Soil Nutrient Status and okra pod yield as Influenced by plant density and Cattle dung Manure Application

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Abstract

The productivity of okra was enhanced by application of cattle dung which influenced soil nutrient status positively. Highest pod yield (7.39 t ha^{-1}) was obtained with 83,333 plants per hectare (pph)) and 450 kg N ha^{-1} cattle dung application. However, the population of 83,333 pph and 300 kg N ha^{-1} cattle dung application which gave the highest return per naira invested (3.28) and benefit: cost ratio (2.93) was assessed to be the best combination for optimum yield (7.13 t ha^{-1}).

Introduction

Low native soil fertility and in-appropriate plant population constrained okra production in Nigeria. Organic manure ameliorated nutrient imbalance, soil acidity, low organic matter, scarcity and high cost (Akanni *et al.,* 2011) which may improve okra productivity. Cattle dung contains appreciable content of organic matter. Three levels of cattle dung (0, 300 and 450 kg N ha^{-1}) and three plant densities (47,619, 66,666 and 83,333 plants per hectares (pph)) were evaluated to determine the best option for okra pod yield. The effect of organic amendment (cattle dung) on soil nutrient status was also considered.

Material and methods

The study was conducted for two years at the University of Benin, Benin Research farm located within Latitude $6^0$14′ S and $7^0$34′ N and Longitude $5^0$40′ and $6^0$43′ E. There were nine treatment combinations from two factors laid out in randomized complete block design (RCBD). The first factor was cattle dung application ((0, 300 and 450 kg ha^{-1})) incorporated into the soil two weeks before sowing okra seeds. The second factor was plant population derived by intra and inter row spacing of plants at 30 x 70 cm, 30 x 50 cm and 30 x 40 cm, to give plant densities of 47,619, 66,666 and 83,333 pph, respectively. Pre-sowing soil surface (0 – 15 cm depth) were collected on treatment basis from each plots and processed for chemical analysis as described by Mylavarapus and Kennelley (2002). Data obtained were combined and subjected to analysis of variance using SAS. Economic analysis was determined for the most profitable combination of tested factors for okra production (Erhabor, 2005).

Results

The cattle dung contained the following: organic C (5.65 %), total N (2.25 %), available P (890.00 mg kg^{-1}), Ca (2.00 cmol kg^{-1}), Mg (0.56 cmol kg^{-1}) and K (0.37 cmol kg^{-1}).

Table 1: Soil chemical properties after cattle dung application

Cattle dung	pH	Organic C	Toatal N	Available P	Exchangeable cation (cmol kg-1)		
(kg N ha^{-1})		(%)	(%)	(mg kg^{-1})	Ca	Mg	K
0	4.82	0.95	0.07	19.90	2.69	1.17	0.37
300	5.50	1.27	0.10	27.60	4.55	1.96	1.00
450	5.56	1.36	0.10	22.10	4.69	2.00	1.07
LSD(0.05)	0.560	0.173	0.013	7.370	1.227	0.716	0.383

The soil chemical properties after cattle dung application is presented in Table 1. Cattle dung application had significant effects on soil chemical properties. Soil pH was highest in plots treated with 450 kg N cattle dung ha^{-1} (5.56) and this was statistically similar to 300 kg N cattle ha^{-1} treated plots (5.50). Similar trend was observed in organic C, total N and exchangeable cations. In terms of available P, cattle dung application was only significantly different between control plots and those plots treated with 300 kg N ha^{-1} cattle dung. However, untreated plots and plots treated with 450 kg N cattle ha^{-1} were statistically comparable.

Table 2: Effects of plant density and cattle dung on pod yield

Plant density (pph)	Pod yield (g stand^{-1}) Cattle dung (kg N ha^{-1})				Pod yield (t ha^{-1}) Cattle dung (kg N ha^{-1})			
	0	300	450	Mean	0	300	450	Mean
47,619	44.00	132.00	136.33	104.11	2.09	6.29	6.50	4.96
66,666	25.33	99.67	102.67	75.89	1.70	6.64	6.84	5.06
83,333	20.33	85.67	88.67	64.89	1.69	7.13	7.39	5.4
Mean	29.89	105.78	109.22	81.63	1.83	6.69	6.91	5.14
LSD(0.05) Cattle dung				3.908				0.226
LSD(0.05) Plant density				3.908				0.226
LSD(0.05) Cattle dung x plant density				5.037				0.374

Pod yield per stand responded significantly to cow dung application and plant density (Table 2). Pod yield obtained with 300 and 450 kg ha^{-1} N was statistically comparable. Pod yield per stand decreased as plant population per hectare increased. Plant density and cattle dung application interaction significantly enhanced yield. A plant population of 83,333 pph and cow dung application rate of 450 kg N ha^{-1} recorded the highest yield (7.39 t ha^{-1}) which was statistically at par with those produced from treatments combinations of 83,333 pph and 300 kg N ha^{-1} and 66,666 pph and 450 kg N ha^{-1} with 7.13 and 6.84 t ha^{-1}, respectively.

Discussion

Increase in soil pH, N, P, Ca, Mg, K and organic C after cattle dung application is attributed to the amending effects of cattle dung. Okra benefited from cattle dung application which increased soil nutrients to the crop. This was manifested by the significant pod yield increase in treated plots. This trial clearly showed that higher plant density maximized pod yield through better light use efficiency.

This study revealed that okra pod productivity can be boosted to ensure sustainability and optimum yield through cattle dung application and plant density manipulation. The economic analysis showed that despite high production cost associated with the application of cattle dung in okra production, the venture is profitable. The optimum yield was obtained from a population of 83333 pph and 300 kg N cattle dung ha-1 which had the highest return per naira invested (3.28) and benefit: cost ratio (2.93).

Table 1: Economic analysis of the effect of cattle dung application and plant density on the performance of okra

Plant density	Item (₦)	Cattle dung application (kg N ha^{-1})		
(pph)		0	300	450
47619	Output (t ha^{-1})	2.09	6.29	6.50
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	139,911.03	158,711.03	168,401.03
	Cost of production	159,348.66	178,208.66	187,838.66
	Total revenue	160,000.00	475,000.00	467,000.00
	Gross margin	200,088.97	316,228.97	298,598.97
	Net return	651.34	296,791.34	279,161.34
	Return per ₦ invested	1.14	2.99	2.83
	Benefit : cost ratio	1.00	2.67	2.49
66,666	Output (t ha^{-1})	1.70	6.64	6.84
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	142,523.35	161,783.35	171,313.35
	Cost of production	162,360.98	181,220.98	190,650.98
	Total revenue	150,000.00	512,500.00	550,000.00
	Gross margin	7,476.65	350,716.00	378,786.60
	Net return	(-11,960.98)	331,279.02	359,348.97
	Return per ₦ invested	1.05	3.17	3.21
	Benefit : cost ratio	0.92	2.83	2.88
83,333	Output (t ha^{-1})	1.69	7.13	7.39
	Total fixed cost	19,437.63	19,437.63	19,437.63
	Total variable cost	145,559.26	164,419.26	173,839.26
	Cost of production	164,994.89	183,854.89	193,264.89
	Total revenue	142,500.00	540,000.00	557,250.00
	Gross margin	(-3,059.59)	375,580.74	388,410.74
	Net return	(-22,496.89)	356,145.02	363,973.11
	Return per ₦ invested	0.98	3.28	3.21
	Benefit : cost ratio	0.86	2.93	2.88

Assumption for economic analysis: Exchange rate ₦ 162 = $1

Total cost of production increased as the rate of cattle dung application and plant density increased up to the highest level (Table 3). Revenue, gross margin and net profit increased as cattle dung increased up to 450 kg N ha^{-1} (Table 3). Return per naira and Benefit: cost ratio was highest at a population of 83,333 plants and 300 kg N ha^{-1} cattle dung.

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