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POULTRY MANURE RATE FOR POT-PLANT BITTER LEAF (*Vernonia amygdalina* Del.) PRODUCTION IN A HUMID RAINFOREST ZONE OF NIGERIA

Ndukwe, O.O.[1]*, Nwakanma, V.T.[1], Orji, C.M.[2] and Iheaturu, D.E.[1]

[1]Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria; [2]IFAD Assisted Value Chain Development Programme, Ministry of Agriculture, Awka, Anambra State, Nigeria

*Corresponding Author's Email: oo.ndukwe@unizik.edu.ng

Abstract

Recommended agronomic practices for sustainable production of bitter leaf, especially in Anambra state, Nigeria where the leaves are used to prepare special soup delicacy, is scarce despite the local and global nutritional and pharmaceutical utilization of the crop. A preliminary study was therefore conducted to study the growth and yield responses of bitter leaf, grown as pot-plants, to poultry manure rates with the objective of determining the optimum manure rate under the aforementioned production system. The poultry manure rates were 0, 5, 10, 15, 20, 25 and 30 t/ha. The research was carried out as a pot experiment at the Teaching and Research Farm of Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. The experiment was laid out as a completely randomized design with ten replications. There was a significant increase in growth and leaf yield with increase in poultry manure rate with the peak at 10 t/ha poultry manure application. Specifically, at 6 months after planting, tallest plants (38.3 cm), widest stems (8 mm) were obtained from plants the received 10 t/ha poultry manure. Highest fresh leaf yield (2.02 t/ha) was recorded in plants that received highest amount of poultry manure (20, 25 and 30 t/ha) though the mean value was statistically at par with 1.98 t/ha leaf yield obtained from the application of 10 t/ha poultry manure. Similarly, the application of 10 t/ha PM enhanced the accumulation of highest dry matter in the leaves (0.79 t/ha) compared to other poultry manure rates. Hence, the application of 10 t/ha poultry manure was recommended for optimum growth and yield of bitter leaf as pot plants in Awka, Nigeria.

Keywords: Vernonia amygdalina, household, leaf yield, organic manure, quantity

Introduction

Vernonia amygdalina, a member of the Asteraceae family, is a small shrub that grows in tropical Africa (Ijeh and Ejike, 2011). The plant is commonly called bitter leaf in English because of its bitter taste. The plant is indigenous to Africa and mostly grows in many parts of sub-Saharan Africa (Echem and Kabari, 2013). The crop is widely cultivated in Nigeria especially in the tropical zones. Specifically, the commercialization of the bitter leaf production has been established in Anambra State due to its nutritional, medicinal and economic values.

Every part of the plants is useful (Adaramoye et al., 2008). The leaves are consumed either as vegetable (macerated leaves in soups), in fresh or dried form for preparation of 'onugbu' soup. The soup is common in southeastern and southwestern states of Nigeria, especially in Anambra state where it is a special delicacy. The stem can be used as chewing stick, while its juice extract may be prepared for drinking. This plant is useful in toning the vital organs of the body especially the liver and the kidney (Adaramoye et al., 2008). Bitter leaf is a rich source of vitamins A, B1 and B2 which are needed for the body (Ijeh and Ejike, 2011).

The leaves increase the rate of metabolism in the body system and contains anti-parasite, anti- bacteria, anti-malaria properties implying that it detoxifies the blood, prevents indigestion, rheumatism, scurvy while nourishes the skin (Ijeh and Ejike, 2011). These authors asserted that regular intake of bitter leaf in diet helps to counter the effect of excess sugar in the blood, thereby preventing diabetes.

The leaves of bitter leaf are presently exported from Anambra State to Europe (Eze, 2017) which had promoted the interest of many farmers to bitter leaf farming who employ several production practices so as to obtain higher leaf yield. One of the common production practices by bitter leaf farmers in Anambra State is the arbitrary application of poultry manure to bitter leaf (undocumented survey report, 2019) in order to enhance higher leaf production. However, this could result in higher production cost. This is as a result of lack of documented information on optimum rate of poultry manure for optimum growth and leaf yield of the bitter leaf in Anambra state and Nigeria at large. Providing appropriate rate of poultry manure for bitter leaf production will help increase the leaf yield of the crop as well as reduce the production cost.

The application of poultry manure during crop production in a humid tropical zone of Nigeria is one of the ways to improve the declined soil fertility due to leaching. The manure has been reported to be the most

desirable among other manures because it contains high amount of nitrogen, phosphorus and potassium (Delgado et al., 2010). Enujeke (2013) reported that the poultry manure is not only cheap and effective but is also essential for maintaining optimum soil physical condition for the growth and yield of plants. Hence, the objective of the study was to determine the optimum rate of poultry manure with respect to the growth and leaf yield of bitter leaf grown as pot-plant.

Materials and Methods

Experimental Site: The experiment was conducted at the Teaching and Research Farm of Department of Crop Science and Horticulture Nnamdi Azikiwe University, Awka, Anambra State Nigeria. The experimental site is characterized by tropical rain forest with temperature of 270C - 300C. The area is located between latitude 06° 15´N and longitude 07° 08´E.

Planting Materials: Stem cuttings of bitter leaf ('Nimo' accession) was obtained from Crop Science and Horticulture Teaching and Research Farm at Nnamdi Azikiwe University Awka. The bitter leaf accession was planting material obtained from farmers in Nimo, Njikoka Local Government Area of Anambra State, Nigeria. The stems were cut into an average length of 15 cm, bearing 3-5 nodes.

Treatments and Experimental Design: The treatments comprised varying rates of poultry manure namely 0, 5, 10, 15, 20, 25 and 30 t/ha which were applied to the soil used in growing the bitter leaf plants. The experiment was laid out as a complete randomized design and replicated ten times.

Growing medium: Top soil (0-20 cm) and poultry manure were compounded and composted for four weeks. The composted media was potted in 7-litre pots. The quantity of poultry manure mixed with the top soil (10 kg) varied depending on the poultry manure rate. The actual quantities incorporated into the top soil was 200, 400, 600, 800, 1000 and 1200 g representing 5, 10, 15, 20, 25, and 30 t/ha. The potted media was placed in the field with a spacing of 1 m between rows and 0.5 m within rows. The top soil was collected from the plantain plantation of Department of Forestry and Wildlife, Nnamdi Azikiwe University, Awka. The detailed physical and chemical properties of the soil is as presented in Table 1.

The poultry manure was obtained from a battery cage system of layer birds belonging to a commercial farm in Awka, Anambra state.

Cultural Practices: Planting was done on 12th February, 2019. The stem cuttings were inserted into the soil at 45° position to the soil level with at least two nodes underneath the growing media while two nodes were above the media. Mulching was also done with dried grasses and the plants were irrigated at container capacity every other day with 1.5 liters of water since the experiment was carried out during the dry season. Weeding was done at intervals of four weeks.

Data Collection: Data were collected on growth and leaf yield. Growth data collection commenced 8 weeks after planting (WAP) and were done at two weeks interval. At 8WAP, each plant was pruned to two most vigorous shoots which was maintained throughout the experiment period. The growth data comprised height of tallest shoot, stem girth of tallest shoot and total number of leaves. Height of tallest shoot was obtained by measuring from the growing media level to the apex of the tallest shoot with the help of a flexible measuring tape. The stem girth of the tallest shoot was obtained by using digital vernier caliper which was measured at 10 cm shoot height from the growing media level. Total number of leaves was obtained by counting the number of leaves on each shoot of the plant. Fresh and fully opened leaves were harvested by plucking at 4 weeks interval. The fresh leaves were weighed immediately with a digital sensitive weighing balance while dry weights of the leaves were also obtained after drying to a constant weight.

Data Analysis: All data collected were statistically analyzed using the procedure outlined for completely randomized design (CRD) using GENSTAT (2011) statistical software package. Separation of treatment means was done using the least significant difference (LSD) at 5 % probability level.

Table 1: Physico-chemical properties of the soil and nutrient content of the poultry manure used for study

	Pre-soil sample	Poultry manure
Particle Size distribution (%)		
Sand	70.8	-
Silt	16.8	-
Clay	12.4	-
Chemical properties		
pH	6.88	-
Organic carbon (%)	0.65	18.35
Total Nitrogen (%)	0.55	1.58
Av. Bray^{-1} P (mg/kg)	2.55	0.02
Exchangeable base (cmol/kg)		
Ca^{2+}	1.2	6.0
Mg^{2+}	0.4	1.50
K^{+}	0.2	0.03
Na^{+}	0.09	0.20
Total exchangeable acidity	1.13	-
CEC	2.49	-

Results

Effect of poultry manure rates on plant height (cm) of bitter leaf

Table 2 shows the effect of poultry manure rates on plant height of bitter leaf at 8, 12, 16, 20, 24 and 26 weeks after planting (WAP). There was no significant difference (P>0.05) in the plant height at 12 and 16 weeks with the poultry manure rates, although the mean height of plants was highest with 10 t/ha poultry manure application. However, at 20, 24 and 26 WAP, the plant height progressively increased with increase in poultry manure rates up to 10 t/ha poultry manure application but significantly declined with 15 t/ha poultry manure application. It was observed that the mean values (31.33 cm, 38.30 cm and 40.50 cm) obtained with 10 t/ha poultry manure application was however not significantly (P>0.05) different with the plant height observed with the application of 20, 25 and 30 t/ha poultry manure.

Effect of poultry manure rates on stem girth (mm) of bitter leaf

The results in Table 3 shows the effects of poultry manure rates on stem girth of bitter leaf at 8, 12, 16, 20, 24 and 26 WAP. At 8 WAP, no manure application produced the widest stems (3.62 mm), although there was no significant difference in the means with 5, 10, 20, 25 and 30 t/ha poultry manure application. At 16 WAP, it was observed that 20 t/ha poultry manure application produced widest stem (6.40mm) although the mean did not differ significantly (P>0.05) with 5, 10, 25 and 30 t/ha poultry manure rates application. However, at 20, 24 and 26 WAP, plants that received 10 and 25 t/ha poultry manure respectively produced widest stems (7.05, 8.62 and 9.91 mm).

Table 2: Effect of poultry manure rates on the plant height (cm) of bitter leaf at 8, 12, 16, 20, 24 and 26 weeks after planting (WAP)

Poultry manure rate (t/ha)	Plant height (cm) of tallest shoot in weeks after planting					
	8	12	16	20	24	26
0	7.78	12.29	16.85	20.95	24.8	26.2
5	4.17	12.29	21.37	27.29	35.0	37.2
10	4.74	12.83	24.80	31.33	38.3	40.5
15	3.71	7.31	15.81	24.21	32.8	34.1
20	4.80	11.60	21.84	30.92	40.8	44.2
25	3.40	10.00	22.76	30.60	39.1	41.7
30	4.85	13.08	21.66	30.20	39.6	42.5
$LSD_{0.05}$	1.870	ns	ns	7.167	8.20	8.56

Table 3: Effect of poultry manure rates on stem girth (mm) of bitter leaf at 8, 12, 16, 20, 24 and 26 weeks after planting (WAP)

Poultry manure rate (t/ha)	Stem girth (mm) of tallest shoot in weeks after planting					
	8	12	16	20	24	26
0	3.622	4.08	4.69	5.47	6.13	6.82
5	3.166	4.46	5.83	6.43	7.59	8.32
10	3.371	4.62	6.27	7.05	8.00	8.76
15	2.781	3.31	4.66	4.98	6.89	7.91
20	3.272	4.37	6.40	6.94	8.37	9.31
25	2.646	3.92	6.21	6.72	8.62	9.91
30	3.533	4.47	5.75	6.29	7.83	9.11
$LSD_{0.05}$	0.6053	ns	1.358	1.387	1.230	1.224

Effect of poultry manure rates on the number of leaves of bitter leaf

Table 4 shows the effects of poultry manure rates on the number of leaves of bitter leaf at 8, 12, 16, 20, 24 and 26 WAP. The number of leaves (on the tallest

shoot) was significantly (P<0.05) different among the poultry manure rates at 8, 12, 16, 20, 24 and 26 WAP. At 8 WAP, the highest mean of leaves (12.10) was obtained with no poultry manure application though the means did not differ significantly at poultry manure rate 5, 10, 20 and 30 t/ha poultry manure application. At 12 and 20 WAP, poultry manure rates of 5 and 30 t/ha gave the highest mean of leaves (20.89 and 18.14) while at 24 and 26 WAP, the highest mean of leaves (19.9 and 34.1) was obtained with 15 t/ha poultry manure rate. There was however no significant difference observed among the means with 10, 20, 25 and 30 t/ha poultry manure application.

At 16, 20 and 24 WAP, the number of leaves significantly (P<0.05) increased with poultry manure application compared to the plants that received no manure. Highest number of leaves were produced by plants that received 10, 30 and 15 t/ha respectively, at 16, 20 and 24 WAP. However, the highest mean of leaves (18.14 and 19.9) enhanced by the application of 30 and 15 t/ha at 20 and 24 WAP respectively were not significantly different with 12.22 and 14.8 obtained with the application of 10 t/ha poultry manure.

Table 4: Effect of poultry manure rates on the number of leaves of bitter leaf at 8, 12, 16, 20, 24 and 26 weeks after planting (WAP)

Poultry manure rate (t/ha)	Number of leaves on tallest shoot in weeks after planting					
	8	12	16	20	24	26
0	12.10	17.20	13.1	6.50	6.2	9.1
5	10.00	20.89	21.8	10.89	11.6	17.8
10	11.86	19.11	22.6	12.22	14.8	23.8
15	9.69	14.50	20.0	11.00	19.9	34.1
20	9.83	17.11	19.7	12.11	16.3	27.4
25	8.80	14.17	21.2	17.49	18.2	30.8
30	11.67	19.16	17.6	18.14	15.0	27.6
$LSD_{0.05}$	2.305	4.570	7.53	7.491	7.84	12.41

Effect of poultry manure rates on fresh and dry weights of leaves (g)

The fresh and dry weights of leaves harvested at 13, 17, 21 and 25 WAP were significantly (P<0.05) influenced by poultry manure rates (Table 5 and 6). Fresh and dried weight of leaves significantly (P<0.05) increased with increase in poultry manure rates up to 10 t/ha application. There was a significant decrease in the weights with 15 t/ha poultry manure application. Although there was an increase after 15 t/ha but the increase was not significantly (P>0.05) different with 10 t/ha poultry manure application.

Table 5: Effect of poultry manure rates on the fresh weight (g) of harvested leaves at 13, 17, 21 and 25 weeks after planting (WAP).

Poultry manure rate (t/ha)	Fresh weight (g) of harvested bitter leaf in weeks after planting			
	13	17	21	25
0	8.48	11.6	9.6	12.6
5	10.02	24.9	21.0	21.0
10	12.53	30.3	24.4	31.6
15	8.31	18.9	21.3	21.1
20	15.05	31.3	25.4	33.8
25	15.22	33.4	30.3	29.5
30	12.23	26.9	30.4	33.2
$LSD_{0.05}$	5.28	9.3	7.5	8.3

The cumulative fresh and dry leaf yield (t/ha) presented in Fig. 1 and 2 showed clearly the increase in leaf yield (t/ha) with increase in poultry manure rates up to 10 t/ha application and also the significant decrease in the weights with 15 t/ha poultry manure application.

Effect of poultry manure rates on above and below

ground fresh biomass of bitter leaf at 6 months of planting

Poultry manure rates significantly (P<0.05) influenced the fresh weights of shoots, leaves, roots and number of primary roots at 6 MAP (Table 7). Expectedly, there was a significant increase in the fresh weights of the shoots, leaves, roots as well as the total number of primary roots with poultry manure application compared to the plants that received no manure. The application of either 10 or 30 t/ha poultry manure produced highest fresh shoots. On the other hand, heaviest leaves and roots were significantly produced by plants that received either 25, 30 or 10 t/ha poultry manure. The highest poultry manure rates (25 and 30 t/ha) however produced more roots than the other poultry manure rates. Lowest mean values for all the above parameter (fresh biomass) were significantly attributed to the plants that received no manure.

Table 6: Effect of poultry manure rates on the dried weight of harvested bitter leaf (g) at 13 and 17, 21 and 25 weeks after planting (WAP).

Poultry manure rate (t/ha)	Dry weight (g) of harvested bitter leaf in weeks after planting			
	13	17	21	25
0	3.54	4.60	4.20	5.48
5	4.33	9.62	8.87	9.33
10	5.00	11.44	10.16	12.78
15	3.40	7.53	8.38	9.28
20	6.65	12.25	9.31	14.96
25	6.58	12.63	10.46	13.03
30	4.70	9.54	10.31	14.83
$LSD_{0.05}$	2.22	3.33	2.22	3.70

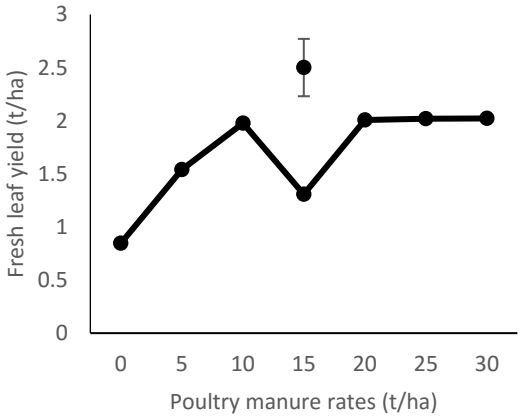

Fig. 1: Total fresh leaf yield of bitter leaf as influenced by poultry manure rates (t/ha). Vertical bar represents $LSD_{0.05}$ = 0.55.

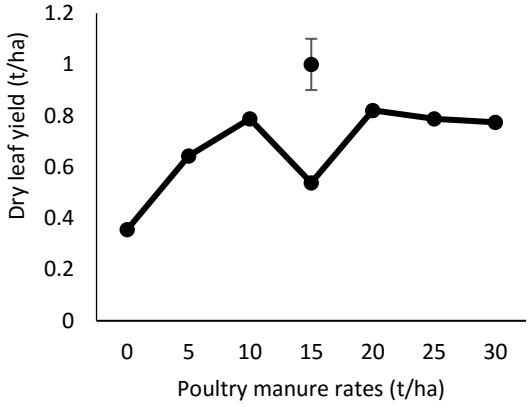

Fig. 2: Cumulative dry leaf yield of bitter leaf as influenced by poultry manure rates (t/ha). Vertical bar represents $LSD_{0.05}$ = 0.20.

Discussion

After the fourth week of poultry manure application, it was observed that the response of plants to poultry manure varied as there was significant increase in growth parameters of plants that received poultry manure. Nutrients from the poultry manure were released and made available to the crop hence enhancing the vigorous growth. This corresponded with the findings of Mangila et al. (2007) and Enujeke (2013) who reported that poultry manure contained more nutrients which improved physical soil condition for plant growth and development.

Table 7: Effect of poultry manure rates on above and below ground fresh biomass of bitter leaf at 6 months after planting

Poultry Manure Rate (t/ha)	Fresh weight of shoots (g)	Fresh weight of leaves (g)	Fresh weight of roots (g)	Number of primary roots
0	21.1	7.00	31.5	55.3
5	45.1	20.27	44.5	76.0
10	53.5	26.67	81.0	71.0
15	27.1	17.47	44.3	54.3
20	36.3	22.33	60.5	58.3
25	45.1	29.40	78.3	109.0
30	53.7	28.80	77.5	104.3
$LSD_{0.05}$	22.18	6.534	26.64	15.74

The progressive increase in growth and yield of bitter leaf with increase in poultry manure rate, the peak being 10 t/ha and the decline in the productivity of the bitter leaf with 15 t/ha poultry manure application indicated that 10 t/ha poultry manure application is the optimum rate for the production of vigorous plants when grown as pot plants. Optimum plant height had been reported to positively correlate with the productivity of plant (Saeed *et al*., 2001). The findings of Okoli and Nweke (2015) showed that different rates of poultry manure influenced the fresh and dry weight of shoot and roots of *Amarathus* with poultry manure rate of 10 t/ha consistently enhanced the productivity of the crop.

Conclusion

The application of 10 t/ha poultry manure produced most vigorous plants and highest fresh and dry leaf yield. Therefore, for optimum production of bitter leaf as pot plants in Awka Anambra state, 10 t/ha poultry manure application is recommended.

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