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Full Length Research Paper

Cost-benefit analysis of melon (egusi) seed and seed-oil yield responses to phosphorus fertilizer application

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ABSTRACT

Seed and seed-oil yield of melon (egusi), relevant to farmers' economic well-being and poverty alleviation, were significantly increased by phosphorus (P) fertilizer application in trials conducted at Ado Ekiti, Nigeria during the early and late seasons of 2008 and 2009. The optimum application rate was 20 kg P.ha^{-1} which increased the two-year average seed yield, oil content and seed-oil yield over the control (0 kg P.ha^{-1}) treatment by 65.6, 23.0 and 126.2%, respectively. Cost-benefit analysis of seed yield and seed-oil yield responses to P application gave highest Value-Cost ratio (VCR) at 20 kg P.ha^{-1} in 2008 and at 10 kg P.ha^{-1} in 2009 as rising costs at higher rates reduced the profit margins. VCR reduced at the unsubsidized prices of the single superphosphate fertilizer for each P rate which justifies the retention of fertilizer subsidy for egusi production. The 40kg P.ha^{-1} rate gave highest seed-oil yield but profit was maximized at the 20kg P.ha^{-1} which should be recommended as the economic rate for melon (egusi) production.

Keywords: Melon (egusi), single superphosphate fertilizer, Value-Cost ratio.

INTRODUCTION

Efforts to expand output, improve processing, utilization and marketing of oil palm and groundnut, as traditional export commodities and promote recent introductions such as soyabean, sunflower etc continue to dominate resources allocation and use in the oil-seed crop sub-sector in Nigeria. Thus, the potentials of several members of the family Cucurbitaceae, as oil-seeds, are neglected and so excluded in the equation for edible oil (food) and raw material self-sufficiency.

Cucurbits are widely distributed in Nigeria, being closely identifiable with the traditional food crop production systems. The species include egusi-melon (*Cucumeropsis edulis*), gourd melons (*Lagenaria siceraria*), watermelon (*Citrullus lanatus*) etc whose economic portion is the melon seed, known as 'egusi'. The seed is normally shelled (de-husked) and ground for use as the main condiment in 'egusi soup' (Burkill, 1985). This common form of utilization qualifies these crops as fruit vegetables (NIHORT, 2000).

The largest form of egusi production is the West African (or local) watermelon whose landraces (*Citrullus lanatus* ssp *mucospermum*; Syn *Colocynthis citrullus*) are widespread (Siemonsma and Piluek, 1994). It is grown sole or intercropped with staple food crops, erect fruit vegetables and juvenile stages of tree crops in orchards and plantations (van der Vossen *et al*., 2004). The seed is high in edible oil, up to 50.2% on dry weight basis such that its use as a soup condiment masks the economic value as an oil-seed. Egusi seed-oil is clear, semi-drying and easily refine-able (Akobundu *et al*., 1982), suitable for cooking (edible), soap-making, pharmaceuticals etc (Adewusi *et al*., 2000) and so offers huge prospects for extraction in cottage vegetable oil mills and processing for industrial use.

The notion that egusi is produced for domestic consumption has been accepted for so long a time that its contribution to inter-regional trade is largely ignored. About 5,000-7,000 metric tonnes (MT) seed were exchanged between Nigeria and countries in the Economic Community of West African States (ECOWAS) and North Africa in 2002, even as unrecorded trade in pulp and oil to African communities in Europe and North America probably takes place. Besides, almost 10-20% of seed produced in Nigeria is made into pulp for sale in the market (van der Vossen *et al*., 2004). These outflows were hardly considered in the egusi output projections to meet human dietary and raw material needs for processing to vegetable oil and livestock feeds that assumed a 4.5% growth rate in 1990-2005 (FMAWRRD, 1989). This domestic consumption need and external demands, so identified, must be met with increased output from hectarage expansion and higher productivity. Herein lays the need to emphasize fertilizer use in the package of technology the farmers would adopt.

Fertilizer use studies in egusi are few and show that optimum yields were obtained from 50kg N.ha^{-1}, 24-30 kg K_2O.ha^{-1} and 36-45kg P_2O_5.ha^{-1} ((Ogunremi, 1978; Ayodele *et al*., 2007). The response to phosphorus (P) was especially reflected in seed and seed-oil yield (Ayodele *et al*., 2006), the two products most relevant to the economic well-being of the farmers and so, to rural poverty alleviation. The profitability of this increase needs to be assessed as a requirement for convincing farmers to adopt P fertilizer use in egusi cultivation. Therefore, the calculation of some agro-economic criteria and analysis of costs and returns were made, to determine the profitability to P application in seed yield and oil output of egusi.

MATERIALS AND METHODS

Analysis of costs and returns was carried out on data obtained from field trials conducted in the Teaching and Research Farm, University of Ado-Ekiti during the early and late seasons of 2008 and 2009, to evaluate the yield responses of melon (egusi) to P applied as single superphosphate (SSP, 18%P_2O_5). The trials involved application of 0, 10, 20, 30 and 40 kg P.ha^{-1} to egusi established at 2x2 m spacing and at 2 seedlings.hill^{-1} with which the recommended population of 5,000 plants.ha^{-1} (Ayodele and Salami, 2006) was attained. All plots received 50 kg N and 25 kg K_2O as urea (46%N) and muriate of potash (MOP, 60%K_2O) respectively. The recommended practices for egusi production were adhered to.

At maturity, the fruits in each plot were detached from the dry vines, counted and weighed. The fruits were broken with heavy sticks and left in heaps for some days, to allow the pulp to soften. Seeds were extracted, by hand, from the fruits, washed in water, air-dried and weighed. Seed samples were shelled (de-husked-removal of seed coat or tegument), ground and the oil content was determined by extracting with petroleum extracts for 16 hours in a Soxhlet and weighing the oil after evaporating the solvent (AOAC, 2005). Oil yield was calculated as the product of seed yield and oil content for respective treatments.

Crop budgets are the standard tools for cost-benefit analysis of fertilizer use and for which additional data were obtained as follows:

- farm gate prices of unshelled egusi seed and seed-oil (ororo-egusi) as 80% of rural market prices in 2008 and 2009.
- labour costs (Naira per man-day, ₦.md^{-1}) in 2008 and 2009.
- total variable costs: SSP fertilizer price (subsidized and unsubsidized) up to the farm gate plus labour cost for application, harvesting and processing the additional output resulting from the P applied.
- labour costs of shelling and processing oil from known quantities of seed samples.

The following agro-economic criteria were calculated for the seed and oil yield components based on farmers' output level assumed to be 70% of the research plot yields (Wedderburn, 1989):

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

RESULTS AND DISCUSSION

Seed yield, oil content and seed-oil yield increased in response to P application in each year (Table 1). The 20 kg P.ha^{-1} rate resulted in average 65.6, 23.0 and 126.2% increase of seed, oil content and seed-oil over the control (0 kg P.ha^{-1}) treatment. This 20 kg P.ha^{-1} had been suggested as the optimum rate to recommend for seed production in sole egusi (Ayodele *et al*., 2006).

Calculation of the agro-economic criteria needed for analysis of costs and returns had been based on some assumptions: (i) yield at farmers' level at 70% of research plot yield, and (ii) farmgate fertilizer prices and farmgate egusi seed and seed-oil prices at 80% of the rural market prices. Incremental egusi seed and seed-oil yield increased with P application and were least at 10 kg P.ha^{-1} in 2008. Response rate was highest at 20 and 10 kg P.ha^{-1} in 2008 and 2009 respectively and decreased as P rates increased (Table 2) which is an indication of declining nutrient use efficiency (Brady and Weil, 1999). The cost-benefit analysis of P application to seed yield response shows rising values of incremental output and variable costs as the rates of subsidized SSP fertilizer increased and indicates highest incremental profit at 20 kg P.ha^{-1} in 2008 and 30 kg P.ha^{-1} in 2009. With subsidized SSP fertilizer, the best VCR values were 1.86 and 1.49 from 20 kg P.ha^{-1} in 2008 and from 10 kg P.ha^{-1} application in 2009. Without subsidy, VCR was 1.12 from 20 kg P.ha^{-1} and 1.14 from 10 kg P.ha^{-1} in 2008 and 2009, respectively. These values are low compared to the VCR obtained from application of subsidized and unsubsidized N fertilizers (Ayodele *et al*., 2007) and K fertilizers (Ayodele and Ajewole, 2011) in egusi seed production.

Table 1. Effect of phosphorus application on egusi seed and seed-oil yield

	Phosphorus application rates (kg.ha^{-1})				
2008	0	10	20	30	40
Seed yield, MT.ha^{-1}	0.34	0.43	0.62	0.56	0.64
Oil content, %	39.62	43.92	48.89	49.05	48.62
Oil yield, kg.ha^{-1}	94.30	132.20	212.18	226.81	217.82
2009					
Seed yield, MT.ha^{-1}	0.31	0.48	0.57	0.63	0.65
Oil content, %	41.20	48.51	50.58	51.43	50.30
Oil yield, kg.ha^{-1}	89.40	162.99	201.82	226.81	228.87

Average of the early and late season cropping

Table 2. Agro-economic criteria for analysis of costs and returns to P application in egusi seed yields

	P application rates (kg.ha^{-1})			
2008	10	20	30	40
Incremental yield, MT.ha^{-1}	0.06	0.19	0.15	0.21
Response rate, kg seed.kgP^{-1}	6.00	9.50	5.00	5.25
Value of incremental yield	4995.00	15817.50	12487.50	17482.50
Variable costs (subsidized)	2852.50	5525.00	8017.50	10510.00
Incremental profit	2142.50	10292.50	5470.00	6972.50
VCR	0.75	1.86	0.68	0.66
Variable costs (unsubsidized)	3806.75	7453.50	10880.25	14327.00
Incremental profit	1188.25	8364.00	1607.25	3155.50
VCR	0.31	1.12	0.15	0.22
2009				
Incremental yield, MT.ha^{-1}	0.12	0.18	0.22	0.24
Response rate, kg seed.kgP^{-1}	12.00	9.00	7.33	6.00
Value of incremental yield	10290.00	15435.00	18865.00	20580.00
Variable costs (subsidized)	4140.00	6480.00	9780.00	12720.00
Incremental profit	6150.00	8955.00	9085.00	7860.00
VCR	1.49	1.38	0.93	0.62
Variable costs (unsubsidized)	4815.00	8190.00	11805.00	15420.00
Incremental profit	5475.00	7245.00	7060.00	5160.00
VCR	1.14	0.89	0.60	0.34

Monetary values in ₦

Costs and returns of egusi seed-oil responses to P application are characterized by increasing values of incremental yield and variable costs while incremental profit was highest at 20 kg P.ha^{-1} in 2008 and 30 kg P.ha^{-1} in 2009 with subsidized and unsubsidized SSP fertilizer (Table 3). The 20 and 10 kg P.ha^{-1} application rates were most profitable in 2008 and 2009 at VCR of 1.6 and 1.2, respectively with subsidized SSP fertilizer. VCR decreased to 1.2 at the 20 kg P.ha^{-1} in 2008 and 1.1 at 10 kg P.ha^{-1} rates in 2009 at the unsubsidized SSP fertilizer prices.

The conventional economic theory of production assumes that for any crop enterprise, profit from fertilizer is maximized where the marginal cost (MC) of the input equals the marginal revenue (MR), that is, at the point where MR/MC =1.00.This is usually determined through Cost-Benefit analysis and the Value-Cost ratio (VCR) obtained is used as the measure of profitability. Farmers in tropical Africa operate under strenuous conditions which curtail high crop productivity while physical and economic access factors limit fertilizer availability such that they would hardly use the input up to the level where VCR = 1 but stop well before a value of 2.0 which Falusi (1990) reasoned should be the target for financial profitability. Egusi has low seed efficiency and does not show the high response coefficients associated with cereals, legumes and other fruit vegetables which make the target of VCR= 1.0 for financial profitability based on domestic prices the logical choice. The 10-20 kg P.ha^{-1} range has ensured profitable seed and seed-oil produc-

Table 3. Cost-benefit analysis of egusi seed-oil responses to P application

P application rates (kg.ha^{-1})				
2008	10	20	30	40
Incremental yield, l.ha^{-1}	25.67	80.60	67.35	86.59
Value of incremental yield	10267.90	32238.34	26937.73	34635.99
Profit (subsidized)	5197.51	19749.79	12381.62	16644.54
VCR	1.03	1.58	0.85	0.93
Profit (unsubsidized)	4243.26	17841.05	9518.87	12827.54
VCR	0.70	1.24	0.55	0.59
2009				
Incremental yield, l.ha^{-1}	62.41	93.81	113.95	118.22
Value of incremental yield	22466.52	33771.96	41020.92	42559.92
Profit (subsidized)	12335.45	17926.10	20302.01	18490.61
VCR	1.22	1.13	0.98	0.77
Profit (unsubsidized)	11660.00	16576.10	18277.01	15790.61
VCR	1.08	0.96	0.80	0.59

Monetary values in ₦

tion and should be recommended for egusi cultivation.

This crop has two economic commodities, one derivable from the other, and so presents a dilemma for analysis of costs and returns: whether to include the cost of seed production or use the market value of equivalent quantity of seed from each rate of applied fertilizer. The lower VCR for egusi seed-oil despite the value of incremental output from high producer prices is due to processing costs. The most tedious task in processing egusi seed-oil is shelling which involves cracking and removal of individual seed coat (tegument) such that development of mechanical devices to remove the drudgery should be the research focus.

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