EFFECTS OF DIFFERENT FERTILIZERS ON ROOT YIELD, ROOT NUMBER PER PLANT AND TOP/ROOT WEIGHT RATIO OF CASSAVA IN TWO CROPPING SYSTEMS IN SIERRA LEONE

W. Godfrey-Sam-Aggrey*

SUMMARY

In two cropping systems carried out on gravelly oxisols in Sierra Leone in which cassava follows cassava and pineapple respectively, the yield responses and financial returns from the use of various fertilizer treatments have been studied. Data indicate that farmers who cannot obtain, or do not know how to use fertilizers, may be right to close their rotation with the cassava crop. However, with a suitable fertilizer application, yields can be sustained in a second crop of cassava. With the prices prevailing at the time of these experiments, the use of fertilizer would be financially advantageous.

RESUME

A partir de deux systémes de culture menés sur oxisols de gravier sur lesquels deux cultures de manioc consécutives ont été suivies d'une culture d'ananas, les rendements et les bénéfices obtenus à l'issue de l'utilisation de divers traitements ont été exposés. Les résultats obtenus indiquent que les fermiers qui ne peuvent pas obtenir ou qui ne savent pas utiliser les engrais ont peut-étre raison de terminer leur rotation avec le manioc. Toutefois, 1'application adéquate d'engrais peut permettre d'obtenir des rendements de manioc en seconde culture. Eu égard aux prix en cours au moment de ces essais, l'utilisation d'engrais pourrait 'etre financièrement bénéfique.

RESUMEN

Se ha estudiado el rendimiento de yuca y las tazas de retorno correspondientes usando varios fertilizantes en dos sistemas de cultivo llevados a cabo en oxisoles gravosos en Sierra Leona; en uno, yuca sigue a yuca y en otro yuca sigue a piña. Los datos indican que los agricultores que no pueden obtener o no saben como usar fertilizantes pueden estar en lo cierto cerrando su rotación con yuca. Sin embargo, con una aplicación adecuada de fertilizantes, los rendimientos se pueden mantener en una segunda cosecha de yuca. Con los precios que prevalecían cuando se hizo este experimento sería ventajoso, financieramente usar fertilizantes.

INTRODUCTION

In four experiments at Kenema and in nine of thirteen other trials, marked responses were observed to superphosphate and sulphate of potash, both singly and in combination[1,2]. The trials however were confined to 'micro' plots, and it was pointed out that the results should be treated with reserve. In the four other trials in the Magburaka area, responses did not reach statistical significance. Sulphate of ammonia depressed yields at all sites whilst liming had no apparent effect. In a trial at Newton, applying single superphosphate and sulphate of potash singly and in combination, sulphate of potash applied alone gave the highest yield of 14.2 tonnes per ha.[3]

MATERIALS AND METHODS

Experiment 1

The experimental design was a 2^5 confounded factorial, consisting of 32 plots, each measuring 6 x 10.8 m. Fertilizer rates, applied singly or in combination consisted of the following: 591 kg/ha sulphate of ammonia, 578 kg/ha basic slag, 1217 kg/ha sulphate of potash, 240 kg/ha lime flour and 71 kg/ha sulphate of magnesium and zero rates of each fertilizer. The respective elements actually applied per hectare were as follows: 159 kg N*, 153 kg P, 546 kg K*, 172 kg Ca and 18 kg Mg*.

*Department of Agronomy, Njala University College, University of Sierra Leone, Njala, Sierra Leone.

*Together with S from sulphate not mentioned by the author. Ed.

Experiment 2

The experimental design was a randomized complete block with five treatments and 5 replications, each plot measuring 6 x 10.8 m. Nijholt's[9] cassava nutrient removal figures were used as the basis for the treatments. Only N, P, and K were varied in three of the treatments and then compared with the corresponding equivalent of Nijholt's removal figures and a no-fertilizer treatment. In all the treatments Ca and Mg were kept constant. The treatments were as follows:

1. Control (no fertilizer)
2. 159 – 153 – 546 – 172 – 18 kg N:P:K:Ca:Mg/ha
3. 318 – 153 – 546 – 172 – 18 kg N:P:K:Ca:Mg/ha
4. 159 – 306 – 546 – 172 – 18 kg N:P:K:Ca:Mg/ha
5. 159 – 153–1092 – 172 – 18 kg N:P:K:Ca:Mg/ha

N, P, K, Ca and Mg used were in the form of sulphate of ammonia, basic slag, sulphate of potash, lime flour and sulphate of magnesium respectively. The respective elements found in the treatment mixtures per hectare corresponded with those cited for Experiment 1 above.

Soils, cropping history and agronomy

The experiments were conducted on Njala upland soils which are well drained, gravelly oxisols (ferrallitic soils) that are strongly acid (pH 4 – 4.8), highly weathered, low in available plant nutrients and low in natural agricultural productivity[1]. Similar soils occur extensively in other tropical and sub-tropical areas.

Experiment 1

The land was covered by secondary bush which was cleared, but not burnt, ploughed and harrowed. Pineapples, cv. 'Smooth Cayenne' had been planted on the flat for two years previously without any use of fertilizer. The pineapples were removed and the land prepared immediately for planting cassava on May 1, 1970.

Soil analysis figures obtained from composite core soil sampling at 10 cm deep were as follows: pH, 4.6: % carbon, 1.99: % N, 0.29: available P, ppm., 88: % K, 0.014: % Ca, 0.034: % Mg, 0.050.

Experiment 2

The land was covered with secondary bush which was cleared but not burnt, then maize followed by cassava were planted in succession without fertilization. The cassava was harvested 10 months after planting and the land prepared immediately for planting cassava again on May 4, 1970.

Soil analysis figures obtained from composite core soil sampling at 10 cm deep were as follows: pH, 4.5: % carbon, 2.07: % N, 0.35: available P, ppm, 132: % K, 0.014: % Ca, 0.029: % Mg, 0.028. Twelve-month old basal (0-60 cm) and midstem (60-120 cm) cassava cuttings 30 cm long were prepared and 22.5 cm buried, inclined in ridges 30 cm high and 120 cm apart. The setts were planted 120 cm apart in ridges, and each type of cutting was planted in a separate experiment. 'Cocoa' the cultivar used, is a popular type in West Africa; it is sweet, with pink-skinned roots and 2-3 forks.

Fertilizers were applied in four split applications 1, 2, 3 and 5 months after planting, the first and second applications corresponding to one-sixtieth of the total amount and the third and fourth to one-third of the total amount to be applied. P and Ca were applied a week before each application of N-K-Mg mixture. The fertilizers were applied in a ring 15 cm wide and covered immediately after application. The width of the ring was increased by 5 cm during the subsequent applications, the final ring being 30 cm from the plants. Weeding was done as often as it was necessary and always just before fertilizer applications.

Data recording

Roots were harvested at 8 and 14 months. Average root number per plant and top/root weight ratio were recorded at 14 months for both experiments.

Economics of production

Value/cost ratios were computed for all treatments and their corresponding root yields*, assessing the value of one tonne fresh cassava roots at le.22.05 (£ stg. 11.03) and taking the subsidized cost per kg. of

*But these are being presented only for statistically significant effects

fertilizers as follows:

Sulphate of ammonia	4 Sierra Leone cents
Basic slag	3 " " "
Sulphate of potash	5 " " "
Lime flour	2 " " "
Sulphate of magnesium	3 " " "

Value/cost ratio was obtained by dividing the value of increased crop by the cost of the fertilizers used.

RESULTS

Root yields

Experiment 1: results obtained using basal cuttings (Table 1).

NKCa was the only significant treatment at P = 0.05 at 8 months, with a mean response of 237 percent. All single nutrients and their respective combinations increased yields (non-significant). At 14 months however none of the treatments showed any significant effect on root yields (Table 2).

Experiment 1: results obtained using midstem cuttings

None of the treatments showed any significant increase in root yields at 8 or 14 months.

Experiment 2: results obtained using basal cuttings (Table 3)

Treatments 2 and 4 gave highly significant effects (at P = 0.01) whilst treatments 3 and 5 showed effect on root yields significant at P = 0.05 at 8 months. Only treatments 2 and 4 gave profitable returns at 8 months. At 14 months, treatments 2, 3 and 4 showed highly significant effects on root yields (at P = 0.01) and gave profitable returns.

Experiment 2: results obtained using midstem cuttings

Treatments 2, 3 and 4 gave significant increases in yield (at P = 0.01), but treatment 5 was significant at only P = 0.05 at 8 months. However, none of the treatments gave profitable returns at 8 months. At 14 months, treatments 2, 3, 4 and 5 gave highly significant yield responses (at P = 0.01). They all gave profitable returns, especially treatment 2 (Table 3).

DISCUSSION

Most nutrient removal figures for and fertilizer trials with cassava emphasize the importance of N P K mixtures to produce high root yields[4,8,10]. Nijholt's nutrient removal figures[9] included the calcium and magnesium requirements. In the cropping system described, in which two years of unfertilized pineapples were followed by cassava, it was worth using fertilizers. Effective fertilizers were NKCa and PKCa combinations for 8 and 14 months harvest dates respectively. However, the most profitable returns can be obtained if it is deficient, by the use of Mg.

West African peasant farmers normally consider cassava as the last crop before allowing their land to go back to 'bush'. They would not normally plant cassava followed by cassava except when they are in commercial production. The implication of the results from Experiment 2 is that farmers can use the recommended fertilizers to obtain economic cassava root yields, even when unfertilized cassava is followed by fertilized cassava. The practice of West African farmers of allowing their land to go back to 'bush' after cassava because of low fertility appears logical if no fertilizer is to be applied to the second crop, but sustained yields can be obtained, at least for a second successive crop, with appropriate fertilizer use which moreover will be profitable.

ACKNOWLEDGEMENT

I wish to thank Mr. H. S. Bundu, Farm Demonstrator, Department of Agronomy, Njala University College for helping with the collection of the data.

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TABLE 1

Effect of fertilizers on cassava root yield from basal cuttings, and corresponding value/cost ratios at 8 months

Treatment per ha		Yield tonnes/ha	Effect
0		8.04	19.71 Mean
159	kg N	22.35	+2.41
153	" P	18.58	+1.46
546	" K	20.84	+0.48
172	" Ca	14.82	+1.96
153-546-172	" N:K:Ca	27.12	+3.16*
18	" Mg	18.58	+0.85
	Mean	19.71	
	s.e.		±1.35
	*P = 0.05		2.94
	**P = 0.01		4.09

TABLE 2

Fertilizer effects on cassava root yields from basal cuttings, and corresponding value/cost ratios at 14 months

Treatment per ha		Yield tonnes/ha	Effect	Value/cost ratio
0		18.83	29.23	0
159	kg N	35.14	-1.51	14.72
153	" P	32.88	+3.44	18.16
546	" K	33.89	+3.84	5.54
172	" Ca	20.83	-0.83	7.66
153-546-172	" PKCa	44.95	-0.40	6.96
18	" Mg	33.89	-1.20	158.03
	Mean	29.23		
	s.e.		±2.64	
	*P = 0.05		5.70	
	**P = 0.01		7.93	

TABLE 3

Effect of fertilizer on average cassava root yields (tonnes/ha) and corresponding value/cost ratios

	* Treatment per ha			8 month harvest				14 month harvest			
				Yield		Value/cost ratio		Yield		Value/cost ratio	
	N	P	K	Basal	Midstem	Basal	Midstem	Basal	Midstem	Basal	Midstem
1.	0	0	0	6.98	9.09	0	0	17.33	16.32	0	0
2.	159	153	546	14.31**	14.01**	1.48	0.99	26.62**	29.33**	1.88	2.63
3.	318	153	546	11.70**	14.82**	0.78	0.95	26.11**	27.17**	1.45	1.79
4.	159	306	546	13.96**	14.56**	1.22	0.95	30.03**	25.91**	2.22	1.67
5.	159	153	1092	12.45*	12.96*	0.53	0.37	21.85	28.78**	-	1.20
	Mean			11.88	13.08			24.39	25.51		
	*P = 0.05			4.24	3.31			6.30	4.97		
	**P = 0.01			5.83	4.57			8.69	6.36		

* All the respective treatments excepting the control (no fertilizer) were supplied with constant amounts of 172 kg Ca and 18 kg Mg per ha.