Seed yield and economic returns of sesame (*Sesamum indicum* L.) as influenced by poultry manure, nitrogen and phosphorus fertilization at Samaru, Nigeria

Rendimiento de semillas y retorno económico del ajonjolí (*Sesamum indicum* L.) influenciado por gallinaza, nitrógeno y fósforo en Samaru, Nigeria

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ABSTRACT

Field trials were conducted during the rainy seasons of 2005, 2006 and 2007 at the Research Farm of Institute for Agricultural Research, Samaru, Nigeria (11^0 11' N, 07^0 38' E, and 686 m above sea level) to study the yield and economic return of sesame cv. Ex-Sudan as influenced by poultry manure, nitrogen, and phosphorus application. The experiment consisted of four rates of poultry manure (0, 5.0, 10.0, and 15.0 t ha^{-1}), three levels of nitrogen in the form of urea (0, 60, and 120 kg N ha^{-1}) and three levels of phosphorus in the form of single super phosphate (0, 13.2 and 26.4 kg P ha^{-1}) applied to the treatments. The thirty six treatment combinations were laid out in a split-plot design with three replications. The factorial combinations of N and P were assigned to the main plot while poultry manure was assigned to the sub-plots. Yield of sesame and economic returns were better at 5 t ha^{-1}, 60 kg N ha^{-1} and 13.2 kg P ha^{-1} of poultry manure, nitrogen and phosphorus application rates respectively. Applications of 5 t poultry manure ha^{-1}, 60 kg nitrogen ha^{-1} and 13.2 of phosphorus ha^{-1} seems to be the ideal rates for sesame production at Samaru, Nigeria and is therefore recommended.

Key words: *Sesamum indicum*, seed yield, economic returns, poultry manure, nitrogen, phosphorus

RESUMEN

Se condujeron experimentos de campo durante las épocas lluviosas en 2005, 2006 y 2007 en la Research Farm of Institute for Agricultural Research, Samaru, Nigeria (11^0 11' N, 07^0 38'E, y 686 m sobre el nivel del mar) para estudiar el rendimiento y el retorno económico del ajonjolí cv. Ex-Sudan influenciado por gallinaza, nitrógeno y fósforo. El experimento consistió de cuatro dosis de gallinaza (0, 5, 10 y 15 t ha^{-1}), tres niveles de nitrógeno en la forma de urea (0, 60 y 120 kg N ha^{-1}) y tres niveles de fósforo en la forma de superfosfato simple (0; 13,2 y 26,4 kg P ha^{-1}). Las 36 combinaciones de tratamientos se arreglaron en un diseño de parcelas divididas con tres repeticiones. Las combinaciones factoriales de N y P se asignaron a las parcelas principales mientras la gallinaza se asignó a las subparcelas. El rendimiento de ajonjolí y los retornos económicos fueron mejor a 5 t ha^{-1}, 60 kg N ha^{-1} y 13,2 kg P ha^{-1} de gallinaza, nitrógeno y fósforo, respectivamente. Las aplicaciones de 5 t de gallinaza ha^{-1}, 60 kg de nitrógeno ha^{-1}y 13,2 kg [1] de fósforo ha parecen ser las dosis ideales para la producción de ajonjolí en Samaru, Nigeria y es por lo tanto recomendada.

Palabras clave: *Sesamum indicum*, rendimiento de semillas, retornos económicos, gallinaza, nitrógeno, fósforo.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop in the tropics and subtropics. It is grown mainly in developing countries by small holder farmers who rarely apply fertilizer. This results in both low yield and poor economic returns. Significantly higher yields have been reported with the application of organic manure, nitrogen and phosphorus fertilizer by many workers. Manure application has been shown to improve solubility and uptake of P from sparingly soluble P compounds in soil and enhances the utilization of P from P containing fertilizers (Zeidan, 2007). Mondal *et al*. (1992) reported that application of 10 t farm yard manure ha^{-1} significantly increased the seed yield of sesame compared to other levels of applied organic and inorganic fertilizers. Working on the effect of spacing and fertilizer application on the growth, yield and yield components of sesame, Bonsu (2003) reported that poultry manure application significantly increased total seed yield by 13% over the control that had no manure. Duhoon *et al*. (2004) working on the optimization of sesame production through

bio/natural inputs reported that application of 3.75 t farmyard manure ha^{-1} plus other organic amendments gave significantly higher seed yield compared with the control. Vaiyapuri *et al*. (2004) reported that application of 45 kg sulphur ha^{-1} and 10 t poultry manure ha^{-1} gave the maximum seed yield per hectare in a study on the effect of sulphur and different organic amendments on the performance of sesame.

Osman (1993) reported that grain yield and yield parameters of sesame were significantly enhanced by the application of 40 kg N ha^{-1}. Mankar *et al.* (1995) showed that phosphorous application at the rate of 22 kg P ha^{-1} significantly enhanced seed yield, seed oil content and seed protein content of sesame. Olowe and Busari (2000) found that application of 60 kg N ha^{-1} and 13.2 kg P ha^{-1} produced significantly the highest number of capsules per plant, branches per plant, capsule weight per plant and grain yield per hectare. Hossein *et al*. (2007) recorded the highest sesame seed yield with the application of 60 kg N ha^{-1}. Okpara *et al*. (2007) found that application of 75 kg N ha^{-1} and 26.4 kg P ha^{-1} significantly increased the number of seeds per capsule and seed yield per hectare.

Works on the yield and economic returns of sesame as influenced by poultry manure, Nitrogen and Phosphorus fertilizer rates at Samaru, Nigeria is lacking. This study, therefore, seek to evaluate the yield and economic returns of sesame as influenced by poultry manure, nitrogen and phosphorus.

MATERIALS AND METHODS

Field Experiments were conducted during the rainy seasons of 2005, 2006 and 2007 at the Institute for Agricultural Research (IAR) Farm, Ahmadu Bello University, Samaru, (11^o 11' N; 07^o 38' E, 686 m above sea level), located in the northern Guinea savanna agro-ecological zone of Nigeria.

The experiment consisted of factorial combinations of four levels of poultry manure (0, 5.0, 10.0 and 15.0 t ha^{-1}), three levels of nitrogen (0, 60 and 120 kg N ha^{-1}) in the form of Urea and three levels of phosphorus (0, 13.2 and 26.4 kg P ha^{-1}) in the form single super phosphate. The thirty six (36) treatment combinations were laid out in a split-plot design with nitrogen and phosphorus assigned to the main-plot, while poultry manure was assigned to the sub-plot. The gross plot size was 13.5 m^2 (4.5 m x 3 m) while the net plot size was 9 m^2 (3 m x 3 m).

The experimental area was disc-ploughed and harrowed twice to a fine tilt. This was then followed by ridging at 75 cm apart (between rows) and the field marked into plots and blocks (replications). The plots were separated by 1.0 m unplanted boarder while replications were separated by 2.0 m unplanted alley. The three levels of phosphorus and the four levels of poultry manure were incorporated into the ridges according to the experimental design after land preparation and left for two weeks before sowing. Half of the nitrogen levels were applied at 3 weeks after sowing (WAS) while the remaining half was applied at 6 WAS. The sesame cultivar used was Ex-Sudan. It is white in colour, of medium height (80 to 100 cm) and medium maturity (85 to 90 days) (RMRDC, 2004). Seeds of the cultivar were sown on July 16, 2005; July 19, 2006 and July 20, 2007 for the three trials using 15 cm intra-row spacing on ridges 25 cm apart. Manual hoe weeding was done at 3, 6, and 9 WAS to ensure a weed-free growth environment.

Harvesting was done on October 23, 2005; October 27, 2006 and October 28, 2007, when the leaves and stems turned yellowish brown. Harvesting was manually done with the aid of a sickle by cutting the plants at the base close to the ground. Plants from each plot were gathered into a sack to dry so as to minimize seed loss when capsule dehisces. When the harvested plants were adequately dry, the sacks were gently beaten with sticks in order to release all the seeds from the capsules. The seeds were then separated from the chaff by winnowing. The entire plants in the net plot were used to obtain the seed yield per hectare.

The data collected were subjected to analysis of variance using the 'F' test to estimate the significance in the effects of the treatments as described by Snedecor and Cochran (1989). Comparisons of treatment means were done using the Duncan's Multiple Range Test (Duncan, 1955). To examine the economic implications of varying the rates of poultry manure, nitrogen and phosphorus, revenues were computed based on the pooled means of yield from all the levels of nitrogen and phosphorus using a farm gate price of two hundred naira (₦200 kg^{-1}). The pooled total revenue estimates were expressed in Naira per hectare (during the study, US Dollar = ₦ 140).

RESULTS

Seed yields (kg ha^{-1}) of sesame in 2005, 2006, 2007 and the mean as affected by treatments are shown in Table 1. Application of 5 t ha^{-1} of poultry manure

produced significantly higher grain yield compared with other level of applied manure. Increasing the rate of poultry manure from 5 to 10 and 15 t ha^{-1} significantly reduced seed yield in all the years. In all the years and the mean of the three years, application of 60 kg N ha^{-1} produced significantly higher grain yield compared with other levels of N application. Seed yield decreased when N rate was increased.

Application of 13.2 kg phosphorus ha^{-1} produced significantly higher grain yield per hectare compared with other levels of applied P. Application of 26.4 kg P ha^{-1} significantly decreased seed yield in all the years and the mean of the three years.

The profitability of sesame in this study was measured using gross-margin analysis and the result is presented in Table 2. The change in gross margin as a response to treatment was in consonance to the yield obtained under the treatments.

Under the poultry manure treatment, application of 5 t ha^{-1} gave the best gross margin of ₦142, 137 (one hundred and forty two thousand one hundred and thirty seven naira). For the nitrogen treatment, application of 60 kg ha^{-1} gave the best gross margin of ₦ 133,540 (one hundred and thirty three thousand, five hundred and forty naira) while application of 13.2 kg ha^{-1} of phosphorus gave the best gross margin of ₦ 126,148.80 (one hundred and twenty six thousand, one hundred and forty eight naira, eighty kobo).

From the above, the weeding cost constituted the highest proportion of total variable cost. The cost of fertilizer or manure increased with increase in the rate of application. However, production in this study was profitable at all levels of applied nutrients as reflected by the positive values of gross margin.

DISCUSSION

Yield of sesame cv. Ex-Sudan was highest at moderate rate of applied poultry manure and nitrogen (5 t ha^{-1} and 60 kg N ha^{-1}) and not the highest doses. This could be because excessive nitrogen has been reported

Table 1. Effect of poultry manure, nitrogen and phosphorus on the grain yield (kg ha^{-1}) of sesame (*Sesamum indicum* L.) cv. Ex-Sudan during the rainy seasons of 2005-2007 at Samaru, Nigeria.

	Grain yield (kg ha^{-1})			
Treatments	2005	2006	2007	Combined
Nitrogen (kg ha^{-1})				
0	699.68 c	732.29 c	582.29 c	671.39 c
60	998.70 a	773.36 a	831.43 a	934.50 a
120	872.22 b	753.15 b	732.28 b	788.22 b
SE±	4.847	4.303	4.164	5.233
Phosphorus(kg ha^{-1})				
0	777.70 c	738.51 c	678.93 c	746.71 c
13.2	946.47 a	880.39 a	766.82 a	864.56 a
26.4	853.42 b	794.91 b	700.17 b	782.83 b
SE±	4.847	4.303	4.164	5.233
Poultry manure (t ha^{-1})				
0	696.23 d	682.92 d	647.95 d	675.70 d
5.0	1066.83 a	900.73 a	835.32 a	960.96 a
10.0	856.39 b	882.17 b	716.54 b	818.37 b
15.0	817.31 c	732.59 c	661.40 c	737.10 c
SE±	5.635	5.419	5.633	5.421
Interactions				
N X P	ns	ns	ns	ns
N XM	ns	ns	ns	ns
P X M	ns	ns	ns	ns
N X P X M	ns	ns	ns	ns

ns = Not significant at 5% level of significance
Means followed by the same letter (s) within the same treatment group and column are not statistically different at 5 % level of significance according to Duncan's Multiple Range Test

to reduce fruit number and yield for sesame but enhances plant growth (Aliyu *et al*., 1996). This finding corroborated those of Bonsu (2003), Fathy and Mohammed (2009).

Yield of sesame was significantly increased by the application of 13.2 kg P ha^{-1}. The application of 13.2 kg P ha^{-1} seems to be sufficient to meet crop nutrient requirement as further increase in the phosphorus level did not confer any beneficial effect on the yield. The beneficial effect of phosphorus on the seed yield in this study could be due to the fact that phosphorous is a component of nucleic acids, so it plays a vital role in plant reproduction, of which seed production is an important outcome (Douglas and Philips, 2008). This finding is in agreement with those of Mankar *et al.* (1995), Olowe and Busari (2000), Okpara *et al*. (2007) and Haruna *et al*. (2010).

Sesame produced with the highest levels of applied N, P, and poultry manure gave the lowest gross margin compared with those that received no treatment at all. This could be due to the fact that, at the highest treatment levels, vegetative growth was enhanced to the detriment of seed yield. At the end, the grain produced at the levels of nutrients application was not high enough to upset the high cost of production. The low stand count at harvest could also be responsible for the low gross margin because the yield obtained from those plots, though higher than those without nutrients but because of the cost of the nutrient procurement and the labour for applying them, their gross margin was lower. The highest gross margin and highest revenue was obtained by the application of 5t/ha of poultry manure, 60 kg N ha^{-1} and 13.2 kg P ha^{-1} respectively.

Table 2. Economic analysis of sesame production cv. Ex-Sudan at Samaru, Nigeria (Three years combined data i.e. 2005 to 2007).

Variable	Poultry manure (t ha^{-1})				Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})		
Cost	0	5	10	15	0	60	120	0	13.2	26.4
Cost of seed ₦ ha^{-1}	1,050	1,050	1,050	1,050	1050	1,050	1,050	1050	1,050	1,050
Cost of fertilizer ₦ ha^{-1}	0	5,000	10,000	15,000	0	6,250	12,500	0	2,700	5,400
Land preparation ₦ ha^{-1}	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Planting ₦ ha^{-1}	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Weeding ₦ ha^{-1}	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000
Fertilizer application ₦ ha^{-1}	0	6,000	7,000	8,000	0	8,000	8,000	0	5,000	5,000
Harvesting ₦ ha^{-1}	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Threshing and winnowing ₦ ha^{-1}	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Total variable cost ₦ ha^{-1}	39,050	50,055	56,060	62,065	39,050	53,360	59,670	39,050	46,763.2	49,476.4
Revenue ₦ ha^{-1}	135,140	192,192	163,674	147,420	134,278	186,900	157,644	149,342	172,912	156,566
Gross margin ₦ ha^{-1}	96,090	142,137	107,614	85,355	95,228	133,540	97,974	110,292	126,148.8	107,089.6

CONCLUSION AND RECOMMENDATION

Contrary to the generally held view at Samaru, Nigeria that sesame can do better without fertilizer application, this study showed that both yield and economic returns of sesame were better with the applications of 5 t ha^{-1} of poultry manure, 60 kg ha^{-1} of nitrogen and 13.2 kg ha^{-1} of phosphorus compared with non application of fertilizer. Applications of 5 t ha^{-1} of poultry manure, 60 kg ha^{-1} of nitrogen and 13.2 kg ha^{-1} of phosphorus is therefore recommended for increased yield and better economic returns to sesame growers at Samaru.

LITERATURE CITED

Aliyu, L.; Y. Yusuf and M. K. Ahmed. 1996. Response of Pepper to Fertilizer: Growth, yield and yield components as affected by nitrogen and phosphorus levels. Edited by A. Adebanjo. *In*: Proceedings of the 14th HORTSON Conference Ago-Iwoye. p. 45-50.

Bonsu, O. K. 2003. Effect of spacing and fertilizer application on the growth, yield and yield components of sesame (*Sesamum indicum* L.). J. Sust. Agric. 23 (1): 40-49.

Douglas, B. B. and T. D. Philips. 2008. Managing phosphorus for crop production. Department of Crop and Soil Sciences. Cooperative Extension. Penn. State University. http://www.cas.psu.edu.

Duhoon, S. S.; A. Jyotishi, M. R. Deshmukh and N. B. Singh. 2004. Optimization of sesame (*Sesamum indicum* L.) production through bio/natural inputs. http://www.cropscience.au/res.

Duncan, D. B. 1955. Multiple range and multiple F-tests. Biometrika 11: 1-42.

Fathy, S. E. and A. S. Mohammed. 2009. Response of seed yield, yield components and oil content to the sesame cultivar and nitrogen fertilizer rate diversity. Electronic Journal of Environmental, Agricultural and Food Chemistry 8 (4): 287-293.

Haruna, I. M.; S. M. Maunde and S. A. Rahman. 2010. Effects of nitrogen and phosphorus fertilizer rates on the yield and economic returns of sesame (*Sesamum indicum* L.) in the northern Guinea savanna of Nigeria. Electronic Journal of Environmental, Agricultural and Food Chemistry 9 (6): 1152-1155.

Hossein, M. A.; A. Hamid and S. Nasreen. 2007. Effect of nitrogen and phosphorus fertilizer on N/P uptake and yield performance of Groundnut (*Arachis hypogea* L.). J. Agric. Res. 45 (2): 119-127.

Mankar, D. D.; R. N. Satao, V. M. Solanke and P. G. Ingole. 1995. Effect of nitrogen and phosphorus on nutrient uptake and yield of sesame. PKV Research Journal 19 (1): 69-70.

Mondal, S. S.; D. Verma and S. Kuila. 1992. Effect of organic and inorganic sources of nutrients on growth and seed yield of sesame (*Sesamum indicum* L). Indian J. Agron. 37(4): 258-262.

Okpara, D. A.; C. O. Muoneke and T. A. Ojikpong. 2007. Effects of nitrogen and phosphorus fertilizer rates on the growth and yield of sesame (*Sesamum indicum* L) in the Southeastern Rainforest Belt of Nigeria. Nigerian Agric. Journal (38): 1- 11.

Olowe, V. I. O. and L. D. Busari. 2000. Response of sesame (*Sesamum indicum* L.) to nitrogen and phosphorous application in Southern Guinea savanna of Nigeria. Tropical Oilseed Journal. 5: 30-37.

Osman, H. E. 1993. Response of sesame cultivars to plant density and nitrogen in the Sudan central rain lands. Arab Gulf Journal of Scientific Research 11 (3): 365-376.

Raw Materials Research and Development Council (RMRDC) 2004. Report on survey of Agro-Raw Materials in Nigeria Beniseed. Raw Materials Research and Development Council, Abuja. p. 99.

Snedecor, G. W. and W. G. Cochran. 1989. Statistical Methods. 8th ed., Iowa State Univ., Press, Ames, Iowa, U.S.A.

Vaiyapuri, V.; A. Amudha, M. V. Sriramachandrasekharan and V. Imayavaramban. 2004. Effects of sulphur levels and organic amendments on the growth and yield of sesame. Advances in Plant Sciences 17 (2): 681-685.

Zeidan, M. S. 2007. Effect of organic manure and phosphorus fertilizers on growth, yield and quality of lentil plants in sandy soil. Research Journal of Agriculture and Biological Sciences 3 (6): 748-752.