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ECONOMIC ANALYSIS OF RAIN-FED AND DRY SEASON BITTER LEAF PRODUCTION UNDER DIFFERENT FREQUENCIES OF POULTRY MANURE APPLICATION

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Abstract

Despite the importance of bitter leaf, the performance on addition of poultry manure at intervals as well as its economic implication remains unknown. Therefore, a field experiment was conducted during the rainy and dry seasons to determine the agronomic performance of bitter leaf (*Vernonia amygdalina* Del.) as influenced by mulching and frequency of poultry manure application and to also examine the economics of bitter leaf production under different frequencies of poultry manure application. The research was carried out 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 split plot in randomized complete block design with three replications. The factors comprised mulching (mulch and no mulch) in the main plot and varying frequencies of poultry manure application (no application, application at planting 2, 4 and 6 weeks intervals) as to the sub-plot. There was significant ($P<0.05$) variation in growth and yield of bitter leaf with the various frequencies of poultry manure application. Application of poultry manure at 2 and 4 weeks intervals gave optimal growth and yield during the rainy and dry seasons. However, using profitability indicators, which were, gross revenue, net revenue, benefit cost ratio (BCR) and profitability index of yield, application at 6 weeks intervals gave the highest net returns (₦37,835.00) as well as BCR (1.65) during the rainy season while application at planting gave the highest net returns (₦1,656,603.00) as well as BCR (36.1) during the dry season. Consequently, applying poultry manure at 6 weeks intervals was adjudged the most profitable for bitter leaf production during the rainy season while applying poultry manure only at planting was adjudged the most profitable for bitter leaf production during the dry season in the study area, hence these were recommended.

Keywords: Bitter leaf, profitability, organic manure, interval, growth and yield

Introduction

Bitter leaf (Vernonia amygdalina Del.) belongs to the family Asteraceae. It is widely distributed throughout tropical Africa and cultivated as food supplement in West Africa including Nigeria (Adegbite and Sanyaolu, 2009; Atangwho et al., 2017). According to Erasto et al. (2006), it is a small tree growing up to 3m high.

Every part of the plants is useful, that is, the stem, leaves, and roots (Adaramoye et al., 2008). The leaves are used to garnish meals and prepare soups, but other parts have medicinal benefits. Bitter leaf is a rich source of vitamins such as vitamin A, B1 and B2 which are needed for the body (Ijeh and Ejike, 2011). The leaves of bitter leaf are presently exported from Anambra State to Europe (Eze, 2017) which has promoted the interest of many farmers to bitter leaf farming. The leaves of bitter leaf are exported from Anambra State to Europe (Eze, 2017) which has promoted the interest of many farmers to bitter leaf farming. Bitter leaf possess a marketable worth that contributes to the revenue generation of Anambra State Government (Eze, 2017).

Providing relevant agronomic practices will help improve the growth and yield of the crop. Mulching and manure application are important agronomic practice in agriculture. According to Atijegbe et al. (2014), application of organic fertilizer is an important means of maintaining soil fertility status and is also environmental friendly because nutrients contained in organic manures are released more slowly and are stored for a longer time in soil, thereby ensuring a long residual effect. Sridhara (2022) reported that mulch has a great role in soil moisture conservation through modification of microclimatic soil conditions. It helps to prevent weed growth, reduce evaporation and increase infiltration of rain water during growing season.

Analysing and documenting the economic implications of utilizing these agronomic practices in bitter leaf production will assist to ensure that farmers make brake-even and make maximum profit from the enterprise. Records on net revenue that emanates from the differences between the gross revenue (the number of goods sold multiplied by the price) and the total cost are key determinants of the profitability of an enterprise (Oke et al., 2022).

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Return on investments, benefit-cost ratio and profitability index are essential indicators of a worthwhile enterprise. These were estimated and policy recommendations were made based on these to prove to would-be investors whether bitter leaf enterprise is profitable and worthwhile using agronomic practices recommended by this study, which is likely to promote bitter leaf cultivation in Anambra State. Encouraging rural farmers to produce bitter leaf using recommended agronomic practices in south-eastern Nigeria will not be fully actualized if the costs and returns of bitter leaf production in the area are not determined. Hence, the broad objective of the present study was to analyze the economics of bitter leaf production in Awka, South-eastern Nigeria under different frequencies of poultry manure application, mulching and the combinations of frequency of poultry manure application and mulching. This will also guide farmers in terms of the inputs to consider most in order to maximize profit in the production of bitter leaf in the study area.

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. Awka is characterized by tropical rain forest region. The area is located between latitude 060 25´N and longitude 070 08´E and has an average rainfall of 1,524 mm per annum which concentrates mainly in the rainy season. The annual minimum temperature is about 22°C while maximum temperature is 34°C. The relative humidity is about 80% at dawn (Ozoememe et al., 2022).

Planting Materials

Stem cuttings of Bitter leaf (Nimo accession) was obtained from Njikoka Local Government Area Anambra State. A total of 270 stem cuttings were used. The stems were cut into 15 cm length with each stem cutting bearing 3-5 nodes.

Treatments and Experimental Design

The treatments comprised of mulching (in the main plot), dried elephant grass was used as mulching material and varying frequencies of poultry manure application (sub-plot) at 10t/ha. The frequency of poultry manure application included; no application, application at planting, application at 2 weeks intervals, application at 4 weeks intervals and application at 6 weeks intervals, which was applied to one accession of Bitter leaf. The experiment was also laid out as a split plot in randomized complete block design (RCBD) and replicated three times.

Land Preparation

A land area of 27m x 12m was cleared of existing vegetation and the plant residues appropriately removed from the field. A total of 30 beds/plots were then raised with each bed/plot size at 3m x 2m and a spacing of 0.5m x 1m; there was a total of 10 beds per block replicated 3times. The experimental plot was further divided into two; mulched and no mulch. Soil from the site was analyzed to determine its physico-chemical properties.

Poultry Manure Application

Poultry manure was obtained from a battery cage system in Awka, Anambra state. The content of the poultry manures was analyzed, moisture content was also gotten after curing the poultry manure and the quantity applied was 10 t/ha at the various frequencies. The frequencies of poultry manure application were application at planting, 2, 4, 6 weeks intervals. There were plots that received no poultry manure. It should be noted that harvesting of bitter leaf by commercial bitter leaf farmers within Awka agricultural zone of Anambra State (Nimo and Oraukwu villages, Njikoka L. G. A.) is usually carried out every two weeks, especially in the rainy season (Field survey, 2018). Fertilizer (either organic or inorganic) is usually applied immediately after the harvest.

Planting and Mulching

The stem cuttings were inserted into the soil at 45o position to the soil level. At least two nodes were inserted into the soil while two nodes remained aboveground. 5kg of dried elephant grass was used for mulching per bed/plot. A survival count was taken after two weeks of planting and dead plants were supplied accordingly.

Weeding and Harvesting

Weeding was done manually with hoe, as the weed emerged while harvesting which started 6 weeks after planting (WAP) was done at two weeks intervals as practiced by bitter leaf farmers in Awka.

Data Collection

Matured leaves of bitter leaf were harvested by hand picking. The cumulative fresh weight of the leaves per plot was determined using a weighing balance. The leaf harvesting continued until after the rainy and dry season. Stems were also harvested at the end of every season.

Data on costs and returns of producing bitter leaf included the production cost (PC), which was the summation of fixed cost and variable cost (Oke et al., 2022). According to Ngbede et al. (2014), the variable cost is determined by adding the cost of variable inputs used and those of all farm operations.

The inputs included planting materials (stem cuttings), field preparation (labour during ploughing, harrowing, mapping out of cropping area), procurement of poultry manure, procurement of mulching material, transportation and labour during application and manual weeding and manual weeding. The price of leaves and stems of bitter leaf was determined by the market price of vegetable and fruit market, Government House, Amaenyi market as well as Eke Awka market, all situated in Awka agricultural zone, Anambra State Nigeria.

Mathematically, the profitability indicators were calculated according to the following formulae as noted by Oke et al., (2022):

(i) Gross Revenue = (Number of Goods Sold) x (The Price of Goods Sold)
(ii) Net Revenue = Gross Revenue – Total Cost
(iii) Return on Investment = Net return on investment/cost of investment
(iv) Benefit-Cost Ratio = Proposed Total Cash Benefit/ Proposed Total Cash Cost
(v) Profitability Index = Present Value of Future Cash Flows/Initial Investment

Data collection for the rainy season started from 18th August, 2021 (4WAP) to 29th September, 2021; 10WAP (when the rainy season ended) and later commenced after the dry season from 16th March, 2022 (34WAP) to 24th June, 2022 (48WAP), while data collection for dry season started from 15th October, 2022 (12WAP) to 4th March, 2022 (32WAP).

Data Analysis

All data collected was statistically analyzed using the procedure outlined for split plot in randomized complete block design (RCBD) using GENSTAT (2012) statistical software package. Separation of treatment means was done using the least significant difference (LSD) at 5 % probability level.

Results

Profitability of bitter leaf production as influenced by frequency of poultry manure application in 2021/2022 rainy and dry seasons

The economic analysis of bitter leaf as influenced by frequency of poultry manure application during the 2021/2022 rainy and dry seasons showed that there was significant difference in the total cost of production, net revenue, return on investment, BCR and profitability index at the various periods of poultry manure application (Table 1). During the 2021/2022 rainy season, the least (₦40,009.00) and highest (₦108,574.00) production cost were obtained with no manure application and application at 2 weeks intervals respectively. Application at 2 weeks intervals gave negative net revenue (-₦35,657.00), return on investment (- ₦0.28) and profitability index (-107.0%), while application of poultry manure at 6 weeks intervals gave the highest values for gross revenue (₦99,861.00), net revenue (₦37, 835.00), return on investment (₦0.65), BCR (1.65) and profitability index (31.0%).

During 2021/2022 dry season, the production cost followed the same trend as that of the rainy season with the least (₦40,009.00) and highest (₦108,574.00) production cost obtained with no manure application and application at 2 weeks intervals respectively. Application at planting gave the highest values for gross revenue (₦1,703,611.00), net revenue (₦1,656,603.00), return on investment (₦35.10) and BCR (36.1) although the mean values gotten for gross and net revenues were not significantly different from other frequencies of poultry manure application. The lowest return on investment (₦10.80), BCR (11.8) and profitability index (88.10%) were gotten from plots that received poultry manure application at 2 weeks intervals.

Economic analysis of bitter leaf production as influenced by the interaction between frequency of poultry manure application and mulching during the rainy and dry seasons

The economic analysis of bitter leaf as influenced by the interaction between frequencies of poultry manure application and mulching during the 2021/2022 rainy and dry seasons showed that there was significant difference in all the cost benefit parameters during the rainy and dry season except for mean values gotten from gross revenue during the rainy season were there was no significant difference (Table 2). During the 2021/2022 rainy and dry seasons, the highest production cost was gotten from mulched plots that received manure application at 2 weeks intervals (₦125,270.00), while plots that did not receive mulch and manure application gave the lowest production cost (₦38,666.00).

During the rainy season, highest mean values for net revenue (₦39,523.00), return on investment (₦0.71) and profitability index (36%) was obtained from no-mulched plots that received manure at 6 weeks intervals. However, negative mean values for net revenue (₦-54,159.0), return on investment (₦0.37) and profitability index (-112.0%) were obtained from mulched plots that received manure at 2 weeks intervals. During the 2021/2022 dry season, Application at planting gave the highest values for gross revenue (₦2,128,889.00), net revenue (₦2,080,226.00), return on investment ₦43.10), BCR (44.10) and profitability index (96.80%). The

lowest return on investment (₦10.50) and BCR (11.5) were gotten from no-mulched plots that received poultry manure application at 2 weeks intervals, while the profitability index (87.96%) were gotten from mulched plots that received poultry manure application at 2 weeks intervals.

Table 1: Profitability of bitter leaf production as influenced by frequency of poultry manure application during the dry and rainy seasons.

Frequency of Poultry Manure Application	Total production cost (₦)	Gross revenue (₦)	Net revenue (₦)	Return on Investment (₦)	Benefit Cost Ratio	Profitability index (%)
			Rainy Season			
No App.	40,009.00	63,472.00	23,463.00	0.59	1.59	31.0
At Planting	47,008.00	67,500.00	20,492.00	0.44	1.44	-54.0
2	108,574.00	72,917.00	-35,657.00	-0.28	0.72	-107.0
4	74,992.00	77,222.00	2,231.00	0.08	1.08	0.0
6	62,026.00	99,861.00	37,835.00	0.65	1.65	31.0
$LSD_{0.05}$	18,923.8	Ns	49,680.80	0.78	0.78	113.4
			Dry season			
No App.	40,009.00	1,244,167.00	1,204,158.00	29.90	30.9	95.77
At Planting	47,008.00	1,703,611.00	1,656,603.00	35.10	36.1	95.64
2	108,574.00	1,170,833.00	1,062,259.00	10.80	11.8	88.10
4	74,992.00	1,382,778.00	1,307,786.00	18.20	19.2	94.29
6	62,026.00	1,498,611.00	1,436,585.00	24.00	25.0	94.80
$LSD_{0.05}$	18,923.80	Ns	ns	16.71	16.71	4.066

Table 2: Economic analysis of bitter leaf production as influenced by the interaction between frequency of poultry manure application and mulching during the dry and rainy seasons.

Frequency of Poultry Manure Application	Mulching	Total production cost (₦)	Gross revenue (₦)	Net revenue (₦)	Return on Investment ₦	Benefit Cost Ratio	Profitability index (%)
				Rainy Season			
No App.	Mulch	41,352	60,278	18,926	0.46	1.46	30.0
	No mulch	38,666	66,667	28,001	0.72	1.72	33.0
At Planting	Mulch	48,663	68,611	19,948	0.42	1.42	-25.0
	No mulch	45,353	66,389	21,036	0.46	1.46	-84.0
2	Mulch	125,270	71,111	-54,159	-0.37	0.63	-112.0
	No mulch	91,878	74,722	-17,156	-0.19	0.81	-103.0
4	Mulch	84,054	79,722	-4,332	0.02	1.02	-9.0
	No mulch	65,929	74,722	8,793	0.13	1.13	8.0
6	Mulch	68,297	104,444	36,147	0.59	1.59	26.0
	No mulch	55,755	95,278	39,523	0.71	1.71	36.0
$LSD_{0.05}$		37,731	ns	63,281	0.99	0.99	ns
				Dry Season			
No App.	Mulch	41,352	1,511,667	1,470,315	35.60	36.60	96.46
	No mulch	38,666	976,667	938,001	24.30	25.30	95.09
At Planting	Mulch	48,663	2,128,889	2,080,226	43.10	44.10	96.80
	No mulch	45,353	1,278,333	1,232,98	27.20	28.2	94.47
2	Mulch	125,270	1,285,000	1,159,730	11.10	12.1	87.96
	No mulch	91,878	1,056,667	964,789	10.50	11.5	88.25
4	Mulch	84,054	1,570,556	1,486,501	19.20	20.20	94.42
	No mulch	65,929	1,195,000	1,129,071	17.10	18.10	94.16
6	Mulch	68,297	1,661,667	1,593,369	25.00	26.00	95.37
	No mulch	55,755.	1,335,556	1,279,800	23.00	24.00	94.23
$LSD_{0.05}$		37,731	1,051,758	1,048,804	21.51	21.51	5.15

Economic analysis of bitter leaf production as influenced by mulching during the dry and rainy seasons

During the dry season, there was no significant difference (P>0.05) in the total cost of production for both mulched and no mulched plots (Table 3). There was also no significant difference (P>0.05) in revenue gotten per naira invested as well as in benefit-cost-ratio. Mulched plots had higher gross and net revenue which differed significantly from no mulched plots. During the rainy season, there was no significant difference observed among most parameters except for profitability index which was also negative.

Table 3: Economic analysis of bitter leaf production as influenced by mulching during the dry and rainy seasons.

Mulching	Total production cost (₦)	Gross revenue (₦)	Net revenue (₦)	Return on Investment (₦)	Benefit Cost Ratio	Profitability index (%)
			Rainy Season			
Mulch	73,527.00	76,833.00	3,306.00	0.23	1.23	-18.0
No mulch	59,516.00	75,556.00	16,039.00	0.37	1.37	-22.0
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns
			Dry Season			
Mulch	73,527.00	1,631,556.00	1,558,028.00	26.8	27.8	94.20
No mulch	59,516.00	1,168,444.00	1,108,928.00	20.4	21.4	93.24
$LSD_{0.05}$	ns	220,910.40	268,375.40	ns	ns	0.75

Discussion

The economic analysis revealed varying production costs, which can be attributed to the different frequencies of poultry manure application, mulching and the labour utilized during the study (Field study, 2022). This aligns with the conclusions made by Chen and Koebel (2017) who suggested that variable costs fluctuate depending on the level of production. The highest total cost of production was observed with plots that received poultry manure application at 2 weeks intervals during the rainy and dry seasons which was not compensated by high returns, as the benefit-cost-ratio (BCR) observed was lower than 1.0 and the profitability index less attractive when compared to others. During the dry season production of bitter leaf, it was observed that application of poultry manure at planting, gave the highest BCR which was greater than 1, as well as return on investment and profitability index. This shows that the project delivered a positive net present value. This finding is in agreement with Yousafi et al. (2020) who opined that when the BCR value is greater than one, then the business is making a profit and, if less than one, the business is running at a loss. During the rainy season, application of poultry manure at 6 weeks intervals was more profitable as indicated by the high BCR also greater than 1, higher revenue per naira invested and an attractive profitability index.

The implication of the results of this study is that the application of poultry manure below 6 weeks intervals during bitter leaf production will amount to the cost of production outweighing the benefits or net revenue. The study also reveals that it is possible to enhance the growth and yield of bitter leaf with the application of poultry manure at 2 or 4 weekly interval yet not break even in terms of benefit and cost ratio, (as evidenced in this study), thus the need to always consider the economic implication of any agronomic practice aside recommending the best practice in any crop enterprise.

Conclusion

Poultry manure application at 2 and 4 weeks intervals gave the optimal growth and yield for bitter leaf but the results from the economic analysis/benefit cost ratio showed that application of poultry manure at planting and at 6 weeks intervals was more profitable during the dry season and rainy season, respectively. It was also observed that mulching did not significantly influence the growth and yield of bitter leaf as well as its profitability thus both plants that were mulched and those that were not mulched gave similar mean values in the various parameters studied.

For optimum and profitable production of bitter leaf during dry and rainy seasons in Awka, Anambra state of Nigeria, farmers should apply poultry manure at planting during the dry season and at 6 weeks interval during the rainy season.

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