Journal of Biology, Agriculture and Healthcare www.iiste.org
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.27, 2014

Costs and Returns to Potassium Fertilizer Application in Melon (Egusi) Seed Yield and Oil Production

O.J. Ayodele
Department of Crop, Soil and Environmental Sciences,Ekiti State University, Ado-Ekiti, NIGERIA
E-mail: ayodele.olufemi@yahoo.com

ABSTRACT

Cost-Benefit analysis was carried out on the responses of economic yield attributes of melon (egusi) to potassium (K) application rates over three years. The Value-Cost ratio (VCR) was determined at the unsubsidized and subsidized prices of muriate of potash (MOP) fertilizer. Returns to seed yield were positive in 2006 and 2007 due to significant agronomic responses to K application. The 20 kg K.ha^{-1} rate resulted in highest profitability of ₦3.93 and ₦7.51 in 2006 and 2007 for every ₦1.00 invested in subsidized MOP and which reduced to ₦3.01 and ₦6.77 without subsidy, respectively. Incremental oil yield rose with K rates but did not attain financial profitability in all the years. Shelling to remove the seed coat was the most labour intensive which increased processing cost. The need to increase seed efficiency in egusi and develop more efficient processing were discussed

Keywords: egusi, seed, egusi oil, response coefficient, Value-Cost ratio

INTRODUCTION

The seed (melon seed or 'egusi') and seed-oil constitute the economic yield of West African (local) water melon (*Citrullus lanatus* ssp *mucospermum;* Syn. *Colocynthis citrullus*). The seed coat (tegument) is removed through a process called shelling (de-husking) and the shelled seed is ground for use as condiment in 'egusi soup' (Burkill, 1985). It contains 47.0-50.2% oil that can be extracted as edible oil or raw material for soap-making, illuminants and pharmaceuticals (Adewusi *et al*., 2000). The protein content (about 34%) and nutritional quality in terms of arginine, tryptophan and sulphur-containing amino acids and minerals make de-fatted melon (egusi) (residue after oil extraction) a substitute for imported concentrates in livestock feeds (Achinewu *et al*., 1992). The energy content of the seed, at 2340 kJ (550kcal).100g^{-1} and absence of hydrocyanic acid increase the suitability for livestock feed formulation (van der Vossen *et al*., 2004).

Melon (egusi) seed and oil yield have been raised by increased supply of nutrients from fertilizer application. This is especially so with potassium (K) fertilizer application which significantly increased the oil output, in relation to higher seed yield and % oil content of the seed (Omotoso *et al*., 2006). These agronomic responses mean little unless they are analyzed for costs and returns, to assess the financial profitability of K fertilizer use. This paper presents seed and oil yield data and analysis of costs and returns, based on some calculated agro-economic criteria, to determine the profitability of K fertilizer and so justify the inclusion in routine fertilizer management for melon (egusi) production.

MATERIALS AND METHODS

Data of melon (egusi) seed yield (Bara seed type with thick black edges) as influenced by application of 0, 20, 40 and 60 kg K.ha^{-1}, supplied with muriate of potash (MOP, 60% K2O were obtained from field trials conducted in 2007, 2008 and 2009. details of the experiments, layout and treatments, collection of seed and oil yield data are described in an earlier report (Omotoso *et al*., 2006).

Additional data were collected as follows:

- farmgate prices of unshelled egusi and oil (ororo-egusi) as 80% of the rural market prices obtained in Survey Reports published by National Horticultural Research Institute, Ibadan and National Agricultural Extension Research and Liaison Services, Zaria for 2007-2009.
- labour costs in naira.man-day^{-1} (₦.md^{-1}) during 2007-2009
- total variable costs = cost of MOP fertilizer at subsidized official price and unsubsidized open market prices, up to the farm gate plus labour cost of application, harvesting and processing the additional output doe to fertilizer application
- labour cost of shelling and extracting oil from known quantities of seed.

The following agro-economic criteria were calculated for the seed and oil yields:

- incremental yield = yield at particular K treatment – control yield; MT.ha^{-1}
- response rate = incremental yield / K rate applied; kg seed or oil. kg K^{-1}
- value of incremental yield = incremental yield x farm gate price; ₦.ha^{-1}
- incremental profit = value of incremental yield – incremental costs (total variable costs); ₦.ha^{-1}
- Value-Cost Ratio (VCR) = incremental profit divided by incremental costs

RESULTS

Application of K increased the incremental egusi seed and seed-oil yields in the three years, being highest in 2008 (Table 1). The response rates were highest at 20 kg $K.ha^{-1}$ in 2007 and 2008 with decreases at the higher K levels.

Cost-Benefit analysis of K application to egusi yield is shown in Table 2. The value of incremental output, variable costs with subsidized and unsubsidized fertilizer increased and this trend was reflected in the magnitude of incremental profit (returns). In 2009, the low incremental output ensured that returns were negative at 20 kg $K.ha^{-1}$. The VCR was positive in 2007 and 2008 for all K rates, with the highest profitability of ₦3.93 and ₦7.51 from every ₦1.00 investment in subsidized MOP applied to supply 20 kg $K.ha^{-1}$. Without subsidy, the variable costs rose, which reduced profitability to ₦3.01 and ₦6.77 in 2007 and 2008. Application of K was not profitable for seed production in 2009 as indicated by the low and negative returns and VCR at the subsidized and unsubsidized MOP prices.

Incremental seed-oil yield converted to $litres.ha^{-1}$, value of incremental yield, variable costs and incremental profit increased progressively at rising levels of K application (Table 3). The VCR values were highest at 1.28 and 1.03 from 20 kg $K.ha^{-1}$ application in 2007 and 2008 respectively. Without subsidy, VCR exceeded 1.00 in 2007 only, when highest value of 1.22 was obtained from 20 kg $K.ha^{-1}$ application. In 2008 and 2009, VCR at all K levels was below 1.00, such that K application did not ensure profitable seed-oil production.

DISCUSSION

The economic portion of egusi is the seed normally shelled by removing the seed coat (testa or tegument) and the edible seed ground to provide the main condiment in 'egusi' soup. This form of utilization makes the crop a fruit vegetable (Olufolaji and Denton, 2000) which masks the seed as a source of edible (vegetable) oil, raw material for soap making, pharmaceuticals and livestock feed formulation (Adewusi *et al*., 2000; van der Vossen *et al*., 2004). The potentials have been difficult to attain. First, the seed yield is low under the prevailing mixed cropping in traditional food crop production systems the crop is readily identified with (Siemonsma and Piluek, 1994). Second, the seed-oil, though highly-valued and expensive, involves tedious and labour-intensive extraction, making the practice unpopular (Adewusi *et al*., 2000). Besides, local processing yields an extraction rate of 1 litre seed-oil from 3.3-4.5 kg shelled seed, which is low compared with output based on laboratory oil content of 38.4-48.5% and seed yields reported in Omotoso *et al*. (2006).

Egusi seed yields calculated at the farmers' level, used in this analysis, exceed the national average of 0.17 $MT.ha^{-1}$ (Olayide, 1982) and farmers' yields of 0.25 $MT.ha^{-1}$ (van der Vossen *et al*., 2004). This suggests the possibility of higher egusi seed output with widespread adoption of improved agro-techniques that emphasize adequate nutrition especially K fertilizer management which increased seed and seed-oil yields (Ayodele *et al*., 2007). The concern is for profitability of using the input, which relates to three agro-economic criteria: technical efficiency of the added nutrient in fertilizer (response rate or coefficient), cost of fertilization and price of the output (Falusi, 1990). The technical efficiency is low with highest value of 10 kg $seed.kgK^{-1}$ which reflects the low seed efficiency of egusi put at <3% of the fruit (Siemonsma and Piluek, 1994). Fertilizer supplied by government enjoyed 25% price subsidy but the farmgate prices have been rising annually such that the main determinant of profit was egusi seed and seed-oil domestic price which increased during the study period in response to nationwide inflationary pressure.

From conventional economic theory of production, profit is maximized at the point where the cost of an additional input equals the returns from using that quantity of the input. It is the point where marginal revenue (MR) equals the marginal cost (MC), that is, MR/ MC = 1.0 and calculated as the Value-Cost ratio (VCR) of 1.0. The VCR refers to the monetary value of returns for every Naira (₦) invested in fertilizer, and so measures the profitability of its use.

Application of K was profitable in 2007 and 2008 with VCR greater than 1.0 at all rates for seed yield. The highest profitability at 20 kg $K.ha^{-1}$ is consistent with the agronomic response reported by Ayodele *et al*. (2007). Without subsidy, K application was profitable but the VCR values were lower. The higher profitability with subsidized fertilizer is one of the conditions that justify the retention of subsidy (Idachaba, 1994).

Seed-oil yield increased with K application resulting in VCR>1.0 in 2007. The theoretical consideration in analysis of production costs and returns regard VCR=1.0 as the point of profitability but Falusi (1990) had noted that because of the myriad of productivity constraints that confront farmers in tropical Africa, they hardly use the input up to the level where MR/MC= 1.0 but would stop well before MR/MC=2.0. He suggested using VCR=2.0 for financial profitability based on domestic prices and economic profitability at VCR=1.0 based on border prices. Egusi products are not tradable and do not have the international prices needed for economic analysis. Thus, the VCR at 1.22-1.28 at all K levels in 2007 and 1.03 at 20 kg $K.ha^{-1}$ in 2008 with subsidized fertilizer, and 1.13-1.22 without subsidy in 2007 are not profitable. This is because of the simultaneous increase in processing cost at the larger incremental output. The seed-oil yield was high in 2008 but its values were associated with higher incremental costs which reduced the returns. The implication is that development or adaptation of efficient oil extraction and processing methods that require less man-day for operation should be the focus. Shelling (de-husking) requires breaking the tegument of each seed. Mechanical devices that remove the drudgery would reduce processing costs and make egusi seed-oil extraction attractive.

REFERENCES

Achinewu, S.C., Barber, L.I. and Iteke, A.I. 1992. Chemical and sensory properties of fermented blends of maize (Zea mays L.) with melon (Citrullus vulgaris) and fluted pumpkin (Telfairia occidentalis) seeds. Delta Agriculturist 1: 74-79.

Adewusi, H.G., Ladipo, D.O., Sarumi, M.B., Adebisi, A.A. and Vodouhe, R. 2000. Egusi production, utilization and diversity in Nigeria. In: Akoroda, M.O. (compiler). Agronomy in Nigeria: a book in support of Agronomy Re-Union Day, 04 October 2000, Department of Agronomy, University of Ibadan: 94-100.

Ayodele, O.J., Oladapo, M.O. and Omotoso, S.O. 2007. Fertilizer sector liberalization: effects on the profitability of nitrogen fertilizer application in egusi, okra and tomato production. Int. J. Agric Res. 2: 81-86

Ayodele, O.J., Omotoso, S.O. and Akinrinsola, C.O. 2007. Effect of N, P and K fertilizer application on fruit and seed yield of melon (Citrullus lanatus). Agric Sci. Res. J. 1: 27-32.

Brady, N.C. and Weil, R.R. 1999. The Nature and Properties of Soils. 12th Edition. Prentice-Hall Inc., Upper Saddle River, New Jersey. 881pp.

Burkill, H.M. 1985. The Useful Plants if West Tropical Africa. Vol I. Families A-D. Royal Botanical Gardens, Kew. 960pp

Falusi, A.O. 1990. Benefit-cost analysis of fertilizer application in Nigeria. In: 'Towards Self-Sufficiency in Food Production' Proceedings of 2nd National fertilizer Workshop, organized by NAFCON Ltd, Onne; held at Abuja, 5-7th November 1990: 90-103.

Idachaba, F.S. 1994. The dilemma of fertilizer subsidies in African agriculture. Paper presented to the IFA Regional Conference for Africa, Dakar; 31st Jan-3rd Feb. 1994

NIHORT 2000. NIHORT: 25 Years of Research into Horticultural Crop Development in Nigeria (1975-2000). (Eds: Denton, O.A., Alasiri, K.O. ad Adejoro, M.O.). National Horticultural Research Institute, Idi-ishin, Ibadan. 140pp

Olayide, S.O. 1982. Food and Nutrition Crisis in Nigerai. Ibadan University Press. 123pp

Omotoso, S.O., Ayodele, O.J. and Akinrinsola, C.O. 2006. Effects of potassiul fertilizer on yield components and nutrient composition oif egusi (Citrullus lanatus). Agric J. 1: 303-306.

Siemonsma, J.S. and Piluek, K. 1994. Plant Resources of South East Asia. 8. Vegetables. PROSEA. 412pp

van der Vossen, H.A.M.., Denton, O.A. and El-Tahir, I.M. 2004. Citrullus lanatus (Thumb); Matsum and Nakai. In: Grubben, G.J.H. and Denton, O.A. (eds). Plant Resources of Tropical Africa 2. Vegetables. PROTA Foundation, Wageningen. The Netherlands

Table 1: Effect of K application rates on farmgate incremental yields of egusi seed and seed-oil

	Application rates (kg K.ha^{-1})		
	20	40	60
2007			
Incremental seed yield, MT.ha^{-1}	0.07	0.12	0.16
Response rate, kg seed.kgK^{-1}	3.50	3.00	2.67
Incremental seed-oil yield, kg.ha^{-1}	49.34	73.56	97.34
Response rate, kg seed-oil.kgK^{-1}	2.47	1.84	1.62
2008			
Incremental seed yield, MT.ha^{-1}	0.20	0.27	0.25
Response rate, kg seed.kgK^{-1}	10.00	6.75	4.17
Incremental seed-oil yield, kg.ha^{-1}	107.88	144.35	143.47
Response rate, kg seed-oil.kgK^{-1}	5.39	3.61	2.39
2009			
Incremental seed yield, MT.ha^{-1}	0.01	0.03	0.05
Response rate, kg seed.kgK^{-1}	0.50	0.75	0.83
Incremental seed-oil yield, kg.ha^{-1}	20.10	27.62	43.00
Response rate, kg seed-oil.kgK^{-1}	1.01	0.69	0.78

Table 2: Partial budgeting of K fertilizer application to seed and seed-oil yield of egusi

	Potassium application rates (kg.ha^{-1})		
	20	40	60
Value of incremental yield	5439.00	9324.00	12432.00
Variable costs (subsidized)	1102.60	1953.20	2786.00
Incremental profit	4436.40	7370.80	9646.00
VCR	3.93	3.77	3.46
Variable costs (unsubsidized)	1357.05	2462.35	3549.40
Incremental profit	4081.95	6861.65	8882.60
VCR	3.01	2.79	2.50
Incremental seed-oil yield (l.ha^{-1})	63.26	95.63	127.19
Value of incremental output	21086.46	31876.35	42396.24
Variable costs (subsidized)	8133.43	12295.29	16352.80
Incremental profit	12953.03	19581.06	26043.44
VCR	1.59	1.59	1,59

Based on 2007 prices (₦)

Table 3: Costs and returns of K application to egusi seed and seed-oil yield responses in 2008

	Potassium application rates (kg.ha^{-1})		
	20	40	60
Value of incremental yield	16006.00	21608.10	20007.50
Variable costs (subsidized)	1879.93	2999.86	3759.79
Incremental profit	14126.07	18608.24	16247.71
VCR	7.51	6.20	4.32
Variable costs (unsubsidized)	2059.91	3359.82	4299.73
Incremental profit	13946.09	18248.28	15707.27
VCR	6.77	5.43	3.65
Incremental oil yield (l.ha^{-1})	140.24	187.65	186.51
Value of oil yield	50486.40	67554.00	67143.60
Variable costs	23041.14	32168.57	32373.14
Incremental profit	26265.28	35385.43	34770.46
VCR	1.14	1.10	1.07

Monetary values in ₦

Table 4: Effect of K application on costs and returns to seed and seed-oil yields of egusi in 2009

	Potassium application rates (kg.ha^{-1})		
	20	40	60
Value of incremental yield	861.30	2583.90	4306.50
Variable costs (subsidized)	1366.57	2524.80	3683.03
Incremental profit	-505.27	59.10	623.47
VCR	-0.37	0.02	0.17
Variable costs (unsubsidized)	1683.21	3158.08	4632.95
Incremental profit	-821.91	-574.18	-326.45
VCR	-0.49	-0.18	-0.07
Incremental seed-oil yield (l.ha^{-1})	26.13	35.91	55.90
Value of incremental yield	9326.48	12815.79	19952.17
Variable costs	4307.14	5918.57	9214.29
Incremental profit	5019.34	6897.22	10734.88
VCR	1.17	1.17	1.17

Monetary values in ₦