ECONOMICS OF USING DIFFERENT NITROGEN SOURCES AND MULCHING MATERIALS FOR PRODUCING FRESH MARKET GREENHOUSE CUCUMBERS IN KENYA.

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Abstract

There is increasing need for environmentally safe and economically profitable farming systems. Greenhouse trials for the production of cucumber was carried out in Kenya at Egerton University, Department of Horticulture in 2003 and 2004 to compare the economics of using four nitrogen sources and three mulching materials. Based on partial budget analysis in an on farm scenario, there was no consistency in profitability of using the nitrogen sources and mulch types. In trial 1, Urea and transparent mulch were the most profitable nitrogen source while in trial 2; potassium nitrate and straw mulch were more profitable. These economic benefits make urea and potassium nitrate, and transparent polyethylene and straw mulch attractive alternatives for producing fresh market greenhouse cucumbers.

Key words: nitrogen sources, mulching, cucumber, partial budget analysis, economic analysis.

INTRODUCTION

Small-scale horticulture is an important and rapidly growing segment of Kenyan Agriculture (HCDA, 2004). This sector is greatly dominated by vegetable production, and cucumber is rapidly gaining acceptance as a highly profitable vegetable crop for both field and greenhouse production. In many parts of the Kenyan highlands, grain production has been the main enterprise for many farmers. However, increasing uncertainties in grain production threatens many farmers as average farm size decreases due to increasing land demarcation. In addition there is a growing demand for Kenyan vegetables in Europe. Consumption of vegetables is increasing due to their nutritive as well as medicinal properties. Vegetable production can also thrive under alternative production practices unlike grain production. Vegetable yields can be high even under organic and low input production practices. In addition, the high management that characterizes vegetable production fits well with the management intensive nature of sustainable agriculture (Kelly et al, 1995).

Nitrogen sources may differ in their effect on cucumber yields as well as their impact on the environment. Some nitrogen sources may leave residues in the soil or plants while others may leach into water sources (Tisdale et al,). There is also an increasing interest in organic mulch systems as these have immense environmental benefits, which include reduced soil erosion, reduced need for organic nutrient amendments, improved soil organic content, reduced weed competition and need for herbicides (Abdul-Baki and Teasdale, 1993). However, for any agricultural practice to be sustainable, it must be productive and give growers an adequate income. Any farming practice that reduces farming returns tends not to be adopted by farmers. Profitability is the kingpin of any viable agricultural practice. This paper evaluates the economics of using urea, potassium nitrate (KNO_3), ammonium sulphate (AS), and calcium ammonium nitrate (CAN) as nitrogen sources relative to no nitrogen top dress. In addition, it investigates the economics of using grass straw organic mulch relative to black polythene, transparent polythene and no mulch systems for fresh market greenhouse grown cucumber.

MATERIALS AND METHODS

Investigations to study the performance of cucumber under different nitrogen sources and mulching materials were carried out at Egerton University, Department of Horticulture research and demonstration field in two seasons. The first trial was conducted from August to November 2003 and the second from November 2003 to February 2004. The field is located approximately at latitude 0°23’ South, longitude 35° 35’ East and at an elevation of 2238 meters above sea level. Soils at the site are vintric mollic andosols, had a pH of 5.9 and 6.0 and total nitrogen of 4.7 Kg/ha and 3.8 Kg/ha in trials 1 and 2 respectively. Temperatures in the field were 19-22ºC (maximum) and 5-8ºC (minimum) while greenhouse temperatures were 26-35ºC (maximum) and 11-14ºC (minimum). The site had been previously used for greenhouse grown vegetables.

The treatments were four nitrogen sources namely urea, calcium ammonium nitrate (CAN), potassium nitrate (KNO_3), and ammonium sulphate (AS) and three mulching materials namely black polyethylene (BP) and transparent polyethylene (TP) both made of thin (0.0025mm) linear, low density photodegradable material, and couch grass straw mulch (S). Grass straw mulch was applied at 10t/ha (Dry weight) to give a 5 cm thick mat. The reflectance, transmittance and absorptance of the polyethylene mulches were 0.03, 0.01 and 0.96 respectively for black polyethylene and

0.11, 0.84 and 0.05 respectively for transparent polyethylene. All the fertiliser nitrogen was applied at one rate of 75kgN/ha, as recommended by the Ministry of Agriculture, Kenya. Cucumber 'Ashley' was used, as it is a widely grown, exported and locally consumed variety.

The experimental design in both seasons was a split-plot embedded in a randomised complete block design with three replications. The main plot factors were nitrogen sources (CAN, Urea, KNO_3, AS) with no nitrogen (NN) as the control, while mulching materials (BP, TP, G and No mulch) formed the subplot treatments so as to increase precision in estimating effect of mulch. There were 15 main plots while subplots were 60 with measurements of 10.7 m x 0.9 m for main plots and 2.3 m x 0.9 m for sub plots. The entire experimental set up covered 460 m^2 in a 480m^2 greenhouse.

Economic Analysis

Cost benefit analysis [(yield x price) - other variable costs - cost of factor (nitrogen and/or mulch)] (Abbot and Makeham, 1979) was done to determine the relative profitability of using different nitrogen sources and mulching materials. The cucumber yields used in the analysis were the yields of experimental plots. However, because they are typically at the high end of the yields realised by farmers, the results were subjected to sensitivity analysis for expected, optimistic and pessimistic yield scenarios. Experimental yields are considered optimistic. A more realistic or expected yield level would be 80% of the optimistic yield while a pessimistic or poor yield would be 60% of the optimistic (Kelly et al., 1995). Thus to arrive at the expected and pessimistic yields, the yields from the experimental plots were multiplied by 0.8 and 0.6 respectively for the sensitivity analysis. Kenyan average cucumber yields are considerably lower than these but reflect a preponderance of less intensively managed systems.

Gross returns were calculated by matching the actual total yield with the appropriate average cucumber market price for each trial. The prices of cucumber used in this analysis were the seasonal wholesale averages at the Nakuru municipal market in Nakuru and Wakulima market in Nairobi, Kenya. These prices were Ksh 13.00 and Ksh 8.00 (Based on the exchange rate of Ksh 75.00 to 1US dollar) in trials 1 and 2 respectively.

Production costs for greenhouse cucumber were derived from vegetable crop budgets from the Department of Horticulture vegetable production unit, Egerton University. Field operations and amounts of chemical inputs reflect actual operations at the experimental site. The general agricultural production costs did not vary between the trials hence did not require adjustment (Tables 1 and 2). However, harvest and marketing costs changed with varying yield levels and were thus adjusted accordingly. Land rent, management and depreciation on structures were not included since they were the same for all the treatments.

RESULTS

Table 3 shows that cucumbers grown with urea in trial 1 outperformed those under other nitrogen sources and no nitrogen topdressing even though the yields were not statistically different. In trial 2, potassium nitrate gave the highest yield that was however statistically similar to the yields from the other nitrogen fertiliser treatments (Table 4).

When these yields are converted to returns, partial budget analysis reveals that in trial 1 urea was the most profitable nitrogen source to apply under optimistic, expected and pessimistic yield scenarios. In trial 2, potassium nitrate was the more profitable alternative. The higher relative profitability of urea and potassium nitrate in trials 1 and 2 respectively was mainly due to the higher yields since the cost of production between the nitrogen sources did not vary greatly to explain the profitability. In addition, there was no relative advantage of early yields under any nitrogen fertiliser treatment in both trials. Furthermore, cucumber market prices were relatively uniform within each trial.

Cucumber grown under no mulch in trial 1 was the least profitable while transparent polyethylene mulching was the most profitable way of producing greenhouse cucumber followed by straw then black polyethylene mulch. Though production costs for when using black and transparent polyethylene mulch were similar, transparent polyethylene gave higher yields that translated to the high relative profitability. The profitability of straw mulch may be attributed to its lower cost of procurement and lack of disposal costs. By the end of the study, straw had degraded enough to warrant no need for disposal but incorporation into the soil.

In trial 2, the scenario was different with straw giving the highest relative profitability followed by black polyethylene, no mulch and least under transparent polyethylene mulch. Since higher returns could be achieved without using any mulch than when transparent polyethylene is used, it implies that the extra cost of purchasing, installation and disposal of transparent polyethylene in trial 2 was not necessary. The high relative profitability of using straw mulch in this trial despite the lower prices is attributed to the high yields under straw that though not statistically different from the yields from other mulches, translated to higher returns which is the ultimate goal of production.

DISCUSSION

Profitability of local vegetable production is increasingly important if producers are to remain in business. There is a growing need for highly profitable production methods in order to maximise returns to investment (Upton, 1987).

In this study, returns to land, structures and management from using the different nitrogen sources was inconsistent over the two trials with urea and potassium nitrate giving higher relative profitability in trials 1 and 2 respectively. The return from using CAN, the most commonly used nitrogen topdressing fertiliser in vegetable production was lower in both trials. The relative profitability advantage of using urea or potassium nitrate is due to the generally high yields accruing from their use in trials 1 and 2 respectively. Since the relative importance of this reason varied with the trials, it may require more trials and analyses to understand the strength of this factor more clearly.

Returns from mulching also varied between the trials with relative profitability of transparent polyethylene mulch being the highest in trial 1 and lowest in trial 2. In trial 2, use of straw was the most profitable method of mulching. The variations in profitability between the trials can be attributed to the variation in yield that occurred as a result of differences in weather at the time when the two trials were undertaken. The high yields from transparent polyethylene mulch in trial 1 and straw mulch in trial 2 led to their respective profitability. Black polyethylene gave modest returns in both trials indicating that it can be used in all seasons in case there is lack of either transparent polyethylene or straw.

In addition to the direct economic advantages of using straw mulch, used straw can be incorporated into the soil at the end of the cropping season. This means that soil amelioration can be achieved through use of straw and thus reduce the need for added inorganic fertiliser by a succeeding crop planted in the same field. Straw mulching may also eliminate the need for using polyethylene mulch, which apart from being expensive is a problem to dispose.

The combination of economic as well as possible environmental benefits to the farmer makes use of grass straw mulch in the greenhouse an attractive option for the production of greenhouse cucumbers in the Kenyan highlands especially during hot periods of weather. Straw can also be used in cold periods with exceptionally good results.

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Tab. 1. : Production costs for 1 ha of cucumber when using different nitrogen sources under the expected yield scenario in trial 1.

	CAN	SA	NN	KNO_3	Urea
Bed preparation	10000	10000	10000	10000	10000
Transparent mulch	15000	15000	15000	15000	15000
Labour for laying mulch	6000	6000	6000	6000	6000
Seedlings	48500	48500	48500	48500	48500
Fertilisers					
T.S.P	7000	7000	7000	7000	7000
Nitrogen fertiliser	7000	9000		10000	3500
Planting labour	12000	12000	12000	12000	12000
Pesticides	10000	10000	10000	10000	10000
Spraying labour	6000	6000	6000	6000	6000
Staking					
Stakes–700	28000	28000	28000	28000	28000
Twine–120kg	9200	9200	9200	9200	9200
Wire	10000	10000	10000	10000	10000
Staking labour	15000	15000	15000	15000	15000
Harvesting	4380	4640	4690	4170	5360
Post harvest	3000	3000	3000	3000	3000
Marketing	19115	18566	18752	16665	21450
Mulch disposal	5000	5000	5000	5000	5000
Total production costs	**215195**	**216906**	**208142**	**205535**	**215010**

Tab. 2. : Production costs for 1 ha of cucumber when using different mulches under the expected yield scenario in trial 1.

	Black	Clear	Straw	**No mulch**
Bed preparation	10000	10000	10000	10000
Transparent mulch	17000	15000	5000	
Labour for laying mulch	6000	6000	6000	
Seedlings	48500	48500	48500	48500
Fertilisers				
T.S.P	7000	7000	7000	7000
CAN	7000	7000	7000	7000
Planting labour	12000	12000	12000	12000
Pesticides	10000	10000	10000	10000
Spraying labour	6000	6000	6000	6000
Staking				
Stakes – 700	28000	28000	28000	28000
Twine – 120kg	9200	9200	9200	9200
Wire	10000	10000	10000	10000
Staking labour	15000	15000	15000	15000
Harvesting	4740	5320	5010	3550
Post harvest	3000	3000	3000	3000
Marketing	18968	21271	20019	14201
Mulch disposal	5000	5000		
Total production costs	**214408**	**217791**	**203229**	**183451**

Tab. 3.: Returns to Management, Land and Structures in trial 1 (Ksh)

	Nitrogen sources						Mulch types		
	CAN	SA	NN	KNO_3	UREA	BP	CP	S	NM
				Optimistic yields (Experimental plots)					
Yields (kg/ha)	54734	58019	58599	52077	6753	59275a*	66473a	62560a	44378b
Gross returns	711542	754247	761787	677001	871698	770575	864149	813280	576914
Production costs	219370	219370	222700	213960	210710	223330	224450	209460	187940
Returns	**492172**	**531547**	**547827**	**466291**	**649947**	**547545**	**639699**	**603820**	**388974**
				Expected yields (80% of experimental plots)					
Yields (kg/ha)	43787	46415	46879	41662	53624	47420	53178	50048	35502
Gross returns	568231	603395	609427	541606	697112	616460	691314	650624	461526
Production costs	215195	216906	208142	205535	215010	217408	217791	203229	183451
Returns	**354036**	**386489**	**401285**	**336071**	**482102**	**399052**	**473523**	**447395**	**278075**
				Pessimistic yields (60% of experimental plots)					
Yields (kg/ha)	32840	34811	35159	31246	40232	35565	39884	37536	26627
Gross returns	426920	452543	457067	406588	523016	462345	518492	487968	346148
Production costs	208116	211104	202284	200329	208313	211486	211144	196964	179011
Returns	**218804**	**241439**	**257783**	**206259**	**314703**	**250859**	**307348**	**291004**	**167137**

*Means followed by the same letter are not significantly different according to DMRT

Tab. 4.: Returns to management, land and structure in the production of cucumber under green house production

	Nitrogen sources					Mulch types			
	CAN	SA	NN	KNO3	UREA	BP	CP	S	NM
	Optimistic yields (Experimental plots)								
Yields (kg/ha)	120531	125604	127923	138357	125411	129952	118213	136425	126667
Gross returns	964248	1004832	1023384	1106856	1003288	1039616	945704	1091400	1013336
Production costs	256950	261460	253690	258840	255940	263700	255820	251940	234070
Returns	707298	743372	769694	848016	747348	775916	689884	839460	779266
	Expected yields (80% of experimental plots)								
Yields (kg/ha)	96425	100483	102338	110686	100329	103962	94570	109140	101334
Gross returns	771400	803864	818704	885488	802632	831696	756560	873120	810672
Production costs	244910	248943	240865	245044	243360	250685	243988	238266	221367
Returns	526490	554921	577839	640444	559272	581011	512572	634854	589305
	Pessimistic yields (60% of experimental plots)								
Yields (kg/ha)	72319	75362	76754	83014	75247	77971	70928	81855	76000
Gross returns	578552	602896	614032	664112	601976	623768	56742	654840	608800
Production costs	232830	236340	228080	231200	213200	230828	23770	232190	224590