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RESEARCH NOTE: 2

EVALUATION OF OPTIMUM POPULATION AND BIOLOGICAL EFFICIENCY OF SWEET POTATO IN SWEET POTATO/MAIZE INTERCROPPING SYSTEM

BY

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ABSTRACT

Field experiments were conducted during the 1996 and 1997 cropping seasons at the National Root Crops Research Institute Umudike, to investigate the Productivity of sweet potato inter cropping system. Results showed that growing sweet potato with maize reduced the yield of sweet potato. TIS 8164 out yielded TIS 87/0087 and TIS 2498; while TIS 87/0087 out yielded TIS 2498. The difference shows significant effects. Plant population also showed significant difference with 30,000/ha out yielding the 20,000/ha and 10,000/ha while 20,000 also out yielded 10,000/ha. When the biological efficiency of the mixture (Sweet potato + Maize) were tested using either total Energy (Kal/ha) and Land Equivalent Ratio (LER), the indications showed that it uses true profitable to give sweet potato mixed with maize then giving sweet potato sole mixture LERs ranged from 1.76 to 2.06.

INTRODUCTION

It is generally recognized that increased food production in the tropics will involve replacing shifting cultivation with more intensive land use (Akobundu, 1987). Thus in the tropics where over 70% of the population are farmers who are constrained to operate on small land holdings (less than 5ha), multiple cropping is the common practice. Crop mixtures have been described as more stable dynamic biological systems that withstand natural hazards than sole crops (Casewell and Rahaja, 1972; Hayward, 1975). In the heavy rainfall regions of the tropics where

excessive leaching can pose serious agricultural problems, multiple cropping with its quicker, greater and longer crop cover, aids in erosion control. It also improves soil water penetration and retention, reduces surface run-off and leaching losses (ICRTISAT, 1974; Okorie and Chinaka 1985).

Although multiple cropping is very extensive practiced in Nigeria, there are cases where certain crops are grown sole. Farmers usually grow sweet potato on headlands and compound farms as a sole crop. Although in some situations, the crop is seen grown with maize in mixture. In such situations, the plant populations of both crops and the crop geometry are not standard for optimum performance and yield (Chinaka, 1998). Growing sweet potato mixed with maize appears agronomically very sound and stable. The concept appears dynamic because maize is a fast growing and short duration crop (3-4 months), just like sweet potato. Furthermore, maize which is a C-4 plant and an erectophyle will combine very well with minimal competition with sweet potato which is a C-3 plant and a planophyle. Since both crops are day neutral, the mixture combining them can be recycled at least twice a year (Chinaka, 1998).

It has earlier been reported that the practice of inter cropping makes the collection of information on individual crops and the aggregation of total output difficult. (Mijindadi, 1980). This often poses the problem of looking for a "common denominator", money index has been found to be highly deficient in the aggregation of farm outputs in the production function analysis of crop mixtures (Ugwu, 1990). This is also because farmers pursue other objectives such as socio-cultural and food security goals, rather than just profit maximization; and the fact that money is affected by the issue of sharp fluctuation in prices. Consequently, indices like calorific values and Land Equivalent Ratios become advantageous common denominators (Ugwu, 1990).

The study reported was undertaken to determine the optimum population of sweet potato in a sweet potato/maize intercrop system for maximum biological efficiency.

MATERIALS AND METHODS

The experiments, were conducted at the National Root Crops Research Institute (NRCRI) Umudike during the 1996 and 21997 cropping seasons. Land preparation in the two years of trial was done by the conventional tillage method with the aid of tractor mounted implements. In each year, the

field was cleared, ploughed; harrowed and left for about one week to allow weed seeds to germinate. Subsequently, the plots were re-harrowed before ridging Ridges (1 meter apart) were made.

The planting materials used were: three morphologically different sweet potato varieties – TIS 2498 (spreading type); TIS 87/0087 (intermediate type); TIS 8164 (erect type) and the maize variety; TZSR-Y. the experimental design was Randomized Complete Block Design (RCBD) in a split-split plot arrangement.

Factor 'A' (Main plot) was cropping system at 2 levels: Sweet potato sole (M_0) and sweet potato + maize (M_1)

Factor 'B' (Sub plot) was sweet potao variety at 3 levels: V_1 (TIS 2498): V_2 (TIS 87/0087); V_3 (TIS 8164).

Factor 'C' (Sub-sub plot) was sweet potato population at 3 levels; maize was planted at 50cm x 100cm at 3 seeds per hole and later (2 WAP) thinned to 2 stands per hole to give a population of 40, 000/ha.

The cropping pattern was row inter cropping. Sweet potato was planted at the crest of the ridges and maize planted 2/3 down the ridge from the top on one side of the ridge.

In both years, all the plots were weeded only once at 4 weeks after planting (WAP). In all the trials, compound fertilizer, NPK 15:15:15 was applied at the rate of 400kg/ha in bands between crop rows at 5 WAP.

The indices used for evaluating inter cropping advantages were Land Equivalent Ratio (LER) and Energy yield.

(a) LER = $\frac{\text{(Yield of inter cropped sweet potato)}Y_1}{\text{(Yield sole maize)}Y_2} + \frac{\text{(Yield inter cropped Maize)}Y_2}{\text{(Yield of sole sweet potato)}Y_1}$

..... (Adetiloye, et al 1983.)

b. Energy Yield (1 x 104 K caals/ha).

In calculating the Land Equivalent Ratin (LER) it was necessary to convert the tuber yields (t/ha) of sweet potato and maize to the same unit for proper comparison. Thes were converted to kilo calories per hectare (K cals/ha) using 391.06 calories/100gm for sweet potato and 409.65calories/100gm for yellow maize (Oyenuga, 1968)

RESULTS AND DISCUSSIONS

Yield of Tubers:

Tables 1-3 show theyield of sweet potato tubers as affected by cropping system, sweet potato varieties and sweet potato plant population.

Table 1. Effect of Cropping System On Sweet Potato Tuber Yield

		Tuber Yield (T/Ha)	
Cropping System		1996	1997
Sole Sweet Potato		12.13	12.59
Sweet Potato/maize		10.87	10.87
	0.05	NS	0.16
FLSD			
	0.01	NS	0,38

Table 1 shows that irrespective of sweet potato varieties and plant populations sweet potato had higher tuber yields in both years under sole cropping. Although the higher yield observed under sole sweet potato in 1996 was not significantly affected by cropping system in 1997 cropping system significantly affected tuber yield. This observation agrees with earlier reports which stated that crops gave higher yields when grown sole than when mixed (Okigbo, 1978; Andrews, 1975 and Lepiz, 1971). The effects of the three sweet potato morphotypes representing the three broad groups of sweet potato – the spreading type (TIS 8164) in tuber yield are given in Table 2.

Table 2. Effect of Sweet Potato Varieties on Tuber Yield

Sweet Potato		Tuber Yield (T/Ha)	
Varieties	Types	1996	1997
TIS 2498	Spreading	5.20	4.14
TIS 87/0087	Intermediate	11.69	13.18
TIS8164	Erect	17.59	17.76
0.05		2.46	0.53
FLSD			
0.01		3.58	0.77

Highly significant yield difference were rendered for both years with TIS 8164 being superior to both 87/0087 and 2498 and 87/0087 significantly out yielding 2498. The superiority of TIS 8164 over 87/0087 and 2498 confirms the earlier reports Ene and Chinaka (1979), and Agbo, (1992).

Table 3 shows that plant population very highly significantly affected sweet potato tuber yield irrespective of sweet potato varieties. As the population decreased from 20,000 stand/ha there was a decrease in yield of tubers of 2.73 t/ha in 1996 and 2.52 t/ha in 1997. Similarly, as

population decreased from 20,000/ha to 10,000/ha, there was a very sharp drop in later yield of 4.66 t/ha in 1996 and 6.10 t/ha in 1997. These observations conform with earlier reports showing that low plant densities tended to leave large areas of soil surface exposed and so favored weed establishment and soil erosion. thus resulting in decreased yields (Langemann, 1977).

Table 3. Effect of Sweet Potato Population on Tuber Yield

	Tuber Yield (T/Ha)	
Population/Ha	1996	1997
30,000	14.87	15.41
20,000	12.14	12.89
10,000	7.48	6.77
0.05	0.74	0.89
FLSD		
0.01	1.01	1.20

Calorific Equivalents (1 x 104 Kcals/Ha)

Table 4 shows the calorific equivalents (1x14K cals) obtained from inter cropping systems involving three sweet potato varieties grown under three population regimes with a fixed population of maize and their corresponding sole components. It would have been expected that higher total calorific values be obtained from mixed crop yields over their corresponding sole crop yields; but this was not always true especially in situations where some sweet potato varieties like TIS 8164 and 87/0087 showed very superior sole crop yields. Realizing however that the small-holder Nigerian farmer according to Ugwu (1990) and Mijindadi (1980) pursues other objectives such as socio-cultural values and food security, the issue of using aggregate (total) calorific yields in judging the superiority of a system over the other becomes of secondary importance. However, total calorific values still remains a very valid tool for aggregating the total yield of different crops in a mixed crop system.

Table 4. Calorific Equivalents (1x104Kcals/Ha) Obtained from the different crop combinations

			Calorific Values						
	Sweet Potato		Sweet Potato		Maize grain		Total (S. Potato + Maize)		
Cropping system	Var.	Pop./Ha.	1996	1997	1996	1997	1996	1997	Mean
S. Potato Sole	TIS 2498	30,000	2.80	2.31	-	-	2.80	2.31	2.51
.....	,,	20,000	2.31	1.96	-	-	2.31	1.96	2.14
.....	,,	10,000	1.54	1.18	-	-	1.54	1.18	1.36
.....	TIS 87/0087	30,000	6.25	6.80	-	-	6.25	6.80	6.53
.....	..	20,000	4.61	6.43	-	-	4.61	6.43	5.52
.....	..	10,000	3.31	3.02	-	-	3.31	3.02	3.17
.....	TIS 8164	30,000	9.50	10.30	-	-	9.50	10.30	9.40
.....	..	20,000	7.55	7.66	-	-	7.55	7.66	7.61
.....	..	10,000	4.78	4.60	-	-	4.78	4.60	4.69
S. Potato+Maize	TIS 2498	30,000	2.49	1.82	0.41	0.42	2.90	2.24	2.57
.....	,,	20,000	1.89	1.52	0.45	0.42	2.34	1.94	2.14
.....	,,	10,000	1.17	0.91	0.45	0.42	1.62	1.36	1.41
.....	TIS 87/0087	30,000	5.44	6.58	0.04	O.41	5.84	6.98	6.41
.....	,,	20,000	4.88	5.51	0.45	0.37	5.33	5.88	5.61
.....	,,	10,000	2.93	2.54	0.37	0.45	3.30	2.02	3.16
.....	TIS 8164	30,000	8.37	8.31	0.41	0.41	8.78	8.72	8.75
.....	..	20,000	7.23	7.14	0.41	0.45	7.64	7.59	7.62
.....	,,	10,000	3.80	3.63	0.45	0.41	4.23	4.04	4.14
Sole Maize	-	40,000	-	-	0.45	0.41	0.45	0.41	0.43

Land Equivalent Ratio (LER):

Table 5 shows the LER obtained from the different crop combinations in the two trials (1996 & 1997). In 1996, the LER of the mixed crops ranged from as high as 2.06 to 1.71, while in 1997, the LER ranged from 2.03 to 1.76. These mixture LERs were all above 1.00 obtainable from sole cropping (Adetiloye et al, 1983) and which obtained from the sole crops in the two years of trial. The superior LERs obtained by inter cropping made the mixtures more productive. These observations agreed with the earlier reports of Pinchinat *et al* (1976) who had recommended that crop mixtures that produce LERs between 1.63-1.87 should be adopted as very viable crop combinations. All the mixture LERs (Table 5) in the years of trial ranged from 1.71-2.03; and therefore fall within the range of LERs recommended by Pinchinat *et al* (1976). Thus, the crop combination (Sweet Potato + Maize) under the conditions tried in the two years is justified as being biologically dynamic and economically feasible, and is therefore recommended as a viable agronomic cropping system.

Table 5. Land Equivalent Ratio (LER) obtained from the different crop combination.

Cropping System	Sweet Potato Variety	Pop./Ha.	Land Equivalent Ratio (LER) 1996	1997	Mean
Sweet Potato Sole	TIS 2498	30,000	1.00	1.00	1.00
.....	,,	20,000	1.00	1.00	1.00
.....	,,	10,000	1.00	1.00	1.00
.....	TIS 87/0087	30,000	1.00	1.00	1.00
.....	,,	20,000	1.00	1.00	1.00
.....	,,	10,000	1.00	1.00	1.00
.....	TIS 8164	30,000	1.00	1.00	1.00
.....	,,	20,000	1.00	1.00	1.00
.....	,,	10,000	1.00	1.00	1.00
Sweet Potato + Maize	TIS 2498	30,000	1.80	1.81	1.81
.....	,,	20,000	1.82	1.80	1.81
.....	,,	10,000	1.76	1.87	1.82
.....	TIS 87/0087	30,000	2.76	1.97	1.87
.....	,,	20,000	2.06	1.97	2.02
.....	,,	10,000	1.71	1.95	1.83
.....	TIS 8164	30,000	1.79	1.81	1.8
.....	,,	20,000	1.87	2.03	1.95
.....	,,	10,000	1.79	1.79	1.79
Sole Maize	-	40,000	1.00	1.00	1.00

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