NIGER AGRIC. J. 33 (2002): 11-18

EVALUATION OF CASSAVA/SOYBEAN INTERCROPPING SYSTEM AS INFLUENCED BY CASSAVA GENOTYPES

E.U.MBAH, C.O. MUONEKE*and D.A. OKPARA

Department of Agronomy
Michael Okpara University of Agriculture, Umudike,
P.M.B. 7267, Umuahia, Nigeria

***Corresponding author.**

ABSTRACT

The effects of three cassava genotypes (NR 8212, TMS 91934 and TMS 30572) grown sole or intercropped with soybean were investigated in two field experiments in 2000/2001 and 2001/2002 cropping seasons at Umudike in the lowland humid forest zone of south-eastern Nigeria. The plant height, canopy diameter, number of leaves per plant and leaf area index (LAI) of soybean and cassava were significantly ($P<0.05$) affected by intercropping but days to 50 per cent flowering of soybean were not affected. Canopy diameter, number of leaves per plant and LAI of cassava were highest with TMS 30572 in sole or intercropping cultures and least with sole or intercropped TMS 91934 genotype in both seasons. Soybean plants were taller when intercropped with NR 8212 or with TMS 30572 than in sole soybean, which had similar height with soybean in soybean/TMS 91934 mixture. The soybean canopy diameter, number of leaves per plant and LAI were higher with sole soybean. Within the soybean intercrops, canopy diameter, number of leaves per plant and LAI were higher with soybean/TMS 91934 and soybean/NR 8212 than with soybean/TMS 30572 mixture. The yield and yield components of cassava (total number of tubers per plant, number and weight of marketable tubers per plant and fresh tuber yield per hectare) were not affected by intercropping. The number of pods per plant, pod dry weight per plant and grain yield of soybean were significantly ($P<0.05$) affected by intercropping but 100-seed weight was not. Grain yields of soybean in mixtures (449.28 and 387.85 kg/ha) were lower than that in sole crop (670.10 and 566.35 g/ha). Among the soybean intercrops, the highest soybean yields (533.67 and 462.00 kg/ha) were with soybean/TMS 91934 whereas the lowest (385.91 and 339.52 kg/ha) were with soybean/TMS 30572 mixture in 2000/2001 and 2001/2002 seasons, respectively. Yield increment for cassava ranged from 1.42-3.43 per cent (2000/2001) and 3.72-7.74 per cent (2001/2002) for fresh tuber yield/ha while yield reduction for soybean ranged from 20.36-42.41 per cent (2000/2001) and 18.43-40.05 per cent (2001/2002) for grain yield/ha. There was yield advantage due to intercropping. The productivity of cassava/soybean mixture showed yield advantage of 59-84 per cent (2000/2001) and 64-90 per cent (2001/2002). The highest monetary returns (₦133,786.00 and ₦156,161.00/ha) were achieved with TMS 30572/soybean intercropping system in both years.

Running Title: Evaluation of cassava genotypes/soybean cropping system.

Keywords: Cassava, soybean, intercropping, genotypes, productivity.

INTRODUCTION

Mixed intercropping is a very common feature in the cropping system among the peasant farmers in the less developed countries of the world. It is thought to have evolved to meet the local situations and conditions (Egharevba, 1982). The practice is popular because of its advantages over sole cropping which includes security of returns and higher profitability due to higher combined returns per unit area of land (Enyi, 1973; Crookston and Kent, 1976; Egharevba, 1979; Ezulike *et al.*, 1993). In addition, the practice controls erosion and weeds, and allows a more

even distribution of farm labour than sole cropping. However, due to its popularity in southeastern Nigeria, agronomists are now improving its technology to enhance productivity.

Cassava, which is an important tuber crop and a major source of energy in the diet of the people, is the most dominant component in crop mixtures in the region (Unamma *et al.*, 1985); Ikeorgu and Iloka, 1994). Furthermore, a number of cassava varieties adaptable to the growth environments and acceptable to diverse end users have been developed by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and the National Root Crops Research Institute (NRCRI), Umudike, Nigeria. Some of these improved varieties have made tremendous impact on the farming systems of the humid tropics of southeastern Nigeria. Soybean, however, is a new introduction that is fast gaining acceptance due to the high nutritional quality of its protein that is comparable to that of egg (Martin *et al.*, 1976; Ajayi and Wainaina, 1993). More so, Tijani and Akinnifesi (1996) and Makinde and Agboola (2001) reported that intercropping soybean with cassava could be very productive. But there is inadequate information on the growth and yield performance of soybean and cassava when intercropped with some of the introduced cassava genotypes in the region. The objectives of this investigation, therefore, were to assess the productivity of cassava/soybean intercropping system in the study area.

MATERIALS AND METHODS

Field experiments were conducted during the 2000/2001 and 2001/2002 cropping seasons at the Michael Okpara University of Agriculture, Umudike Research Farm (05° 29'N, 07° 33'E, 122 m above sea level) in the humid rainforest zone of south-eastern Nigeria. Three cassava genotypes (NR 8212, TMS 91934 and TMS 30572) with different morphological characteristics obtained from NRCRI), Umudike were intercropped with an early maturing soybean variety (TGX-1485-1D) obtained from IITA, Ibadan, using the randomised complete block design with three replicates. The soils of the experimental sites were sandy loam {pH 5.2 an 5.9 (1:2.5, soil:water); organic matter 2.61 and 1.2 per cent; total N 0.05 and 0.07 per cent; available P 19.0 and 17.0 mg/kg (Bray-2); and exchangeable K 0.11 and 0.11 c mol/kg} in 2000/2001 and 2001/2002 cropping seasons respectively.

The morphological characteristics of the cassava genotypes were:

NR 8212: An improved variety with moderate canopy. It is characterised by its erect and high branching habit. The variety branches mainly in whorls of three orders.

TMS 91934: A low to medium branching variety with sparse canopy. The variety is usually tall and branches up to the fifth order.

TMS 30572: An improved low to medium branching variety with dense spreading canopy. The variety branches in 3-4 orders.

The land was ploughed, harrowed and made into 1 m ridges. The plot size was 5 m x 4 m (20 m^2). All the crops in the sole and intercropped stands were planted simultaneously on 18 August 2001 and 21 August 2001. Cassava stem cuttings (20 cm long) obtained from 12-month old matured stems were planted along the crest of the ridges at 1m apart. Soybean seeds were planted three seeds per hole midway between the crest and the furrow of the ridges at 7.5 cm apart and were thinned to one plant per hole two weeks after planting (WAP). This gave a plant population of 10,000 plants/ha for cassava and 199,000 plants/ha for soybean. Sole cassava genotypes and sole soybean were also established. Manual hoe weedings were carried out at 3, 8 and 12 WAP. Compound fertiliser N: P: K (20:10:10) was applied at the rate of 400 kg/ha by banding 3 WAP on soybean and 8 WAP on cassava. Soybean plants were sprayed 5 WAP with cypermethrin at the rate of 600 ml/ha to control insect pests.

Data on plant height, canopy diameter, number of leaves per plant, leaf area, and leaf area index were taken from 3 cassava and 5 soybean plants at 8 WAP. Also, number of days to 50 per cent flowering was taken on soybean. At maturity, yield and yield components of the crops under sole and intercropping situations were taken from three inner rows of each plot. Soybean and cassava were harvested 4 and 12 months after planting (MAP), respectively. Data were taken on the number of tubers per plant, number and weight of marketable tubers per plant and fresh

tuber yield/ha of cassava as well as the number of pods per plant, pod dry weight per plant, 100-seed weight and grain yield/ha of soybean. The growth and yield of cassava and soybean were statistically analysed using the procedures outlined by Steele and Torrie (1980) for a randomised complete block design and significant treatment mean differences that were determined by Duncan's new multiple range test at

$P < 0.05$.

The productivity of the intercropping system was determined by the land equivalent ratio (LER) (the sum of the ratios of yields of the intercrops to those of the sole crops (Fisher, 1977; Mead and Willey, 1980) and area x time equivalent ratio (ATER) as described by Hiebsch and McCollum (1987).

$ATER = \{(R_{ys} \times t_s) + (R_{yc} \times t_c)\}/T$. R_{ys} and R_{yc} = relative yields of soybean and cassava, respectively; t_s and t_c = maturity periods of soybean and cassava, respectively; T is the duration of the intercropping system. Monetary equivalent ratio (MER) was determined by the method of Adetiloye (1988).

$MER = (r_1 + r_2)/R$, where r_1 and r_2 are monetary returns of component crops in the mixture and R is the higher sole crop monetary return compared with the other.

RESULTS AND DISCUSSION

Growth:

Intercropping showed significant variations among cassava genotypes and in soybean plants in height, canopy diameter, number of leaves per plant and leaf area index (LAI), except days to 50 per cent flowering in soybean in 2000/2001 and 2001/2002 (Table 1). Plant heights in sole cassava genotypes were not significantly different from the corresponding intercropped genotypes in 2000/2001 cropping season but in 2001/2002 sole NR 8212 and TMS 30572 were shorter than the intercrops. The sole NR 8212 and TMS 30572 were significantly ($P<0.05$) taller than TMS 91934 and TMS 30572 intercrops. On the average, intercropped TMS 91934 was 28.5 cm and 17.7 cm shorter and had 34.7 per cent and 36.6 per cent less canopy than intercropped NR 8212 and TMS 30572, respectively. Intercropped TMS 30572 had more leaves and LAI than TMS 91934 and NR 8212 intercrops.

Soybean intercropped with TMS 30572 was significantly taller than when it was intercropped with TMS 91934 cassava genotype or when grown sole in both seasons. Soyabean in intercrop with TMS 91934 had more leaves, higher LAI and canopy diameter than the other soybean intercrops. This trend was consistent in both seasons. When averaged over the two cropping seasons, the LAIs of intercropped cassava genotypes (NR 8212, TMS 91934 and TMS 30572) were reduced by 18.5 per cent, 28 per cent and 13.9 per cent while those of intercropped soybean were reduced by 47 per cent, 18.5 per cent and 55 per cent, respectively compared to the sole crops. Similarly, a decline in leaf area development of component crops in intercropping situation had been reported by Egharevba (1982) in maize/cowpea and Olasantan and Lucas (1992) in maize/cassava and maize/cocoyam intercrops. However, tuber yield in all cassava genotypes in both years always tended to be higher in the intercrop and this trend influenced the monetary yields.

Yield and yield components:

Intercropping did not affect total number of tubers per plant, number of marketable tubers, weight of marketable tubers and fresh tuber yield in cassava genotypes (Table 2). Intercropping significantly ($P<0.05$) reduced the number of pods per plant and grain yield of soybean but did not affect the pod dry weight of soybean intercropped with TMS 91934 or 100-seed weight in both seasons (Table 3). TMS 91934 mixture gave the least number of pods per plant among the intercrops. Among the intercrops, grain yield was least with TMS 30572 in both years but highest with TMS 91934. The low grain yield obtained from soybean in association with TMS 30572 was perhaps due to poor grain filling caused by inter and intra plant competition for assimilates (photosynthates) arising from high number of pods per plant. Similar results were reported by Moraghan (1970) as well as Okpara and Ibiam (2000) in their works in which they noted that larger seed size was associated with higher grain yields. In addition, the depressed grain yield could also be due to shading associated with the

morphology of the cassava genotype (TMS 30572) characterised by dense canopy. Huxley and Maingu (1978) and Wahua and Miller (1978) concluded in their works that shading depressed yield in legumes by adversely affecting flowering and suppressing the development of fruiting branches. On the average, soybean grain yields in the mixtures were depressed by 38.5 per cent, 19.55 per cent and 41.3 per cent in association with NR 8212, TMS 91934 and TMS 30572, respectively over the two seasons

Table 1: Vegetative characteristics of cassava genotypes and soybean at 8 WAP in cassava/soybean intercrop in 2000/2001 and 2001/2002 cropping seasons

Genotypes	Plant height (cm)		Canopy diameter (cm)		No. of leaves/plant		Leaf area index		Days to 50% flowering
	Cassava	Soybean	Cassava	Soybean	Cassava	Soybean	Cassava	Soybean	Soybean
Sole NR 8212	52.68ab	-	75.58ab	-	30.67c	-	0.28b	-	-
Sole TMS 91934	26.06e	-	47.27c	-	21.00d	-	0.26bc	-	-
Sole TMS	35.42cd	-	76.94a	-	43.00a	-	0.38a	-	-
Sole Soybean	-	21.65cd	-	48.43a	-	18.77a	-	4.15a	38
NR 8212 + Soybean	55.98a	30.00b	69.24ab	37.10b	30.00c	11.06c	0.22cd	2.07c	35
TMS 91934 + Soybean	27.88e	25.80bc	44.24c	40.60b	19.0d	14.49b	0.17d	3.24b	36
TMS 30572 + Soybean	39.08c	37.60a	71.71ab	31.13c	40.00ab	9.43d	0.31ab	1.87c	40
Sole NR 8212	43.80b	-	75.17ab	-	31.67bc	-	0.26b	-	-
Sole TMS 91934	27.76c	-	64.38bc	-	25.00cd	-	0.24bc	-	-
Sole TMS	40.74b	-	83.43a	-	44.67a	-	0.34a	-	-
Sole Soybean	-	21.59c	-	43.33a	-	14.96a	-	3.29a	36
NR 8212 + Soybean	59.75a	30.83ab	73.25abc	33.78c	20.33d	9.99c	0.22cd	1.87bc	35
TMS 91934 + Soybean	30.86c	25.14bc	48.45d	38.80b	19.30d	12.83ab	0.19d	2.82ab	36
TMS 30572 + Soybean	55.02a	36.69a	74.99abc	29.77d	37.67ab	7.26d	0.31a	1.46c	41

Within each column and for each cropping season, means followed by different letter (s) are significantly different ($P<0.05$) according to Duncan's new multiple range test.

Productivity of the intercropping systems:

The efficiency of intercropping relative to sole cropping, expressed as (LER) and ATER was greater than 1.0, indicating that a higher productivity per unit area was achieved by intercropping cassava with soybean than by growing the two crops separately (Table 4). This agreed with the findings of Willey (1979) and Okpara *et al.* (1995) which stated that intercropping was more advantageous, especially when legumes which improved soil fertility were involved, resulting in higher component yields and invariably in higher productivity and monetary returns. Intercropping cassava and soybean gave a mean LER of 1.70 (2000/2001) and 1.75 (2001/2002) indicating 70 per cent and 75 per cent yield advantages. Averaged over the two cropping seasons, the highest LER (1.87) and ATER (1.33) were achieved in TMS 91934/soybean mixture. On the basis of LER and ATER, therefore, the highest yield advantage accrued from intercropping soybean with TMS 91934 than with other cassava genotypes Willey (1979) indicated that practical significance of LER could only be fully assessed when related to the actual economic return. In 2000/2001 and

2001/2002, the economic performance of the cropping systems showed that more money was realised in intercrops than in sole crops. The highest monetary equivalent ratio was achieved with TMS 30572/soybean intercrop in both seasons. In addition, the highest monetary returns of ₦133, 786/ha and ₦156, 161/ha obtained with the TMS 30572/soybean intercrop were 28.0 per cent and 25.7 per cent greater than the best TMS 30572 sole crop return of ₦104, 500/ha (2000/2001) and ₦124, 200/ha (2001/2002). Although, on the basis of LER, the highest yield advantage was achieved in the TMS 91934/soybean intercrop (85 per cent) and (90 per cent) in 2000/2001 and 2001/2002, respectively, this mixture gave the least monetary return. This conformed with the reports of Ifenkwe and Odurukwe (1990), Kumar and Yusuf (1991) and Muoneke *et al.* (2002), which indicated that the highest LER values did not always reflect the highest monetary return to the farmer.

The reason why TMS 30572/soybean was more economically beneficial than the TMS 91934/soybean cultural in spite of the higher productivity of TMS 91934/soybean mixture could be that unit market price for the TMS 30572 variety was greater than that of TMS 91934.

Table 2: Yield and yield components of cassava genotypes in cassava/soybean intercrops in 2000/2001 and 2001/2002 cropping seasons

Cassava genotypes	Total no. of tubers /plant	NO. of marketable tubers/plant	Weight of marketable tubers (kg/plant)	Fresh weight of tubers (t/ha)
2000/2001				
Sole NR 8212	6.06	3.27	1.96	19.6
Sole TMS 91934	5.91	3.23	1.69	16.9
Sole TMS 30572	7.31	4.23	2.09	20.9
NR 8212 + soybean	5.19	2.79	2.01	20.1
TMS 91934 + soybean	4.87	2.68	1.75	17.5
TMS 30572 + soybean	6.12	3.46	2.12	21.2
2001/2002				
Sole NR 8212	5.81	4.02	1.85	18.5
Sole TMS 91934	5.74	3.86	1.55	15.5
Sole TMS 30572	8.74	4.17	2.07	20.7
NR 8212 + soybean	5.71	3.76	1.99	19.9
TMS 91934 + soybean	5.15	3.29	1.68	16.8
TMS 30572 + soybean	6.06	4.06	2.15	21.5

Table 3: Effect of sole or intercropped soybean on the yield and yield components of soybean in 2000/2001 and 2001/2002 cropping seasons

Cropping system	No. of pods/plant	Pod dry weight/plant (g)	100-seed weight (g)	*Grain yield (kg/ha)
2000/2001				
Sole soybean	46.31a	12.64a	12.87	670.1a
NR 8212 + soybean	32.51bc	8.62bc	11.16	428.87bc
TMS 91934 + soybean	27.56c	10.14ab	11.31	533.67b
TMS 30572 + soybean	38.4b	7.05bc	9.34	385.91c
2001/2002				
Sole soybean	37.44a	15.26a	11.33	566.35a
NR 8212 + soybean	22.01c	7.70bc	9.30	362.02b
TMS 91934 + soybean	20.30c	10.61ab	10.04	462.00ab
TMS 30572 + soybean	31.78b	6.53bc	8.18	339.52b

Within each column and for each cropping season, means followed by different letter (s) are significantly different ($P<0.05$) according to Duncan's new multiple range test

*Grain yield at 13% moisture content.

.Table 4: Effect of cassava genotypes on land equivalent ratio, area x time equivalent ratio, monetary equivalent ratio and gross returns in sole and cassava/soybean intercrops in 2000/2001 and 2001/2002 cropping seasons

Cassava genotype	Land equivalent ratio			Area x time Equivalent Ratio	Monetary equivalent ratio			Gross returns (₦/kg)		
	Partial		Total		Partial		Total	Partial		Total
	cassava	soybean			Cassava	soybean		cassava	soybean	
2000/2001										
Sole NR 8212	1.00	-	1.00	-	1.00	-	1.00	98,000	-	98,000
Sole TMS 91934	1.00	-	1.00	-	1.00	-	1.00	84,500	-	84,500
Sole TMS 30572	1.00	-	1.00	-	1.00	-	1.00	104,500	-	104,500
Sole soybean	-	1.00	1.00	-	-	1.00	1.00	-	48,247	48,247
NR 8212 + soybean	1.03	0.64	1.67	1.24	0.96	0.30	1.26	100,500	30,879	131,379
TMS 91934 + soybean	1.04	0.80	1.84	1.31	0.84	0.37	1.21	87,500	38,424	125,924
TMS 30572 + soybean	1.01	0.58	1.59	1.20	1.01	0.27	1.28	106,000	27,786	133,786
2001/2002										
Sole NR 8212	1.00	-	1.000	-	1.00	-	1.00	111,000	-	111,000
Sole TMS 91934	1.00	-	1.00	-	1.00	-	1.00	93,000	-	93,000
Sole TMS 30572	1.00	-	1.00	-	1.00	-	1.00	124,200	-	124,200
Sole soybean	-	1.00	1.00	-	-	1.00	1.00	-	45,308	45,308
NR 8212 + soybean	1.08	0.64	1.72	1.29	0.96	0.24	1.20	119,400	29,201	148,601
TMS 91934 + soybean	1.08	0.82	1.90	1.35	0.81	0.30	1.11	100,800	36,960	137,760
TMS 30572 + soybean	1.04	0.60	1.64	1.24	1.04	0.22	1.26	129,000	27,161	156,161

REFERENCES

Adetiloye, P.O. (1988). A review of current competition indices and models for formulating component proportions in intercropping. In: *Cassava Based Cropping Systems Research*, **II**: 72-90. International Institute of Tropical Agriculture, (IITA), Ibadan.

Ajayi, F. and S. Wainaina (1993). Nutritious soybeans, Africa's food of tomorrow. *African Farmer*, **8**: 48-49.

Crookston, R.K. and R. Kent (1976). Intercropping: a new version of an old idea. *Crops and Soil*, **28**: 7-9.

Egharevba, P.N. (1979). Plant type combination in mixed cropping involving sorghum and millet. The *Nigerian Agricultural Journal*, **16**: 115-129.

Egharevba, P.N. (1982). Testing varieties for compatibility in mixed cropping involving maize and cowpea. *Nigeria Agricultural Journal*, **17/18**: 231-242.

Ekanayake, I.J. (1994). Terminology for growth analysis of cassava. *Tropical Root and Tuber Crops Bulletin*, **8**: 2-3.

Enyi, B.A.C. (1973). Effects of intercropping maize or sorghum with cowpeas, pigeon pea or beans. *Experimental Agriculture*, **9**: 113-120.

Ezulike, T.O., A. Udealor, F.O. Anuebunwa, and R.P.A. Unamma (1993). Pest damage and productivity of different varieties of yam, cassava and maize in intercrops. *Agric., Sci. and Techn.*, **3 (1)**: 99-102.

Fisher, N.M. (1977). Studies differences in relative productivity of crop mixtures and pure stands in Kenya highlands. *Expl. Agric.*, **13**:185-191.

Hiebsch, C.K. and R.E. Mccollum (1987). Area x time equivalency ratio – a method for evaluating the productivity of intercrops. *Agron. J.*, **79**:15-20.

Huxley, C.K. and Z. Maingu (1978). Use of a systematic spacing design as an aid to the study of intercropping: Some general design considerations. *Expl. Agric.*, **14**: 49-56.

Ifenkwe, O.P and S.O. Odurukwe (1990). Potato/maize intercropping in the Jos plateau of Nigeria. *Fld. Crops Res.*, **25**: 75-82

Ikeorgu, J.E.G. and A.W. Iloka (1994). On-farm evaluation of the effects of three contrasting maize varieties on the productivity of cassava/maize intercrop in S.E. Nigeria. In: *Proceedings of the Fifth Triennial Symposium of the International Society for Tropical Root Crops,* Africa Branch, Kampala, Uganda, 22-28 November 1992, pp. 243-246.

Kumar, V. and Y.Yusuf (1991). Effects of row arrangements and component density of mixture on cotton/millet, cotton/groundnut and cotton/maize. *Niger Agric. J.*, **76**: 43-53.

Mazkinda, E.A. and A.A. Agboola (2001). Effects of fertiliser type and soybean residue incorporation on the performance and yield of cassava-sorghum intercrop. *Trop. Oil Seeds J*, **6**: 32-40.

Martin, J.H., W.H. Leonard and D.L. Stamp (1976). Soybean chemical composition. In: *Principles of Field Crops Production*. 3rd Ed., 698 pp. Macmillan Publishing Company Incorporated, New York.

Mead, R. and R.W. Willey (1980). The concept of a land equivalent ratio and advantages in yields from intercropping. *Expl. Agric.*, **16**: 217-228.

Moraghan, B.J. (1970). Plant characters related to yield responses of unselected lines in various row widths and plant populations. Ph. D. Dissertation, Iowa State University Microfilms. Ann. Arbor. Mich. Dissertation Abstracts, **70**, 07311.

Muoneke, C.O., I.O. Akigbade and M.D. Magaji. (2002). Productivity of roselle/cowpea intercropping system in a semi-arid agroecology. *Global J. Agric .Sci.,* **1 (2)**: 111-117.

Okpara, D.A., C.P.E. Omaliko, and R.A.E. Ugbaja (1995). Evaluation of the productivity of African yam bean (*Spenostylis stenocarpa*)/yam (*Dioscorea rotundata*) in intercrops under different African yam bean plant densities. *J. Sci., Engr., Techn.*, **2 (1)**: 9-15.

Okpara, D.A. and B. Ibiam (2000). Evaluation of soybean varieties for adaptability to a humid tropical environment in southeastern Nigeria. *J. Sustain. Agric. Environ.***2**: 26-31.

Olasantan, F.O. and E.O. Lucas (1992). Intercropping maize with crops of differing canopy heights and similar or different maturities using different spatial arrangements.J. Agric., Sci.. Techn., **1**: 13-22.

Steele, R.C.D. and J.H. TORRIE (1980). *Principles and procedures of statistics: A biometrical approach.* 2nd ed., 633 pp. New York. McGraw-Hill International Book Company Incorporated.

Tijani, E.H. and F.K. Akinnifesi (1996). On-farm evaluation of soybean and cassava intercropping in a south-west Nigeria. *Afr. Crop Sci. J.*, **4 (2)**: 151-157.

Unamma, R.P.A., S.O. Odurukwe, H.E. Okereke, L.S.O. Ene and O.O. Okoli, (1985). *Farming systems in Nigeria*, Report of the Bench Mark Survey of the Farming Systems of the Eastern Agricultural Zone of Nigeria, 141 pp. National Root Crops Research Institute (NRCRI), Umudike, Umuahia, Nigeria.

Wahua, T.A.T. and D.A. Millar (1978). Effects of shading on the N_2-fixation, yield and plant composition of field-grown soybeans. *Agron. J.*, **70**: 387-392.

Willey, R.W. (1979). Intercropping – Its importance and research needs. Part 1. Competition and yield advantages. *Fld. Crops Abstr.*, **32**: 1-10.