Journal of Animal and Veterinary Advances 3 (11): 758-762, 2004

The Use of Manure to Increase the Yield and Quality of Amaranthus to Feed Rabbit in a Humid Tropical Region

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Abstract: The use of NPK 15-15-15 and of poultry manure and wood ash in improving the yield and quality of Amaranthus vegetable as rabbit feed supplement was investigated in an experiment conducted in Akure, Ondo State, Nigeria in 2000 and 2001. The five manurial treatments investigated on Amarathus hybridus were NPK 15-15-15, Poultry Manure, Wood Ash, Poultry Manure - Wood Ash mixture and a control without manure application. Manure was applied at two weeks after transplanting. Amaranthus vegetable (Amaranthus hybridus) was raised in nursery and transplanted at three weeks. Harvesting by repeated cutting began at four weeks after transplanting and repeated at two weekly intervals. Total yield was taken and the proximate composition of percentages protein, fat, crude fiber and carbohydrate were carried out. The addition of NPK 15-15-15, poultry manure and wood ash manure improved the fertility status of the soil, which increased the yield and improved the quality of amaranthus vegetable. The increase in yield of amaranthus vegetable in plots treated with NPK 15-15-15, poultry manure, poultry manure - wood ash mixture and wood ash alone over the control plot without manure were 71.3%, 70.6%, 69.8% and 60.2% respectively while the corresponding increase in protein content, a good measure of nutrient quality, were 71.5%, 67.3%, 56.3% and 54.3% respectively. Nitrogen in soil correlated with yield ($r = 0.90$) and with percentage protein in Amaranthus ($r = 0.96$). The yield of amaranthus vegetable in plots treated with NPK 15-15-15, poultry manure and poultry manure-wood ash mixture were comparable. Poultry manure and wood ash that are cheaply obtained can replace NPK of high cost to increase yield of Amaranthus to feed rabbit.

Key words: Manure, amaranthus vegetable, yield and quality, rabbit feed supplement

Introduction

The continued rise in the cost of production of beef, sheep and chicken as sources of animal protein in Nigeria has necessitated the need to explore another potential source in rabbit. Rabbit meat has the highest percentage of protein (21%) and the least (11%) fat content when compared with other meat sources (Ayinde and Aromolaran, 1998). Mba (1983) had put the adult human minimum requirement for dietary protein to range from 65g/day to 72g/day and 35g of this minimum requirement should be obtained from animal products. The consumption of rabbit could raise this protein intake.

Previous research had confirmed good rate of growth in rabbit fed with green feeds (Ositelu 1977; Pote *et al.*, 1980 and Onwudike 1995) while Ojewola *et al.* (1999) listed such green feeds to include vegetable leaves, common grasses and legume forages. Rabbits can feed on vegetable amaranthus to supplement the pelleted rabbit feed and research findings in Malawi showed satisfactory growth and reproduction in rabbits fed on amaranthus (Lebas *et al.*, 1986). Commercial rabbit producers in Nigeria have found amaranthus vegetable a suitable feed supplement to rabbit pelleted feed and it has been recommended that such green vegetable should be cut daily and fed to the rabbits in the evening while the left overs should be packed out in the morning (Ministry of Agriculture and Cooperative, Lagos State, 1984 and Fadare, 1994). Amaranthus is a vegetable of high dietary value produced and consumed in most parts of Nigeria and it is also widely distributed in the warm regions of the world. It contains a high level of vitamin A, calcium and potassium and high protein content (Tindall, 1983). The high nutrients contained in amaranthus make it a high quality leafy supplement for rabbit, which is consumed by man to increase the protein intake and the need to investigate the increased production of Amaranthus with the use of manure types becomes necessary.

Manure both as inorganic and organic forms had been applied to improve the performances of amaranthus (Adeyemo *et al.*, (1986). The inorganic form is the synthetic fertilizers such as the compound NPK fertilizers while the organic forms are the types of poultry manure, goat manure, compost manure and wood ash. Amaranthus responds to the order of three to four fold yield increase with adequate fertilizer. Application of 100 – 150 kg N/ha, 60kg P O /ha, 60kg K O/ha had increased the crop yield.

(Folorunsho, 1999). Kogbe (1976), reported amaranthus to respond well to poultry manure to give a yield of 20tons per hectare. This view agreed with the findings of Olayinka (1990); Akinola and Ojeniyi (2000) that poultry

and goat manure as organic manure can build poor agricultural soil into valuable cropland. The yield and nutrient contents of amaranthus, have responded positively to application of wood ash treatment as high content of calcium in wood ash had been found to influence the absorption of other elements and to counteract the effects of high concentration of magnesium and sodium. This is in addition to increasing soil pH, improving high microbial activities and bacterial growth rates (Baath and Armebrant, 1994).

The successful use of Amaranthus vegetable as rabbit feed supplement in Malawi (Lebas, 1986) and in Ondo State, Nigeria (Fadare, 1994) had necessitated the need to investigate the use of NPK 15-15-15, as inorganic manure and poultry manure and wood ash as organic manure to improve the yield and quality of vegetable amaranthus to be used as rabbit feed supplement.

Materials and Methods

Field Experiments: The field experiments were carried out in Aule farm center in Akure South Local Government Area, Nigeria (7°15'N 7°15'E) in 2000 and 2001. The experimental site was under a three- year fallow dominated by *Chromolaena odorata* and *Helianthus onus*. The site was well drained with gentle slope of two to three percent and sandy loam surface soil. The parent material is developed on the basement complex and made up of gneisses and granites. The soils are alfisols and the pre-treatments soil analysis were 1.84% organic carbon, 5.7ppm available phosphorus, 0.06 cmol/kg K, 0.15 cmol/kg Na, 1.68 cmol/kg Ca, 0.5 cmol/kg Mg and pH 6.8. The five manurial treatments investigated on Amaranthus hybridus were

NPK 15-15-15 at 100kg/ha, poultry manure at 2000kg/ha, wood ash at 4000kg/ha, poultry manure wood ash mixture of 1000kg poultry manure and 2000kg wood ash per hectare and a control without manure application. The treatments were replicated three times using a randomized complete block design (Steel and Torrie, 1980). Each plot was 5m x 5m and Amaranthus raised in the nursery for three weeks was transplanted at a spacing of 10cm x 10cm on 1m x 5m bed in September. The manure were applied by ring method two weeks after transplanting and the plots manually weeded twice

Surface (10-15cm) soil samples were collected at harvest at four weeks after transplanting and were air-dried and sieved through a 2mm sieve for soil analysis following the laboratory procedures of Association of Official Analytical Chemists (AOAC.1990). Organic carbon was determined by the Walkey-Black wet oxidation method. The nitrogen was determined by the micro-kjeldahl methods, available phosphorus extracted by Bray-1 method and phosphorus determined by the molybdate blue method. Exchangeable bases were determined by extraction with neutral ammonium acetate and potassium was determined by flame emission while calcium and magnesium were determined using Pye Unicom SP 192 atomic absorption spectrophotometer. The poultry manure and the wood ash were separately analyzed for their nutrient contents. Five plants were selected for the determination of root length, plant height, number of leaves, leaf area, stem girth. Total yield was taken and proximate composition of percentages crude protein, crude fiber and fats carried out. Collected data were analyzed using the Statistical Package for Social Sciences (SPSS) soft ware package and the means compared using Duncan Multiple Range (DMR) at the 5% probability level ($P = 0.05$)

Results

The chemical composition of the poultry manure was 12.8% organic carbon, 2.13% nitrogen, 0.19% phosphorus, 1.06% potassium, 0.36% sodium, 0.45% calcium, 0.58% magnesium while the analysis of the wood ash showed values of 18% organic carbon, 1.4% nitrogen, 1.42% calcium, 0.68% magnesium.

Effects of manure application on soil chemical properties. The effects of manure application on soil chemical properties are shown in Table 1.

The pH of the soil was significantly high in plots treated with wood ash, poultry manure-wood ash mixture and poultry manure with mean values 7.3, 7.3 and 7.2 respectively compared to other treatments of NPK 15-15-15 and the control without manure application with mean values 6.8 each.

The highest organic carbon of 3.48% was found in plot treated with poultry manure while a significantly low organic carbon value of 1.96% was found in the control plot without manure. Significantly high values of 11.2ppm phosphorus and 0.25% nitrogen were found in plots treated with NPK 15-15-15 while significantly low values of 5.2ppm phosphorus and 0.16 % nitrogen were found in the control without manure application. The total exchangeable bases of sodium, potassium, calcium and magnesium were significantly high in plot treated with wood ash with a mean value 9.27 cmol/kg. This was followed in a decreasing order of magnitude by plots treated with poultry manure-wood ash mixture, poultry manure, NPK 15-15-15 and the least value of 4.53 cmol/kg in the control without manure.

Effects of manure application on the growth and yield of amaranthus vegetable. The effects of manure application on the growth and yield of amaranthus vegetable are shown in Table 2. The plant growth parameters of plant height, number of leaves, leaf area, stem girth were significantly high in plots treated with NPK 15-15-15, poultry manure, poultry manure-wood ash mixture while a significantly low values were found in control plot without

Table 1: Effects of NPK 15-15-15, Poultry manure, poultry manure-wood ash mixture, wood ash alone on soil chemical properties at harvest

Manure Treatment	pH	Organic Matter (%)	Avail P (%)	Nitrogen (%)	Na	K (cmol/kg)	Ca	Mg Exch.	Total Bases
NPK 15-15-15	6.8b	3.30a	11.2a	0.25a	0.27a	0.34a	5.25d	1.07c	7.01c
Poultry manure	7.2a	3.48a	10.4a	0.23b	0.27a	0.31b	5.68c	1.11c	7.43c
Poultry manure-wood ash mixture	7.3a	3.33a	10.9a	0.21c	0.28a	0.31b	6.50b	1.80b	9.01b
Wood ash	7.3a	3.35a	8.8b	0.21c	0.28a	0.34a	6.78a	1.87a	9.42a
Control without	6.8b	1.96b	5.2c	0.16d	0.25b	0.24c	3.32e	0.72d	4.57d

Table 2: Effects of NPK 15-15-15, poultry manure, poultry manure-wood ash mixture, wood ash alone on Amaranthus growth and yield parameters

Manure Treatment	Root length (cm)	Plant Height (cm)	No. of Leaves	Leaf Area (cm^2)	Stem girth (Cm)	Yield (Ton/ha)
NPK 15-15-15	24.7a	33.4a	34a	57.9a	4.7a	23.2a
Poultry manure	23.3b	33.2a	33a	56.7a	4.7a	23.3a
Poultry manure-wood ash mixture	24.3a	32.6b	33a	55.5a	4.3b	23.1a
Wood ash alone	24.0a	31.9c	31b	54.2b	4.2b	21.8b
Control without manure	15.0c	21.3e	23c	31.6c	2.7c	13.6c

Table 3: Effects of NPK 15-15-15, poultry manure, poultry manure-wood ash mixture, wood ash on Amaranthus Leaf Analysis

Manure Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Sodium (%)	Ca (%)	Mg (%)
NPK 15-15-15	5.4a	0.83a	2.62a	0.44a	0.33c	0.07b
Poultry manure	5.4a	0.75b	2.28c	0.31b	0.35c	0.06b
Poultry manure-wood ash mixture	5.3a	0.73b	2.36b	0.26c	0.40b	0.18a
Wood ash alone	5.2b	0.71c	2.36b	0.23c	0.45c	0.18a
Control without manure	3.8c	0.54d	1.81d	0.13d	0.25d	0.05b

Table 4: Effects of NPK 15-15-15, Poultry manure, Poultry manure-wood ash mixtrue, Wood ash on the proximate composition of Amaranthus vegetable

Manure Treatment	CHO (%)	Fat (%)	Protein (%)	Crude Fiber (%)
NPK 15-15-15	40.12c	18.13b	33.92a	10.31d
Poultry manure	39.09d	18.73a	33.10a	11.36c
Poultry manure-wood ash mixture	40.32b	17.83b	30.92b	13.41a
Wood ash	40.83b	17.73b	30.53b	13.03b
Control without manure	49.74a	16.63c	19.78c	12.60b

manure.

The yield was significantly high in NPK 15-15-15, poultry manure and poultry manure-wood ash mixture compared to the control without manure. The increase in yield in NPK 15-15-15, poultry manure, poultry manure-wood ash mixture and wood ash alone over the control without manure were 71.3%, 70.6%, 69.8% and 60.2% respectively. There were positive correlation between yield and plant height ($r = 0.99$) and between yield and number of leaves ($r = 0.99$).

Effects of manure treatment on leaf analysis of amaranthus vegetable

The effects of manure application on the leaf analysis of amaranthus vegetable are shown in Table 3. There were significantly high nitrogen and phosphorus uptake in plots treated with NPK 15-15-15, poultry manure and poultry manure-wood ash mixture compared to other treatment plots. The least mean value was found in the control

without manure. The plot treated with wood ash, had significantly high calcium and magnesium uptake compared to other treatment plots.

Effects of manure application on amaranthus proximate composition

The effects of manure on the proximate composition of amaranthus vegetable are shown in Table 4. Significantly high protein values were obtained in plots treated with NPK 15-15-15 and poultry manure with mean values 33.92% and 33.10% respectively compared to other treatment plots with the least value 19.78% found in the control plot. The increase in protein in plants treated with NPK 15-15-15, poultry manure, poultry manure-wood ash mixture and wood ash alone over the control plot was 71.5%, 67.3%, 56.3% and 54.3% respectively. The crude fiber, were significantly low in plots treated with poultry manure and NPK 15-15-15 compared to other treatments. There was observed a positive correlation between nitrogen in soils and percentage protein ($r = 0.96$)

Discussion

The higher soil pH value found in plots treated with wood ash could be adduced to the liming effects of wood ash. The cations especially calcium in the ash would have played a significant role in soil liming (Sharland, R.W. 1997). The pretreatment soil analysis had shown the soil to have low levels of potassium, calcium and magnesium (Kparmwang and Malgwi, 1997). The organic matter content were lower in plots treated with manure because the nitrogen supplied could increase microbial activities which in turn would increase the mineralization of organic matter (Olayinka, 1990; Baath and Amebrant, 1994).The increased mineralization of organic matter had increased the soil nutrient contents, which would be in addition to the nutrients already available in poultry manure and wood ash (Olayinka, 1990 and Sharland, 1997).

The high soil nutrient that obtained as a result of poultry manure, wood ash application had increased the amaranthus vegetable nutrient uptake of N, P, K, Ca, Mg which had manifested in the good growth of the plant. This corroborated the earlier observation of Ojeniyi *et al.* (1999) in south west Nigeria who found positive responses of yield and nutrient contents of amaranthus and okra to application of wood ash and that of Olayinka (1990) who observed improvement in the yield and nutrient uptake in vegetable crops as a result of poultry manure and straw mixture.

The higher yield of amaranthus vegetable observed with NPK 15-15-15, poultry manure and wood ash over plants in the control plot without manure was as a result of higher nutrient availability and plant uptake of the nutrients. The quality of the amaranthus plant was also improved with higher nitrogen supplied from the manure applied as increasing nitrogen content would result in increasing the protein content.

Conclusion

Poultry manure and wood ash are locally cheap sources of plant nutrients for increased production of amaranthus and other vegetable crops. The equally high yield and quality obtained compared favourably with values obtained with

NPK 15-15-15 treatments which showed that poultry manure and wood ash can effectively replace inorganic fertilizer to increase yield and quality of amaranthus vegetable, while reducing cost of production that would have been incurred with the use of costly inorganic fertilizers. It is expected that the use of amaranthus which cost of production can be reduced and if used as feed supplement to rabbit will boost rabbit production to increase and improve the protein intake of people.

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