Organic Fertilizer Sources and Rates for Potted Bitter Leaf (*Vernonia amygdalina* Del.) Production

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KEYWORDS

Vernonia amygdalina,
Poultry manure,
Cow dung,
Rates,
Leaf yield.

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ABSTRACT

Bitter leaf possess medicinal, pharmaceutical and bioprotective properties aside its nutritional importance. However, there is a dearth of documented information on the production requirements of this important crop as pot-plants with regards to fertilizer source and rates. A pot experiment was conducted at Crop Science and Horticulture Teaching and Research Farm, Nnamdi Azikiwe University, Awka to study the effect of organic fertilizer types (poultry manure, cow dung, poultry manure + cow dung) and rates (0, 5, 10, 15 t ha^{-1}) on the growth, fresh leaf yield and dry matter partitioning of bitter leaf. The experiment was laid out as 3x4 factorial experiment fitted into completely randomized design (CRD) and replicated ten times. Data were collected on growth and fresh leaf yield. Organic fertilizer types and rates and the interaction significantly ($P<0.05$) influenced the growth and yield of bitter leaf. Applications of 10 t ha^{-1} poultry manure or combined application of poultry manure and cow dung at 10 t ha^{-1} significantly ($P<0.05$) produced tallest plants and highest number of leaves. The combined application of poultry manure and cow dung also produced highest fresh leaf yield (2.15 t ha^{-1}). This was followed with poultry manure applied at either 10 or 15 t ha^{-1} (1.96 and 1.97 t ha^{-1}, respectively). It was therefore recommended that growers should apply poultry manure at 10 t ha^{-1} or combination of poultry manure and cow dung at 10 t ha^{-1} for enhanced growth and leaf yield of bitter leaf in containers.

INTRODUCTION

Bitter leaf (*Vernonia amygdalina* Del.) is a shrub that grows in tropical Africa and belongs to the Asteraceae family (Singha, 1966). The leaves of bitter leaf are used as soup condiments after washing and boiling to get rid of the bitter taste (Hamzah *et al*., 2013). Specifically, the leaves are used to prepare the popular Nigerian bitter leaf soup called 'onugbo' soup (Ho *et al*., 2012) which is a special soup and delicacy in Anambra state. Hence, there is scarcely any household in the state that do not have a stand of bitter leaf in the homestead.

In some part of Africa, the plant is made into tonic and drank for medicinal purposes (Igile *et al*., 1994). Other popular use of *Vernonia amygdalina* in Africa includes traditional treatment of diseases such as malaria, infertility, diabetes, gastrointestinal problems and sexually transmitted diseases (Argheore *et al*., 1998; Farombi and Owoeye, 2011). The bitter leaf extracts also possess ability to prevent kidney and liver damage because of the antioxidant properties (Minari, 2012). Recently, Anambra state government had commenced the exportation of bitter leaf which has resulted to increased bitter leaf farming in the state. Despite these numerous importance of bitter leaf, there is scarcity of information on the appropriate agronomic practices for optimum production of the crop.

Low soil fertility is considered as one of the main factors responsible for the low productivity of vegetables (Hamden and Fadni, 2010). The additions of fertilizers to the soil or directly on the crops have enhanced crop production. The prevailing exorbitant prices and shortage in supply of mineral fertilizers resulted in a shift of attention by many farmers towards making better use of organic fertilizers as an alternative source of plant nutrients (Agyenim-Boateng *et al*., 2006). The value of organic fertilizer as a source of plant nutrients has long been recognized, due to their ability to supply essential elements, improve soil structure and aeration, increase soil organic matter and encourage good root growth (Udom *et al*., 2007).

Poultry manure and cow dung are among the commonest organic fertilizers that farmers in Anambra state utilize for crop production. This is attributed to the fact that poultry manure are relatively available within the state because of increased production of broilers and layers. In addition, there exist abattoirs where cow dung are dumped. At present, there are no recommended standards with respect to rate of poultry manure and/or cow dung for optimum yield of *Vernonia amygdalina* in southeastern Nigeria and the country at large. Therefore, the objectives of this study were to determine the effects of organic fertilizer types and rates on the growth and fresh leaf yield of bitter leaf.

MATERIALS AND METHODS

Experimental site, planting materials and treatments

The experiment was conducted at the Teaching and Research Farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka (latitude 6° 25' North and longitude 7° 11' East). The coordinate of the experimental site is latitude 6° 13' 8.209" North and longitude 7° 04' 38.773" East During the experiment (February - August, 2019), the meteorological data of the experimental site was as follows - maximum and minimum temperature of 28.74°C and 28.96°C, respectively with average rainfall of 1828 mm and relative humidity of 72.3%.

The planting materials used were stem cuttings of bitter leaf obtained from the teaching and research farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra state. The stems were cut into 15 cm length bearing 8 to 10 nodes. The poultry manure utilized was poultry dropping obtained from a battery cage system of a commercial farm while the cow dung was gotten from 'Amansea' cattle abattoir, Awka South Local Government of Anambra State, Nigeria. The results of physicochemical analyses of the organic manure and soil utilized are presented in Table 1.

Table 1: Physicochemical properties of the soil before planting, cow dung and poultry manure utilized

Parameter	Soil	Cow dung	Poultry manure
Sand (%)	70.8	-	-
Silt (%)	16.8	-	-
Clay (%)	12.4	-	-
pH (H_2O)	6.88	-	-
Organic carbon (%)	0.65	12.45	18.35
Total Nitrogen	2.55	1.08	1.58
Av. Bray P (mg/kg)	2.55	0.006	0.02
Ca^{2+} (cmol/kg)	1.2	1.48	6.0
Mg^{2+} (cmol/kg)	0.4	1.90	1.50
K^{+} (cmol/kg)	0.20	0.007	0.03
Na^{+} (cmol/kg)	0.09	0.03	0.20
Total exchangeable acidity (cmol/kg)	1.13	-	-
CEC (cmol/kg)	2.49	-	-
Base saturation (%)	75.9	-	-

The experimental treatments comprised two factors namely organic fertilizer types and application rates. The organic fertilizer types were poultry manure, cow dung and combination of poultry manure and cow dung while organic fertilizer rates included 0, 5, 10 and 15 t ha^{-1}. The treatment combinations were laid out, in a pot experiment, as a 3x4 factorial experiment in completely randomized design, replicated ten times.

Media preparation, treatment allocation and cultural practices

The top soil, collected at 0-15cm depth, from the plantain plantation of Department of Forestry and Wildlife, Nnamdi Azikiwe University, Awka, were mixed with the poultry manure or cow dung or both organic fertilizers according to the organic fertilizer rates earlier stated. The substrates were composted for one month before potting into 7-litre nursery pots. The actual quantities of the organic manure applied to the soil were 200 g, 400 g and 600 g representing 5, 10 and 15 t ha^{-1}. These actual quantities were determined considering the weight and moisture content of the soil as well as the moisture content of the poultry manure. The topsoil that received no organic manure irrespective of the rates represented the control.

The stem cuttings with 15 cm length and possessing 3-5 nodes were planted in the 7-litre nursery pots filled with the composted media in a slanting position (45° to the soil level). The stem cuttings were watered daily using watering can, while dry grass mulch was applied six days after planting to help conserve moisture during the dry season. The experiment became rain fed when the wet season commenced. At 8 weeks after planting (WAP), each plant was pruned to two most vigorous shoots from the stem cuttings. These shoots were maintained throughout the experiment period (Ndukwe *et al*., 2022).

Data collection and analysis

The growth data measurement commenced at 8 weeks after planting from the two most vigorous shoots. Thereafter, the growth data were collected at two weeks interval. Data were collected from each of the ten (10) plants representing the 10 replicates. Growth data collected from the bitter leaf plants included height of tallest branch (measured from the soil level to the point of attachment of the last leaf on the shoot obtained with a the aid of a flexible meter tape in centimeter), stem girth of the tallest branch (measured with the aid of a digital venier caliper at 10 cm above soil level), total number of leaves obtained from counting. Fresh leaves were harvested at monthly interval and weighed.

All the data collected was subjected to analysis of variance following the procedure laid out for factorial experiment in completely randomized design using GENSTAT (2007). Separation of means was done using least significance difference at 5% level of significance.

RESULTS

The interaction of organic manure types and rates significantly ($P<0.05$) influenced plant height at 8, 12, 16, 20 and 24 weeks after planting (WAP) (Table 2). Plants were tallest when poultry manure was applied at 10 t ha^{-1} specifically at 8, 12 and 16 WAP. At 20 WAP, the application of poultry manure at either 10 or15 t ha^{-1} significantly produced tallest plants. However, at 24 WAP, plants were tallest (66.5 cm) with the combined application of poultry manure and cow dung at 10 t ha^{-1} but the mean value was not significantly difference with the mean height (62.7 cm) obtained with 10 t ha^{-1} poultry manure application.

Table 2: Interaction effects of organic manure types and rates on plant height (cm) of bitter leaf

		Weeks after planting				
Organic manure types	Organic manure rates (t ha^{-1})	8	12	16	20	24
Cow dung (CD)	0	3.29	7.02	8.54	13.43	25.60
	5	3.16	9.56	15.66	26.42	43.10
	10	2.83	7.72	14.34	22.34	40.10
	15	4.02	6.65	16.29	27.26	56.60
PM + CD	0	3.29	7.02	8.54	13.43	25.60
	5	5.87	8.86	15.54	26.44	48.20
	10	3.93	9.41	19.48	34.04	66.50
	15	4.23	6.49	15.55	26.44	54.50
Poultry manure (PM)	0	3.29	7.02	8.54	13.43	25.60
	5	4.84	11.00	13.60	28.05	41.70
	10	8.15	20.31	24.28	39.71	62.70
	15	4.28	14.61	18.61	41.00	58.40
$LSD_{0.05}$		1.43	3.35	4.27	7.23	11.70

The total number of leaves of bitter leaf was significantly (P< 0.05) influenced by the interaction effects of organic manure types and rates at 8 and 16 WAP (Table 3). Highest number of leaves was produced by the application of poultry manure at 10 t ha^{-1}. Whereas at 16 WAP, the application of poultry manure at either 10 or 15 t ha^{-1} produced highest number of leaves. Although the mean number of leaves did not significantly (P>0.05) differ among the organic manure types and rates combinations at 24 WAP but highest mean values (55.5 and 75.3) were recorded with the application of poultry manure at 10 t ha^{-1}.

Table 3: Interaction effects of organic manure types and rates on total number of leaves of bitter leaf

		Weeks after planting				
Organic manure types	**Organic manure rates (t ha^{-1})**	**8**	**12**	**16**	**20**	**24**
Cow dung (CD)	0	16.30	20.40	12.10	22.8	29.3
	5	15.67	28.50	27.10	39.9	42.6
	10	17.75	27.22	26.08	38.0	45.0
	15	16.30	21.51	26.87	42.1	62.8
PM + CD	0	16.30	20.40	12.10	22.8	29.3
	5	17.49	21.80	22.20	35.2	48.9
	10	14.48	25.80	31.30	47.7	63.3
	15	14.77	20.75	21.85	37.4	72.6
Poultry manure (PM)	0	16.30	20.40	12.10	22.8	29.3
	5	16.30	23.84	18.26	31.8	50.2
	10	31.34	26.30	38.20	55.5	75.3
	15	21.28	27.08	42.01	51.1	69.0
$LSD_{0.05}$		5.83	ns	8.74	ns	ns

Highest fresh leaf yield of bitter leaf was obtained with the combined application of 10 t ha^{-1} poultry manure and cow dung (Fig. 1). However, the mean value (2.152 t ha^{-1}) was not significantly (P>0.05) different with the mean value (1.956 t ha^{-1}) obtained with the application of 10 t ha^{-1} poultry manure.

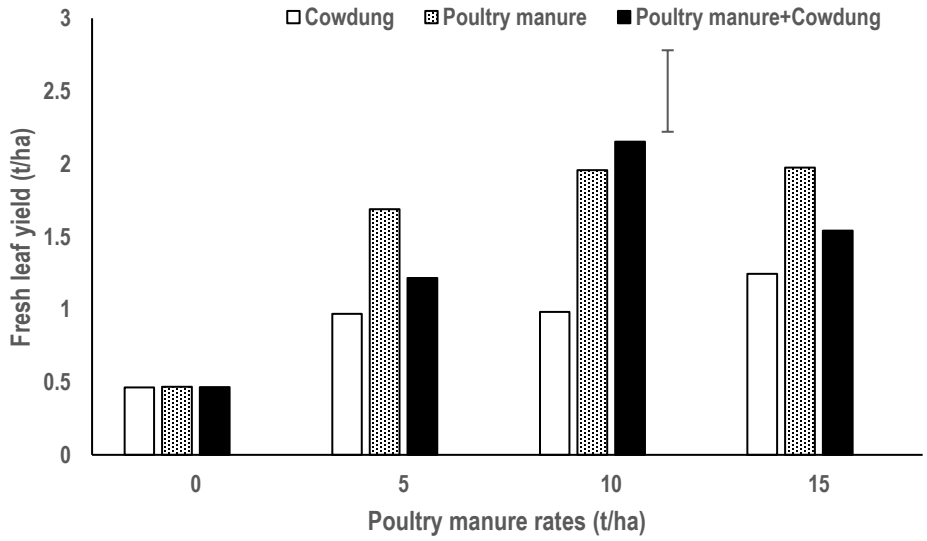

Fig. 1: Interaction of organic manure types and rates on fresh leaf yield (t ha^{-1}) of bitter leaf after 24 weeks of planting. Vertical bars represents $LSD_{0.05}$ = 0.56.

DISCUSSION

Results from the study had revealed that bitter leaf yield can be increased with the application of organic fertilizer at certain rates. The most vigorous plants (tallest plants, widest stems and highest number of leaves) observed in plots that received poultry manure at 10 t ha^{-1} affirmed that poultry manure is a veritable material in the production of the bitter leaf. The soil amendment must have improved the soil biophysical properties as was also noted in previous study (Adeyemo *et al*., 2019) that the application of poultry manure at 10 Mg/ha improved the organic matter, soil water infiltration as well as the biomass and cob yield of maize. The poultry manure might have released essential soil nutrients and conditioned the soil needed by the bitter leaf for optimum growth and leaf yield. The enhanced performance of the bitter leaf as a result of 10 t/ha poultry manure application could be attributed to the increased availability and subsequent accessibility of nutrients to the plants by the application of optimum rate of poultry manure. This is in agreement with the study of Ndubuaku *et al*. (2015) who reported that the application of 10 t/ha poultry manure to potted Moringa produced consistent increase in the plant height, number of leaves, and branches, stem length as well as number of pods, number of seeds, pod length and circumference. .

Poultry manure is perhaps the most desirable manures as it contains high amount of nitrogen (Delgado *et al*., 2010; Anjum *et al*., 2017). Evidently the poultry manure utilized in the study possessed higher amounts of organic carbon, nitrogen and calcium than the cow dung. Composted poultry manure has been reported to provide organic matter, nitrogen, phosphorus and other nutrients (Delgado *et al*., 2010; Oyedeji *et al*., 2014). It was also observed that increasing organic manure rate (up to 10 t ha^{-1}) increased the growth of the bitter leaf. This could have been caused by the increased mineral content as the manure decomposed and released more minerals with the increased rate of organic manure.

CONCLUSION

The application of poultry manure at 10 t ha^{-1} or combined application of poultry manure and cow dung at 10 t ha^{-1} produced most vigorous plants and highest leaf yield compared to organic manure sources and rates hence either 10 t ha^{-1} poultry manure or combined application of poultry manure and cow dung at 10 t ha^{-1} should be utilized for improved potted bitter leaf production especially by the urban dwellers who have limited space for field cultivation of crops. .

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