GROWTH, YIELD AND LAND USE EFFICIENCY OF INTERCROPPED CASSAVA AND MAIZE[1]

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ABSTRACT

Although intercropping of cassava and maize is highly compatible and give system yield advantages, cases of cassava yield reduction suspected to be caused by shedding by maize have been reported. We studied cassava and maize intercrop in an Alfisol (Oxic Paleustalf) in Southern Nigeria using different maize varieties and found that the optimum maize population giving the highest cassava and maize yields based on relative yield and land equivalent ratios varied with maize variety. Short duration ($\pm$ 95 days) maize required higher maize population for highest grain yield (up to 32,000/acre) than late maturing (120-day) types. With three of the maize varieties (TZPB, TZSRW and new modified br2), cassava root yield from the intercrop system decreased with increased population of associated maize beyond 16,000/acre. Cassava root yield obtained in the intercrop system with the other maize varieties were either not effected [Ferke (1)7635, Poza Rica 7729] or increased (Kewesoke, Population 49 and TZESRW). Early maize maturity, short stature and sparse leaf characteristics seem to give high intercrop cassava yields. The land use efficiency measured by relative yields increased with increasing maize population.

Planting cassava and maize in the same row, in interrow and in alternate row arrangements had no significant effect on maize grain nor on cassava root yields, the earliness of maize maturity notwithstanding. Due to a compensatory relationship in the yields of cassava and maize under

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intercropping systems, the choice of an appropriate maize variety and maize population in cassava and maize intercrop system will depend on the relative importance to a farmer of the two crops. A farmer also has choice of a range of row planting arrangements in cassava and maize intercropping system without adversely affecting crop yields.

Key Words and Phrases: Bivariate analysis, Compensatory relationships, Intercrops, Maize and cassava system, Land use efficiency, Monocrops, Populations, Row arrangement, Transition zone, Tropical Alfisol.

INTRODUCTION

In the humid African tropics, cassava (*Manihot esculenta* Crantz) is a major staple for over 160 million people. Intercropping system dominates and crops grow in association with cassava are maize (*Zea mays* L.), yams (*Dioscorea spp.* L.), vegetables such as okra (*Abelmoschus esculentus* Moench), melon (*Citrillus lunatus* Thunb), African spinach (Ezumah and Okigbo, 1980; Ikeorgu, Wahua and Ezumah, 1989; Okigbo and Greenland, 1976), and grain legumes (Lutaladio, 1986). Cassava may be grown with maize in two crop mixtures (e.g., Alfisols of Southern Nigeria), or as complex mixtures of cassava with yam and melon as well as maize in Eastern Nigeria with acidic Ultisol. The cassava and maize intercropping is usually initiated at the beginning of the rainy season, to utilize much of the year's soil moisture. In general, yields of the associated maize are not affected while those of cassava may be significantly reduced (Okigbo, 1978; Ezumah and Ikeorgu, 1986). Maize (cv TZPB) planted at 12,000 plants/acre with cassava (TMS 30395) at 4,000 plants/acre produced the best yield in Southwestern Nigeria (Kang and Wilson, 1981). The most limiting factors of competition were light and nutrients, since moisture in this humid environment is usually adequate for both crops in the mixture (Lawson, 1981). Plant arrangement in the cassava – maize intercrop system is important to provide favorable light, since there is a direct relationship between radiation in the canopy and cassava root yields (Annon, 1980). Common problems of small-holder tropical African farming systems are that (a) crop mixtures are grown in no distinct row arrangement, and (b) the related difficulty to manage some field operations with respect to use of chemicals and mechanical weed control (Okigbo and Greenland, 1976).

Information is lacking on the combined effects of maize and cassava varieties and row arrangements on cassava and maize systems. This study has two objectives: (1) to determine the effects of different cassava and maize morphology on cassava and maize growth and yield under intercropping systems, and (2) to determine the effects of planting cassava and maize in the same row, in interrows, or in alternate rows.

MATERIALS AND METHODS

Experimental Environment:

The experiments were established during the 1980-81, 1981-82 and 1982-83 seasons at the International Institute of Tropical Agriculture (IITA), Ibadan research station in southwestern Nigeria on tropical Alfisol (Oxic paleustalf). The 1980-81 trial was during the minor season (Aug. – July) while for the other years, the trial was conducted during the major season (April – March) in the bimodal rainfall regime (Fig. 1). Ibadan is on longitude 3°51' E and latitude 7°23' N at an elevation 200 m above sea level. At commencement of the experiments, selected soil properties were as follows: soil pH was 6.5 (measured in water); organic carbon 1.81%; Bray 1P, 15.75 $mg.g^{-1}$. The exchangeable cations per 100g soil were K, 0.21; Ca, 0.38; Mg, 0.25 me. Annual rainfall during the one-year growing period for cassava (April – March), for 1980-81, 1981-82, 1982-83 and 1983-84 was 70, 49, 36 and 77 inches, respectively. The lowest (36 inches) deviated 39% below normal (50 inches), the 1981-82 was at par with normal, while the 1980-81 and 1983-84 means were 52% and 54% above normal, respectively (Fig. 1).

Cassava and Maize Variety Characteristics:

TMS 30001 is a relatively erect, early maturing, high-branching (about 30 inches to first branch) cassava variety. TMS 30572 is a highly vegetative, low-branching (15 inches), late maturing cassava variety. Both of these improved varieties were bred by IITA; TMS 30572 is gradually spreading in West Africa. While TMS 30001 matures earlier (about 300 days), TMS 30572 requires about 365-400 days.

Height, leaf display and time to maturity of the different experimental maize varieties are presented in Tables 1 and 2. For convenience, maize maturity was classified into four groups, ranging from less than 100 days to longer than 120 days (see Table 4).

These contrasting morphological characteristics of cassava and of maize varieties provided opportunity to study the effects of populations and spatial arrangements on crop interactions under various intercropping systems.

Population and Variety Response of Intercropped Cassava and Maize:

In order to determine the performance of maize and cassava varieties under intercropping systems, two cassava varieties, TMS 30572 (vegetative) and TMS 30001 (erect), were intercropped with two maize varieties, TZSRW (tall, highly vegetative, late maturing) and TZESRW (intermediate height, sparse vegetation, early maturing). Maize and cassava were grown at three populations. Cassava populations were 4-, 8-, and 16- $\times 10^3$ plants/acre and corresponding spacings and spatial arrangements are illustrated in Fig. 2. Maize populations, also shown in Fig. 2, were 8-, 16- , and 32- $\times 10^3$ plants/acre. Treatments were arranged in factorial combinations and replicated three times. To obtain information on sole crop yield, necessary for determining land use efficiency of the intercrop system, eight sole plots, two each of the two maize varieties at 16,000/acre (spacing 3.3 ft. $\times$ 0.8 ft.) and two each of the cassava varieties at 4,000/acre (spacing 3.3 ft. $\times$ 3.3 ft.), were randomly assigned to the treatment combinations. These were the optimum sole crop densities of these crops in the experimental area (Kang and Wilson, 1980; Ezumah and Okigbo, 1980).

Soil was plowed to about 8 inches depth and harrowed. Cassava cuttings 10 inches long of similar sizes and ages were obtained from a mature, woody 12-month old cassava field. Cuttings were planted flat, in rows spaced 3.3 ft. apart. Maize was interplanted between two adjacent cassava rows. Within-row spacings for each cassava variety were adjusted to three densities of 3.3 ft., 1.6 ft., and 0.8 ft., giving 4-, 8-, and 16- $\times 10^3$ plants/acre, respectively. Similarly, within-row spacings for maize were adjusted to give 8-, 16-, and 32- $\times 10^3$ plants/acre, respectively, for each of the maize cultivars. The experiment was set up as a complete block design. Plot size was 26 ft. $\times$ 26 ft. The experiment was conducted in 1980-81 and repeated in 1981-82.

Weeds were controlled by applying primextra [Atrazine: (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine + metolachor: 2-chloro-N-(2-ethyl-6-methyl-fain-N(2-methoxyl-1-methyl ethyl) acetamidel at the rate of 2.7 lb a,i/acre as a pre-emergent herbicide, aided by hand hoeing as required by visual observation. Plots were fertilized with 268 lb./acre of 15-15-15 N-P-K at planting, followed by side dressing with 40 lb./acre N applied as urea at 4 weeks after planting. All fertilizer applications were banded in furrows beside the maize row. The 1980 planting was carried out August 14-16 and cassava was harvested a year later. The 1981 planting was April 16-18, and also harvested a year later. Maize harvesting dates varied from 95 days after planting for TZESRW to 125 days after planting for TZSRW. Cassava yield was the fresh tuberous root weight. Maize grain weight was adjusted to 14% moisture level to enable data comparison.

In addition to the yield, data were also collected for cassava and maize plant heights and leaf area at 8 weeks after planting for the second year. Leaf area of cassava was determined at eight weeks by destructive sampling of six plants and relating dry weights to areas removed by the cork borer method (Enyi, 1973). Leaf area of maize was determined by measuring the length and breadth at the widest point of flag leaf, counting the total of leaves, and multiplying by a factor as described by Yamaguchi (1974).

Row Arrangement, Maize Variety and Maize Population Effects on Cassava and Maize:

Since maize dominates cassava and light is the most limiting factor in their intercrop in Southern Nigeria (Lawson, 1981), it was important to determine the effects of row arrangement on the performance of cassava and maize intercrop. Therefore, nine maize varieties were studied at three spatial arrangements (same row, interrow and alternate crop) and intercropped with cassava [(TMS 30572, the highly vegetative type)] (Table 2). The details of plant arrangements and spacings to give cassava and maize populations of 4,000 and 16,000 plants/acre, respectively, are also given in Fig. 2. Plot preparation, fertilizer rates and application procedures, weed control and harvesting, were as described in the first trial. Plot size was also 26 ft. × 26 ft.

The experiment was conducted for two years. The first-year planting was on April 9, 1982. Maize harvest dates ranged from about 100 to 130 days after planting, while cassava was harvested at 12 months.

In both trials cassava yield was recorded as fresh tuberous root weight and maize yield was adjusted to 14% moisture. Other observations included plant height and leaf area of maize at eight weeks after planting, as described above.

The experiment was repeated in April, 1983 to determine the effects of growing the different maize varieties at two populations (16,000/acre and 32,000/acre) on yield of intercropped cassava (at 4,000/acre) and maize. Since the earlier results showed no significant effects of row arrangement, this trial was limited only to the interrow spacings (Fig. 2b). All cultural practices were as described during the first year of this trial, and yields were observed at maturity as described earlier.

RESULTS

Population and Variety Response of Intercropped Cassava and Maize:

Maize and Cassava Growth: The height at eight weeks after planting was not significantly affected by maize population but was characteristic of each variety. Height averaged over the three maize populations, cassava variety and cassava population for the 1981 plant planting was 76.8 in. for TZSRW and 66.5 in. for TZESRW (Table 3). These were significantly different at the $P < 0.05$. Maize leaf area index at 32,000 plants/acre was higher than at 8,000 plants/acre. Also the leaf area of the late maturing TZSRW maize was 42% higher than the early TZESRW (Table 3).

Height increased with increasing maize population and cassava associated with taller-growing TZSRW tended to be taller than cassava grown with the TZESRW maize at high maize populations (Table 3). Cassava leaf area decreased with increasing maize population.

Maize Grain Yield: Generally, maize yields were low but not unusual in the rather humid environment. Also maize planted in August, the minor season in the bimodal regime, tended to senesce earlier and this in part accounts for the earlier harvesting dates in the first trial. The results of 1981 were similar to those of 1980 since TZSRW maize significantly out-yielded TZESRW by 50%, i.e., 1.89 to 1.24 tons/acre for TZSRW and TZESRW, respectively (Table 4).

Intercropping maize with TMS 30572 or TMS 30001 cassava variety did not affect the maize grain yield. Grain yield reduction of maize ranged from 5-7% below monocrop yields (Table 4).

Cassava Root Yield: TMS 30572 significantly outyielded TMS 30001 by 23% (12.0:9.8 tons/acre) in 1980 and by 58% (16.6:10.6 tons/acre) in 1981 under intercropping with maize (Table 4).

Intercropping cassava with maize reduced the root yield of cassava (Table 4). The 1980 data showed 39% mean cassava yield reduction for intercropped TMS 30572 and 34% for intercropped TMS 30001. These data show that maize dominates cassava under intercropping irrespective of cassava architecture. Similar results have been reported in more humid, acid soil environments in Brazil (Porto *et al.*, 1979) and southern India (Kumar and Hirshi, 1979).

Increasing cassava population from 4,000 plants/acre to 16,000 plants had no effects on cassava root yield (Table 5). There was no significant interaction of cassava population and cassava variety on root yield. Averaged over the cassava varieties and maize populations, root yields were similar but number of tuberous roots per plant increased slightly and root number increased inversely with root size (Table 5).

Productive Efficiency. The relative yield totals (RYT) of intercropped cassava and maize ranged from 1.38 to 1.99 (Table 6). These high RYT values reflect the high resource use efficiency of this intercropping system and indicates yield advantage of intercropping cassava and maize in the humid, tropical Alfisol environment with bimodal rainfall pattern represented by the Ibadan site. Intercropping with the early (TZESRW) maize, which competes less with cassava, gave higher RYT values than the late TZSRW. The higher RYT values in general were found in combinations of TZESRW maize with TMS 3001 cassava, especially at higher populations. Cassava development is extremely slow during the early growth phase (0-3 months). This period corresponds to that of rapid vegetative development of maize (Juo and Ezumah, 1989; Ikeorgu *et al.*, 1989). The complementarity of cassava and maize can be attributed to nonsynchronization of their periods of high resource demand (Leihner, 1983).

For the small-scale, traditional, African farmer, improved land use efficiency is only part of the overall gain due to intercropping. Continuous vegetative cover suppresses weed infestation, improves soil chemical and physical properties, and improves soil microbial characteristics including earthworm activity, all perhaps leading to more stable and sustainable land use (Aina *et al.*, 1979; Hulugalle and Ezumah, 1991).

<u>Row Arrangement and Ma ize Variety Effects on Cassava and Maize</u>:

<u>Maize Grain and Cassava Root Yields</u>: Cassava root and maize graint yields averaged over two years are shown in Table 7. The late-maturing maize varieties, especially TZPB, yielded significantly higher than the early TZESRW under intercropping with cassava. The later the time to maturity and the higher the maize LAI, the more the grain yield of maize intercropped with cassava. There was no significant effect of row arrangement on maize intercropped with cassava and no significant interaction between row arrangement and maize variety on maize grain yield. However, grain yield tended to be higher in the interrow arrangement (Table 7). The highest average maize grain yields were obtained from TZPB while the lowest was from TZESRW. Analysis of variance gave highly significant effects of maize variety on average cassava root yield. Cassava intercropped with the early maturing and short maize type, e.g., TZESRW, yielded higher than when intercropped with the tall, late maize, e.g., TZPB or TZSRW (Table 7). Again, no significant effect of row arrangement on cassava yield and no interaction between row arrangement and maize variety on root yield were observed.

Bivariate analysis on the same data set gave a visual appreciation of the two-crop interaction in a skewed axes diagram, as originally illustrated by Pearce and Guiliver (1978), and applied for maize and cowpea intercropping by Ezumah *et al.* (1987). A skewed-axes graph displays the effect of maize variety on average grain yield of maize and cassava root (Fig. 3). The 95% confidence region of each treatment mean is represented by a circle and two treatment means are not significantly different from each other at the 5% level if their confidence regions overlap. The residual correlation between cassava and maize yield is −0.19, indicating a weak interspecific competition between the two crops, which is a clear indication of their compatibility in intercrops. This shows clearly that TZPB gave the highest maize grain yield but resulted in the most serious interference with cassava, whose yield it reduced. On the contrary, TZESRW maize gave the lowest maize yield but highest cassava root yield. The second graph (Fig. 4) shows the effect of plant population on mean maize grain and cassava root yields. The angle between the two axes deviates a little from horizontal. This is a characteristic of weak residual correlation between the two crops (Pearce and Guiliver, 1978).

Accordingly, increasing maize populations increased maize yield considerably while causing only a slight decrease in cassava yield (Table 8). Maize grain yield varied with variety, the highest yielding varieties being TZSRW and Poza Rica 7729 — the highly vegetative, relatively late maturity varieties. Among the low average yielders were the early TZESRW and the short Population 49 (Table 8).

Average yield response of cassava was similar to yields from the previous years, i.e., association with Population 49 gave the best cassava root yield, which was significantly higher than that of TZSRW. Other intercrop associations were placed between these extremes (Table 8).

SUMMARY AND CONCLUSIONS

Although some variations attributed to maize variety may be observed, cassava root yield generally declined with increasing maize population (from 8,000 to 32,000 plants/acre) in their intercrop system. While nearly linear increase was observed for grain yield with increasing maize population for TZESRW, grain yield with TZSRW tended to decline beyond 16,000 plants per acre.

Cassava and maize intercropping is a highly efficient crop combination based on total yield and land use efficiency. Cassava growth habit, whether low branching, e.g., TMS 30572, or tall, relatively nonbranching, TMS 30001, does not significantly reduce the land use efficiency of this intercrop system. However, the optimum maize population for intercropping with cassava varies with maize types. Short stature, early maturing and sparse leaf area maize appear to be more compatible for intercropping with cassava (assuming that differences in yield under intercropping is a measure of competitiveness). Furthermore, the results also show that planting maize at 16,000 plants per acre in differing row arrangements with cassava does not affect cassava root and maize yield in a tropical Alfisol in humid Southern Nigeria. The effect of maize population on yields of both cassava root and maize depend upon the choice of maize variety. Maize types such as TZESRW and Population 49 are, however, lower yielding than the late TZSRW variety. Therefore a decision as to what maize variety to use in cassava and maize intercrop systems will be determined by the relative importance a farmer attaches to maize or to cassava. The flexible row arrangement is particularly important in mechanized farming where equipment, e.g., tractors, are set to desired width.

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Table 1. Population and spacing of cassava and maize in 1980-81 and 1981-82 experiments in Southwestern Nigeria

Crop	Spacing (ft)	Population/Acre
Cassava	3.3 × 3.3	4,000
	3.3 × 1.6	8,000
	3.3 × 0.8	32,000
Maize	3.3 × 1.6	8,000
	3.3 × 0.8	16,000
	3.3 × 0.4	32,000

Design: Randomized complete design. Treatments were in factorial arrangement with 3 replications.

Table 2. Effects of maize variety and maize population on intercropped maize and cassava heights, and leaf area index at 8 WAP*
in Southwestern Nigeria (1981)

Maize Variety	Maize population (× 10^3)/Acre							
	8	16	32	Mean	8	16	32	Mean
	Maize Height (inches)				Maize leaf area Index			
TZSRW	71.3	76.0	82.7	76.8	3.96	5.14	5.50	4.87
TZESRW	65.0	66.1	68.9	66.5	3.38	3.72	3.72	3.42
Mean	68.2	71.1	75.8		3.67	4.43	4.61	
LSD 0.05 +a.		8.54		4.57^b		1.03		0.77^b
c.		NS				0.49		
	Cassava Height (inches)				Cassava leaf area Index			
TZSRW	46.9	56.3	65.0	55.9	0.56	0.59	0.30	0.48
TZESRW	51.2	51.6	54.3	52.4	0.63	0.55	0.46	0.54
Mean	49.1	54.0	59.7		0.60	0.57	0.38	
LSD 0.05 +a.		4.84		2.79^b		0.197		0.14^b
c.		1.01				0.14		

* Weeks after planting.

\+ LSD a = For comparing interactions of variety × maize population;
LSD b = For comparing mean variety effects.
LSD c = For comparing mean population effects.

Table 3. Agronomic characters of maize varieties in the interrow system with cassava

Maize Variety	Total Plant + Ht. (inches)	Ear Ht. (inches)	LAI	Days to maturity + +
TZPB	107	44	5.7	135
TZSRW	106	46	5.4	125
TZESRW	81	28	3.6	96
Poza Rica 7729	100	41	4.5	115
Pirsabak(1)7930	83	35	3.5	110
Ferke(1)7635	87	29	4.1	118
New Modified br2 BHF Satucaq	87	27	3.9	110
Population 49	69	25	4.0	122
LSD 0.05	16.38	4.96	0.96	29.8
Kewesoke + + +	81	28	3.6	108

\+ Height ranges observed are tall (TZPB, TZSRW); intermediate [Pirsabak(1)7930, TZESRW, Ferke(1)7635, New Modified br2); and very short (Population 49).

\+ + Determined by leaf senescence and blackened silk: Early 85-100 days to maturity; Intermediate 100-110 days; Late 110-120 days; Very late > 120 days.

\+ + + Not included in statistical analysis: available during only one season trial.

Table 4. Effects of cassava variety, maize variety and maize population on maize grain and cassava root yields of cassava + maize intercrop system in southwestern Nigeria (1980 and 1981).

Cassava variety	Maize variety	Maize population per acre	Maize grain t/A	Cassava root t/A	Maize grain t/A	Cassava root t/A
			1980		1981	
30572	TZSRW	8,000	2.26	10.8	1.46	16.3
		16,000	2.18	9.4	2.30	15.4
		32,000	1.89	8.9	2.02	13.7
	TZESRW	8,000	0.75	15.7	0.88	11.8
		16,000	1.25	13.1	1.18	17.5
		32,000	1.47	12.1	1.53	16.3
30001	TZSRW	8,000	2.00	11.6	1.37	10.4
		16,000	2.30	7.9	2.16	11.5
		32,000	2.02	7.0	1.91	9.2
						1.81
	TZESRW	8,000	0.88	11.7	0.79	11.2
		16,000	1.45	11.6	1.43	10.4
		32,000	1.43	8.9	1.29	10.7
LSD 0.05			1.23	5.4	0.90	5.98
CV (%)			12.5	29.6	27.4	31.6
Average Yields: (t/Acre)			+ Mono-crops	Inter-crops	+ Mono-crops	Inter-crops
			1980		1981	
	TZSRW		2.23	2.11 + +	1.96	1.89 + +
	TZESRW		1.32	1.24	1.33	1.24
	LSD 0.05			0.65		0.57
	TMS 30572		16.70	12.1 + + +	19.7	16.6 + + +
	TMS 30001		13.0	9.8	13.6 + + +	10.5
	LSD 0.05			2.11		3.05

+ Monocrop yields were based on sole crop yields of the two maize varieties and the two cassava varieties at recommended populations replicated only two times as described in materials and methods. This was not included in statistical analysis of the experiment.

+ + Averaged over cassava varieties and maize populations.

+ + + Averaged over maize varities and maize populations.

Table 5. Effect of cassava population on the average cassava root yield and number of roots per plant under intercropping with maize in Southwestern Nigeria

Population per Acre		Ib/A	Tuberous Root/Plant
Cassava:	4,000	10.6	4.7
	8,000	10.9	5.2
	16,000	11.2	5.8
LSD 0.05		2.73	0.65

Table 6. Effects of cassava variety, maize variety and maize population on productive efficiency of cassava + maize intercrop system in southwestern Nigeria (1980 and 1981).

Cassava variety	Maize variety	Maize population per acre	Relative Yield Totals (RYT)+		Mean RYT+
			1980	1981	1980-81
TMS 30572	TZSRW	8,000	1.66	1.57	1.62
		16,000	1.54	1.96	1.50
		32,000	1.38	1.72	1.55
	TZESRW	8,000	1.51	1.71	1.61
		16,000	1.73	1.97	1.85
		32,000	1.83	1.94	1.89
TMS 30001	TZSRW	8,000	1.78	1.57	1.68
		16,000	1.69	1.79	1.74
		32,000	1.45	1.81	1.63
	TZESRW	8,000	1.57	1.41	1.49
		16,000	1.99	1.84	1.92
		32,000	1.76	1.76	1.76

+RYT is the $\dfrac{\text{Yield of maize in intercrop}}{\text{Yield of maize in sole crop}} + \dfrac{\text{Yield of cassava in intercrop}}{\text{Yield of cassave in sole crop}}$.

Table 7. Effects of row arrangement and maize variety on intercropped maize grain and cassava root yields averaged over two years (1981-82).

	Row Arrangement							
	Maize yield, t/Acre				Cassava yield, t/Acre			
Maize variety	Same row	Alternate row	Inter-row	Mean	Same row	Alternate row	Inter-row	
Mean								
TZPB	3.79	3.66	3.58	3.68	16.0	13.0	16.6	15.3
TZSRW	3.08	2.62	2.27	3.02	16.0	17.4	16.0	16.5
TZESRW	1.54	1.81	2.90	1.79	22.0	18.0	20.2	20.1
Poza Rica 7729	3.12	3.10	3.16	3.13	16.3	20.2	18.2	18.6
Pirsabak(1) 7930	2.03	2.32	2.53	2.30	21.2	18.7	21.3	20.6
Ferke(1) 7635	2.11	2.30	2.86	2.42	17.4	21.1	15.7	17.7
New Modified br2	2.50	2.30	2.36	2.42	16.1	16.0	19.0	17.0
Population 49	1.86	2.02	2.56	2.15	24.0	21.5	20.0	21.9
Mean	2.50	2.52	2.71		18.6	18.2	18.4	

LSD for comparison (:P = 0.05)		
Maize variety (:V)	0.88	3.66
Row arrangements (:R)	1.39	2.95
V × R	1.87	5.23

Table 8. Effects of maize variety and maize population on maize grain and cassava root yields, (t/Acre), with interrow arrangement (1981-83).

Maize variety	Maize grain yield				Cassava root yield			
	1981	1983	1983 +	Average	1981	1982	1983 +	Average
				Tons/Acre				
TZSRW	2.70	2.52	2.62	2.62	18.2	16.5	10.5	15.1
TZESRW	1.76	1.86	2.19	1.94	18.8	17.3	13.3	16.4
Poza Rica 7729(E)	3.52	2.29	2.06	2.76	19.3	14.2	16.5	16.7
Pirsaback (1)7930	2.33	2.31	2.00	2.21	21.5	15.9	16.7	18.0
Ferke (1)7635	2.24	2.35	1.88	2.16	25.9	16.2	16.3	19.5
New modified br2 (BHF Satucaq)	2.29	2.32	1.88	2.16	17.3	14.7	15.6	15.9
Population 49	2.02	2.04	1.95	2.00	24.6	18.4	19.2	20.7
Mean	2.47	2.24	2.10		20.8	16.2	15.5	
LSD 0.05 + + a.		1.938 NS				10.136 NS		
" b.	2.14	0.982	1.625		0.593	5.706	2.893	
" c.		0.866				4.933		

\+ The third year data for these analyses is based on 16,000/Acre maize population only.

\+ + a. LSD for comparing between year interactions for any given variety.
b. LSD for comparing between varieties within a given year.
c. LSD for comparing between year means.

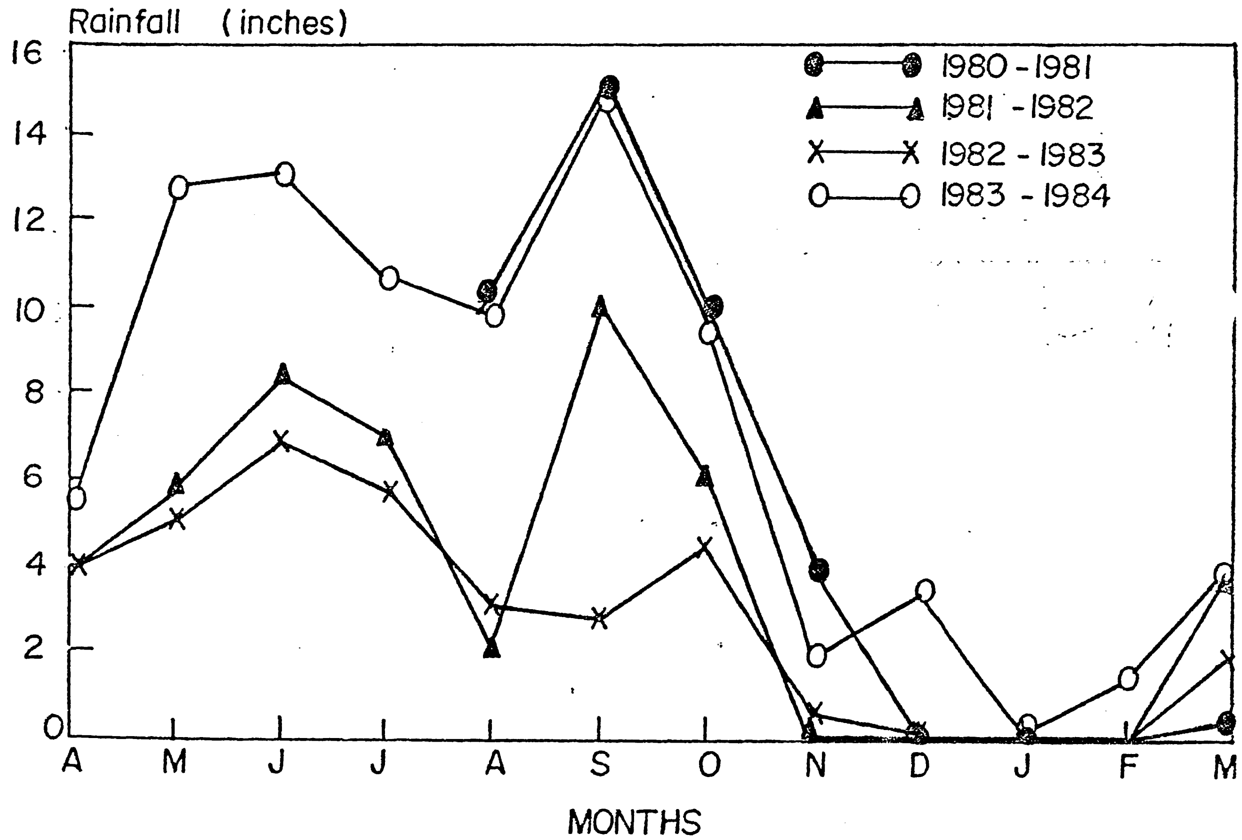

Fig. 1. Distribution of rainfall during growing period of cassava + maize intercropping experiments. The trials were conducted on a tropical Alfisol in southwest Nigeria.

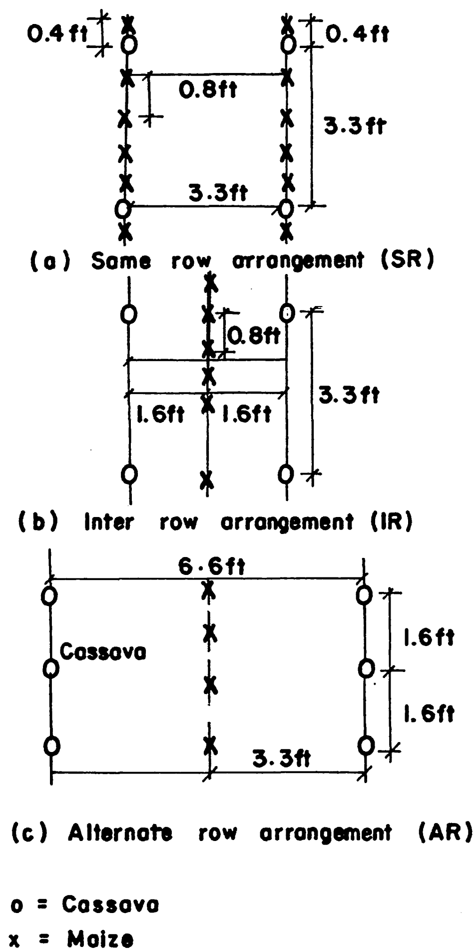

Fig. 2. Spatial arrangement of cassava-maize intercrop

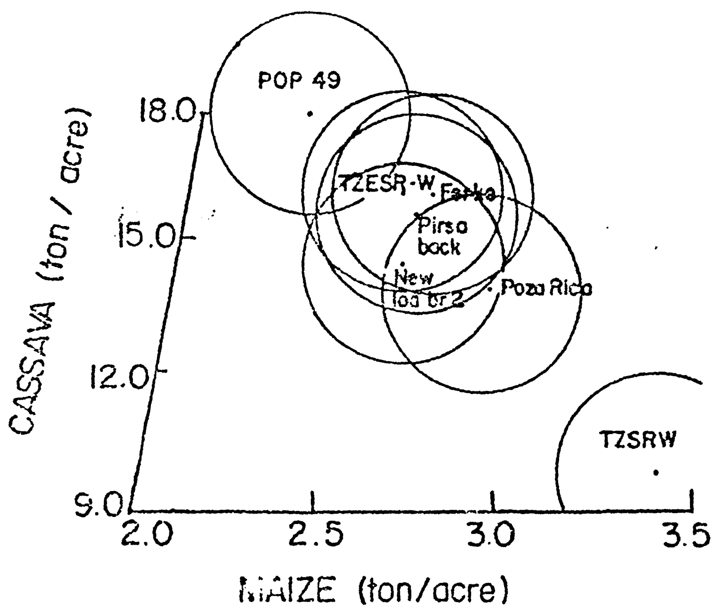

Fig. 3. Effects of maize variety on cassava root and maize grain yield (t/acre) from the interrow planting pattern.

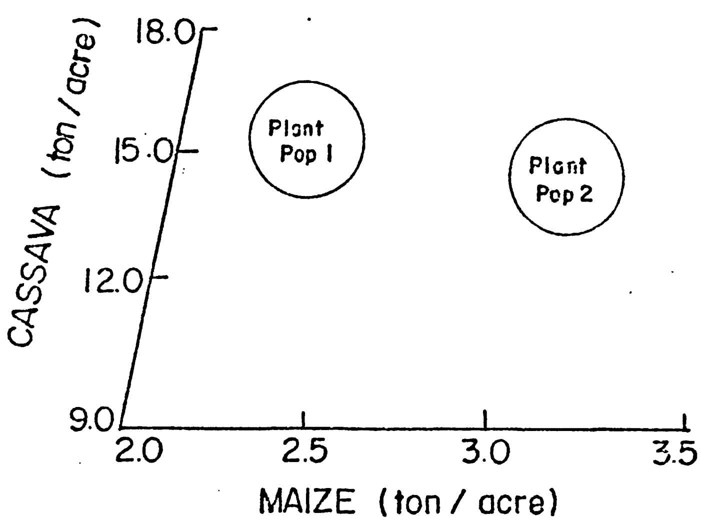

Fig. 4. Effects of maize variety on average cassava root yield and average maize grain yield (t/acre).