	Mean	1st cropping	2nd cropping	Mean
Control	23.50	22.00	22.75	2.20	2.11	2.16
Manure	31.80	32.11	31.96	3.31	3.20	3.26
Urea	41.13	39.97	40.55	3.02	3.01	3.02
½ m + ½ u	42.00	41.01	41.51	3.68	3.29	3.49
¾ m + ¼ u	37.00	32.51	34.76	3.22	3.13	3.18
¼ m + ¾ u	42.80	40.00	41.40	3.56	3.19	3.38
LSD(0.05)	9.96	9.87	9.25	0.91	0.91	NS

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