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EFFECT OF INTERCROPPING PUMPKIN WITH CASSAVA ON SOIL MICRO- ENVIRONMENT, WEED CONTROL, CROP GROWTH AND YIELDS

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ABSTRACT

Experiments were conducted in Abeokuta, Nigeria in a forest-savanna transition zone to evaluate the effects of intercropping pumpkin with cassava (Cv. *Odongbo Idileru and TMS 30572*) on soil micro environment, weed control, crop growth and yields. Experimental design used was Randomized Complete Block Design with three replicates. Intercropping cassava with pumpkin significantly reduced supra-optimal soil temperature by 1.1-2.4 ^{0}C and weed biomass by 19-140%, and increased soil moisture content by 19-33g kg,$^{-1}$ light interception by 67% and earthworm cast by 87% compared with sole cassava. Intercropping did not significantly affect the vegetative characters, number of days to harvesting and harvest duration of pumpkin, irrespective of the cassava cultivars. However, intercropping with cassava significantly increased the aggregate leaf area index of both crops by 35-77% and 45-58% compared with sole cropped pumpkin and cassava, respectively. Although, tuber yield of cassava was significantly reduced by 7-11% when intercropped with pumpkin, yield advantage of intercropping increased by 42-91% compared to sole cropping. Irrespective of the cropping system; TMS 30572 produced higher tuber yield of 5-20% than "Idileru" and 21-41% than "Odongbo". It is concluded that pumpkin can be grown in mixture with cassava to provide a suitable environment for growth, but this depends on the cassava cultivar. Using a short early maturing cassava cultivar with a moderate leaf area index (TMS 30572) in a mixture with pumpkin is therefore recommended.

Key words Intercropping, ***C****ucurbita maxima*, Pumpkin, Cassava, *Manihot esculenta,* Odongbo, Idileru, TMS 30572, Soil microenvironment.

INTRODUCTION

Intercropping is a common farming practice in the tropics. There is rarely a traditional farm in the region where vegetables are not grown as minor crops in mixtures with tubers, cereals and food legumes. About 50-60% of the vegetables consumed locally in Africa come from this source (Olasantan, 1999; Schippers, 2000). Besides the food they produce, vegetables are sometimes intercropped with staple food for their ecological stability and bio-cultural attributes (Okigbo, 1980; Olasantan, 1988). The choice of component crops and mixture proportions, however, depend on the agro-ecological zone and the contribution of different crops in the mixtures to farmers' diets and subsistence.

Cassava is an important staple food of 160-200 million people or 50-60% of west and central Africa population (Anon, 1988).

Besides its use as food, cassava is an important raw material for production of starch, alcohol, pharmaceutics, gums, confectionaries and livestock feed (Nnodu *et al*., 1985). The annual output of cassava in Nigeria; the world's largest producer, is estimated as 33 million tonnes/annum (FAO 2000). Cassava is a long duration crop that is usually grown in wide-spaced rows and planted early when the rains begin. It occupies the land for about 12-18 months and its initial growth and canopy development is slow. It takes about 3-4 months before its canopy closes (Dahniya and Jalloh, 1995), and more than 50% of the light transmitted is wasted during this period (Tsay *et al*., 1987; Olasantan, 1994). It is therefore uneconomical to grow cassava as a sole crop for such a long period. However, the wide inter-row spaces, coupled with the growth habit provide the opportunity of growing vegetables between cassava rows to diversify production (Olasantan, 2001).

Pumpkin (*Cucurbita maxima* Duch. Ex. Lam) is a creeping vegetable widely grown in the humid tropics. Its apical shoot and fruits are edible by humans and some livestock. Pumpkin apical shoots and immature fruits are a good source of protein, vitamins and particularly minerals (Purseglove, 1977; Olasantan, 2007). Because of its creeping foliage, pumpkin is often found in mixtures with staple food crops such as maize (*Zea mays* L), yam (*Dioscorea spp.*), and cassava (*Manihot esculenta*) to suppress weeds and conserve soil moisture within the root zone as well as to protect the soil against insolation, rainsplash and surface erosion. In spite of its nutritional values and ecological attributes, pumpkin is grouped among the endangered crops in West Africa because little research extension has been placed on its production and only a few farmers grow it. Investigation on the ecological and biological attributes of pumpkin in mixed intercropping systems with respect to its productivity, conservation and nutritional improvement is worthwhile, with a view to possibly improving the system. This study was therefore conducted to investigate the effect of intercropping pumpkin with cassava on soil microenvironment, weed control, crop growth and yields.

MATERIALS AND METHODS

Experimental site and cropping history

The experiments were conducted in 2001 and 2002 at the University of Agriculture, Abeokuta, located on 7°15'N latitude and 3° 25'E longitude in south-western Nigeria. The experiment in 2002 was conducted on a plot adjacent to that of 2001. The rainfall pattern is bimodal with peaks in June and September. The annual rainfall values for 2001 and 2002 were 950 and 1721mm, respectively, out of which 62 and 54% of the total rainfall were received during June to November of the two years. The mean, minimum and maximum temperatures ranged from 11-18°C and 30-36°C, respectively (Table 1). The weather records were measured at a meteorological station 2-3km from the experimental site.

The land had previously been planted to maize, but left under natural fallow for three years before the experiment began in 2001. The weeds that were prevalent in the experimental sites were *Tridax procumbens* Linn, *Talinum triangulare* (Jacq.) Willd, *Spigelia anthelmia* Linn., *Euphorbia hirta* Linn, *Corchorus olitorus* L., *Chromolaena odorata* L., *Aspilia africana, Ageratum conyzoides* Linn, *Acalypha ciliata, Commelina benghalensis* Linn and *Andropogon tectorum*, which constituted over 80% of the total weed population. Surface soil (0-

20cm depth) samples were randomly taken from the experimental site with the aid of a soil core sampler of 10cm length and bulked to form a composite. The soil was air-dried and sieved through 2mm mesh size sieve. Sub sample was taken for laboratory analysis. The soil was a sandy loam with an average of 88% sand, 5% silt and 7% clay. The soil had 3.08% Organic matter, 0.15% total Nitrogen, 2.56 $mgkg^{-1}$ available P (bray) with 22.8, 4.55 and 0.62 $Cmolkg^{-1}$ of Ca, Mg and K respectively. Soil pH (H_2O) was 6.95 at 20 cm depth.

Description of test crops

Three cassava cultivars, TMS30572, an improved variety, early branching with dense canopy; "Idileru", a local variety, late branching with dense canopy, and "Odongbo", a local variety, late branching with sparse canopy were used for the experiment. Pumpkin (Elegede), a local, non tendril variety with green-pigmented fruits was used.

Land preparation

The land was ploughed twice and harrowed once, by using disc plough and disc harrow respectively, before the plot was laid out.

Table 1: Monthly rainfall, minimum and maximum temperature in 2001, 2002, at Abeokuta

	Total Rainfall (mm)		Min Air Temp (°C)		Max Air Temp (°C)	
	2001	2002	2001	2002	2001	2002
Jan	2.60	0.0	16.0	14.0	35.1	33.7
Feb	8.60	2.7	15.7	11.8	36.7	36.8
Mar	80.0	380.6	18.5	10	35.0	36.7
Apr	105.0	136.9	16.8	8.9	34.4	32.5
May	154.3	131.9	17.1	9.9	32.8	32.3
Jun	135.9	133.7	17.4	10.2	31.0	31.6
Jul	135.5	325.5	18.0	11.4	29.6	30.5
Aug	57.4	110.1	17.2	8.4	35.7	29.6
Sep	199.3	148.7	11.1	8.4	30.2	30.6
Oct	54.5	297.0	10.7	8.3	32.0	31.5
Nov	17.4	54.5	11.8	10.9	32.2	34.7
Dec	0.0	0.0	12.9	9.9	34.4	35.4
Ann.	950.5	1721.6				
Mean	79.2	143.5	15.3	10.2	33.3	33

Source: Ogun-Oshun River Basin Development Authority, Abeokuta Nigeria.

Treatments and Experimental Design

The experimental design was a Randomized Complete Block Design with three replicates. The treatments consisted of sole pumpkin, sole cassava Odongbo, sole cassava Idileru, sole cassava TMS 30572, Cassava Odongbo + pumpkin, Cassava Idileru + pumpkin, Cassava TMS 30572 + pumpkin. Each plot measured 12 m x 5 m (60 m^2).

Planting

The crops were planted on a flat. Pumpkin was sown on 13 June, 2001 and 20 July, 2002, while cassava was planted on 20 June 2001 and 27 July in 2002. Cassava was planted at 1m x 1m spacing giving 10,000 plants ha^{-1} and pumpkin at 1m x 1m spacing to give 10,000 plants ha^{-1} in both monoculture and mixed stands. A constant arrangement of one row of pumpkin bordering one row of cassava with 0.50 m apart was used in the mixed stands.

Fertilizer application

A basal treatment of 40 $kgNha^{-1}$ of NPK 20:10:10 fertilizer was applied 3 weeks after planting in all plots containing pumpkin using band method. The fertilizer was drilled into furrows 25cm from the pumpkin and cassava.

Weed and Pest Control

All plots were weeded manually at 4, 8 and 12 weeks after planting. Weed dry weights were measured at 8WAP in each year. Weed samples were taken diagonally from three – 1-m^2 areas in each plot and oven dried at 60 ^oC for 72 hr. Foliar pests such as flea beetle and lady bird beetle were controlled by application of 400 ml ha^{-1} of Cymbush 10 EC (containing 100gl^{-1} Cypermethrin in 500L of water).

Field measurements and data analysis

Soil temperature at a depth of 10 cm was measured with soil thermometer installed at the centre rows of all plots at 10 and 12 WAP at 16hr local time when the differences between pure and mixed stands were highest (Olasantan *et al*., 1996). Soil samples were collected with core sampler at 0-15 cm depth adjacent to the thermometers, and oven dried at 105^oC for 24 hr to determine the gravimetric soil moisture content. Average soil temperature and moisture regimes were determined on clear days 22 August and 4 September in 2001 and 24 September and 6 October in 2002. Light interception was measured using a digital micro-ammeter (Type 199.9 μa) at 12WAP. The light meter was positioned between cassava and pumpkin at the ground level in the mixed plots, one at the top of pumpkin and one at the top of cassava canopy. Surface earthworm casts were collected within three 1m^2 quadrants in each plot at 25WAP and counted. Parameters on light interception and surface earthworm casts were obtained only in 2002.

Vine length, number of leaves or branches per plant, leaf area and leaf area index (LAI) were determined on five pumpkin plants at 10WAP. Leaf area of pumpkin was determined from its relationship with the leaf-width using the linear equation described by Salau and Olasantan (2006). The estimated regression line between leaf area (Y) and leaf -width (X) is:

$$Y = -122.45 + 19.41X \quad r^2 = 0.96$$

Leaf area index was calculated as:

LAI = Leaf area of plant (cm^2) $plot^{-1}$/plot area (cm^2).

Harvesting of pumpkin commenced in mid-August and mid-September in 2001 and 2002, respectively, with the harvest of young apical shoot (30cm long) fortnightly for ten

weeks. Harvesting was done on the net plot of 40 m^2 The weight and the number of apical shoots were recorded. Weight and number of fruits of pumpkin were recorded at maturity, 21-22 WAP in both years.

Ten cassava plants from each plot were randomly selected at 12 WAP to determine plant height, number of leaves and branches per plant, leaf area and LAI. Leaf area of cassava was determined from its relationship with mid-lobe length using linear equation described by Ramanujam and Indira (1978). The estimated regression equation between leaf area (Y) and mid-lobe length (X) is

$$Y = 156.64 + 23.07X \quad (r^2 = 0.88)$$

At 15 months after planting, 20 cassava plants were harvested from the centre rows to determine the number of tubers, tuber weight and the fresh tuber yield per hectare.

Land use efficiency of cassava/pumpkin intercrop was determined using land equivalent ratio (LER) concept (Mead and Willey, 1980). LER was defined as the ratio of intercrop yield to sole crop. It was calculated as follows:

$$LER = E_i^n = {}_1 (Y_i 1/Y^M)$$

where Yi^i is the yield of crop i in intercropping, Y_i^m is the yield of crop in monocropping and n is the total number of crops in association.

Data collected were subjected to analyses of variance (ANOVA) using the procedures of Statistical Analysis System (SAS, 1990). Treatment means were separated by using Least Significant Difference (LSD) at 5% probability level. Simple linear correlation analysis was carried out to estimate the degree of association between crop growth and microenvironment factors.

RESULTS

Modification of growth environment

The soil temperatures and soil moisture contents in sole cropped pumpkin and cassava/pumpkin intercrops were not significantly different, irrespective of the cassava cultivars in each year (Table 2). However, cassava/pumpkin intercropping increased soil moisture and decreased soil temperatures when compared with sole cropped cassava. Between 10 and 12 WAP, the soil temperatures were 2.1-2.4^{o}C and 1.0 – 1.1^{o}C cooler, and the soil moisture content 24 – 33 and 19 – 22gkg^{-1} greater, respectively, in 2001 and 2002 in cassava/pumpkin intercrop than in cassava monoculture. However, soil moisture content and soil temperatures were not significantly affected by cassava cultivars. Similarly, intercropping significantly increased light interception and the number of earthworm casts (Table 3). Light interception was 67% higher while number of surface earthworm casts was 87% higher in cassava/pumpkin mixtures than in sole cassava plots. Cassava cultivar effect was not significant on light interception and surface earthworm casts.

Weed growth

In both years, intercropping with pumpkin had significant effect on weed suppression (Table 3). Cassava/pumpkin decreased weed growth by 5-19% and 74-140% compared with sole crop pumpkin and sole cassava, respectively. TMS30572 decreased weed growth more by 17-40%, and 21-23% compared with "Odongbo" and "Idileru" cultivars respectively.

Table 2: Effects of sole crops and cassava/ pumpkin mixtures on soil moisture content and soil temperatures at Abeokuta, Nigeria in 2001 and 2002

Treatment	Soil moisture content (g/kg)				Soil temperature (°C)			
	2001		2002		2001		2002	
	10*	12	10	12	10	12	10	12
Sole crop Pumpkin	170	139	111	157	26.4	27.5	26.8	27.5
Odongbo/Pumpkin	163	143	115	158	26.4	27.6	27.3	27.5
Idileru/Pumpkin	165	142	115	162	26.3	27.5	27.6	27.2
TMS30572/Pumpkin	152	146	113	158	26.0	27.8	27.2	27.3
Sole crop Odongbo	118	108	84	118	28.7	31.3	28.5	28.6
Sole crop Idileru	122	111	82	117	28.4	30.8	28.5	28.3
Sole crop TMS30572	123	111	84	121	28.0	30.5	28.4	28.3
LSD, 5%	14.6	17.3	2.6	18.6	0.49	0.70	0.41	0.40

* Time of sampling (Weeks after planting)

Table 3: Effects of sole crops and cassava/ pumpkin mixtures on weed biomass, percentage light interception and number of earthworm casts at Abeokuta in 2001 and 2002

Cropping system	Weed biomass (g/m2)		Light interception (%)	No. of earthworm casts/m2
	2001	2002	2002	2002
Sole crop pumpkin	197	121	65	87
Odongbo/pumpkin	117	121	65	83
Idileru/pumpkin	110	108	65	86
TMS30572/pumpkin	106	116	66	90
Sole crop Odongbo	311	208	34	50
Sole crop Idileru	268	247	41	40
Sole crop TMS30572	235	176	36	50
LSD, 5%	32.7	23.8	7.6	14.2

*20 weeks after planting

Growth and yield characters of pumpkin

Intercropping did not significantly affect the vine length, number of leaves, number of branches and leaf area index (LAI) in 2001 and 2002 (Table 4). However, the aggregate LAI in the cassava/pumpkin mixture increased by 78 and 35% respectively compared with pumpkin in monoculture in both years. Irrespective of the cropping system, aggregate LAI was significantly affected by cassava cultivars. LAI of cvs "Idileru" in monoculture was 93 and 26% higher, while TMS30572 was 40 and 13% higher than cv. "Odongbo". Similarly, the LAI of cvs "Idileru" and TMS30572 intercrops were 21 and 8% higher than LAI in cv. "Odongbo", respectively in 2001 and 2002. Intercropping did not significantly affect days to first shoot harvest and harvest duration (Table 4), number of apical shoot per plant, weight per apical shoot, apical shoot yield and fruit yield in both years (Table 5).

Growth and tuber yield of cassava

Intercropping with pumpkin significantly reduced the leaf area index (LAI) of cassava by 49-90% at three months after planting in both years (Table 6). Tuber yield of intercropped cassava was also reduced by 7-11% compared with sole cassava in both years (Table 7). Cultivar 'Odongbo' produced the least LAI of 42 and 18% in 2001, and 25 and 14% in 2002, respectively, compared with cvs 'Idileru' and TMS30572. Similarly, cv 'Odongbo' had the lowest numbers of tuber per plant (22 and 36%, and 22 and 39%), and the lowest tuber yield per hectare (15 and 17%, and 15 and 21%) in 2001 and 2002, respectively, compared with cvs 'Idileru' and Odongbo. The corresponding values for cultivars "Idileru" and TMS30572 were similar in both systems.

Land Equivalent Ratio

Relative yield and land equivalent ratio of cassava/pumpkin intercropping was presented in Table 8. Irrespective of cassava cultivars, intercropping cassava with pumpkin gave LER values of 1.42–1.91 in the two years, giving yield advantage of 42–91% compared with sole cassava.

Correlation Analysis

There were significant correlation between micro environment and pumpkin growth and fruit yield. 68.5 and 68.1 % of the variation in aggregate LAI of pumpkin/cassava mixture were accounted for by the variation in soil moisture content and soil temperature, respectively, while 76 and 63 % of the variation were also accounted for by light interception and dry weed biomass, respectively (Table 9). 58% and 72 % of the fruit yields of pumpkin were accounted for by the variation in soil moisture and soil temperature. Soil moisture content, soil temperature, dry weed biomass and light interception significantly correlated with plant height of cassava. There were no significant correlation between soil moisture and soil temperature and tuber yield of cassava (Table 10).

Table 4: Vegetative characters, days to first apical shoot harvest and harvest duration of pumpkin in monoculture and intercropping with cassava at Abeokuta, Nigeria in 2001 and 2002

Cropping system	Vine length (cm)		No. of leaves/plant		No of branches/plant		Leaf area index		Days to 1st shoot harvest		Harvest duration	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Sole crop pumpkin	329	364	70	64	21.6	20.0	1.8	2.0	65	51	80	56
Odongbo/pumpkin	418	334	70	60	18.6	17.7	1.7 (2.8)*	1.8 (2.6)	65	51	80	56
Idileru/pumpkin	373	333	66	58	15.6	16.5	1.6 (3.5)	1.5 (2.8)	65	51	80	56
TMS 30572/ pumpkin	312	347	79	60	20.6	18.4	2.0 (3.4)	1.8 (2.8)	65	51	80	56
LSD, 5%	NS	NS	NS	NS	NS	NS	NS (1.09)	NS (0.41)	NS	NS	NS	NS

* Aggregate LAI

Table 5: Fresh apical shoot and fruit yield characters of pumpkin in monoculture and intercropping with cassava at Abeokuta, Nigeria in 2001 and 2002

Cropping system	No of apical shoot/plant		Length of apical shoot (cm)		Apical shoot yield (t/ha)		No of fruits/ plant		Weight / fruit (g)		Fruit yield (t/ha)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Sole crop pumpkin	13.9	15.0	33.4	34.3	1.78	1.74	1.4	1.8	639	799	8.2	14.4
Odongbo/pumpkin	12.0	14.5	30.1	32.4	1.51	1.61	1.8	1.5	551	845	9.7	12.8
Idileru/pumpkin	12.1	14.5	31.3	33.1	1.60	1.69	1.6	1.2	491	910	8.1	10.8
TMS 30572/pumpkin	12.4	15.9	30.9	31.5	1.53	1.75	1.7	1.3	622	886	10.1	11.6
LSD, 5%	*NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*Not Significant

Table 6: Vegetative characters of cassava (3 months after planting) in monoculture and in mixture with pumpkin at Abeokuta, Nigeria in 2001 and 2002

Cropping system	Plant height (cm)		No. of leaves/ plant		Leaf area index		Number of branches		No. of shoots/ plant	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Sole cassava										
Odongbo	62	83	45	46	1.53	1.51	1.0	1.0	1.5	1.2
Idileru	69	79	71	60	2.88	1.94	1.0	1.0	2.1	1.7
TMS30572	57	75	55	50	2.12	1.74	3.0	3.1	1.5	1.2
Sole cassava (mean)	63	79	57	52	2.18	1.68	1.6	1.7	1.7	1.4
Intercropped cassava										
Odongbo/pumpkin	51	59	40	30	1.15	0.80	1.0	1.0	1.4	1.1
Idileru/pumpkin	49	64	54	43	1.86	1.19	1.0	1.0	1.6	1.8
TMS 30572/pumpkin	38	60	49	37	1.39	0.99	2.0	2.4	1.5	1.3
(mean)	46	61	48	36	1.46	0.99	1.3	1.5	1.5	1.4
LSD, 5%										
Cropping	6.8	4.1	NS	5.3	0.32	0.21	NS	NS	NS	NS
Variety	NS	NS	8.2	6.5	0.40	0.25	NS	0.67	NS	0.21
Cropping x Variety	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 7: Tuber yield and yield components of cassava in sole crop and in mixture with pumpkin at Abeokuta Nigeria in 2001 and 2002

Cropping system	Number of tubers/plant		Weight/tuber (g)		Tuber yield (t/ha)	
	2001	2002	2001	2002	2001	2002
Sole cassava						
Odongbo	3.3	3.7	657	591	21.9	20.7
Idileru	4.9	4.7	554	520	27.3	24.2
TMS30572	5.6	6.0	509	476	28.5	28.6
Mean	4.6	4.8	573	529	25.9	24.5
Intercropped cassava						
Odongbo	3.3	3.3	624	584	20.6	19.4
Idileru	4.1	4.1	587	558	24.3	22.7
TMS30572	4.4	4.5	575	554	25.3	26.2
Mean	3.9	4.0	595	565	23.4	22.8
LSD 5%						
Cropping	0.25	0.24	NS	29.3	0.60	0.93
Variety	0.30	0.30	52.7	36.0	0.74	1.13
Cropping x Variety	NS	NS	NS	NS	NS	NS

Table 8: A comparison of yield advantages indicated by land equivalent ratio (LER) in a cassava-pumpkin intercropping at Abeokuta, Nigeria in 2001 and 2002

	Relative yield				LER	
Treatment	Pumpkin		Cassava			
	2001	2002	2001	2002	2001	2002
Odongbo/pumpkin	1.02	0.74	0.89	0.68	1.91	1.42
Idileru/pumpkin	0.90	0.70	0.76	0.76	1.66	1.46
TMS30572/pumpkin	1.04	0.71	0.74	0.77	1.77	1.48

Table 9: Correlation analysis between micro-environment variables and Aggregate leaf area index (LAI), earthworm casts, and fruit yield of pumpkin at Abeokuta, Nigeria.

Variables (n-2)	Agg. LAI	Earthworm casts (no/m2)	Fruit yield (t/ha)
Soil moisture content(g/kg)	0.685*	0.549*	0.582*
Soil temperature (o C)	-0.681*	-0.576*	-0.729**
Weed biomass (g/m2)	-0.625*	-0.542*	-0.535*
Light interception	0.758**	0.605*	-0.549*

* and ** significant at $p \leq 0.05$ and 0.01, respectively.

Table 10: Correlation analysis between micro-environment variables and plant height, number of leaves, leaf area index (LAI) and tuber yield of cassava at Abeokuta, Nigeria.

Variables	Plant height (cm)	Number of leaves	LAI	Tuber yield (t/ha)
Soil moisture content(g/kg)	-0.841*	-0.290	-0.580*	-0.174
Soil temperature (°C)	0.771*	0.200	0.429	0.257
Weed biomass(g/m2)	0.943**	0.143	0.429	0.029
Light interception	-0.812*	-0.174	-0.464	-0.145

* and ** significant at $p \leq 0.05$ and 0.01, respectively.

DISCUSSION

The study showed that there is a potential for growing pumpkin as an intercrop with cassava in southwestern Nigeria. In this study, the mean daily soil temperature, soil moisture and light interception prevailing in intercropping did not differ significantly from the pumpkin in monoculture. However, when compared with sole cassava, soil temperature in pumpkin sole or in mixture were significantly reduced, while the soil moisture and light interception increased, and weed growth suppressed.

The significant changes in the microenvironment in the pumpkin sole or mixture could be attributed to the aggregate higher leaf area index and spreading habit which covered the soil. As the number of crops in the mixture increased, the canopies became denser and covered the soil against insolation, enhanced water infiltration into the soil, minimizing heat and water loss by evaporation during the day and inversion of temperature gradient at night (Olasantan, 1988). The ground cover reduced the amount of radiant flux reaching the soil surface thereby reducing the energy available for absorption by the soil surface. Cooler environment as a result of lower soil temperature enhanced greater soil moisture with consequent increase in earthworm activity. Intercropping pumpkin with cassava also provided some control over weeds, an indication that pumpkin could be an effective live-mulch either as a sole crop or when intercropped with cassava. A similar effect of intercropping on soil micro environment had been reported for melon and maize (Wahua, 1985) cassava and okra (Olasantan, 2001) maize and cassava (Olasantan *et al.* (1996), Hulugalle and Ezumah (1991) and Ikeorgu *et al.* (1989).

Intercropping pumpkin with cassava did not significantly affect the growth and yield characters of pumpkin. This may be attributed to the difference in the stages of growth and developments in relation to resource requirements and utilization of both crops. The life cycles of cassava and pumpkin are different in both time and space dimension. Under normal conditions, pumpkin starts branching within the first six weeks and by 10-12 weeks, they would have established sufficiently by covering the ground, when the vegetative character of cassava has not attained their maximum values. The vegetative development of crops at any given time is reflected in the number of leaves, number of

branches and leaf size (Wahua, 1985). The number of leaves, number of branches and leaf area per plant of pumpkin which remained similar either in sole or in mixture is an indication that cassava, a long duration crop with slow initial growth and canopy development (Dahniya and Jalloh, 1995) did not compete seriously with pumpkin for environmental resources within the three months during that pumpkin would have established sufficiently.

Intercropping pumpkin with cassava significantly affected the vegetative growth of cassava. This could be attributed to the faster seedling establishment, enhanced vegetative growth and ground cover of pumpkin which slowed down the growth of cassava, when cassava was at its early growth stage. This possibly accounted for the negative correlation observed between microenvironment variables and cassava plant height (Table 10).

The tuber yields of cassava were also drastically affected. This indicated that the development of cassava might not have been enhanced by its recovery growth after pumpkin due to 5 months stay of pumpkin in association with cassava, despite full benefit it obtained from extra residual soil nutrient and moisture left over by pumpkin. Similar result was reported by Olasantan (2007). However, intercropping between pumpkin and cassava resulted in an efficient cropping system, judging by their combined LER, being greater than 1.0. Thus, the disparity in the time of reproductive development of both crop species is advantageous for the vegetables because they did not come to the stage of maximum demand for nutrient and moisture, aerial space and light at the same time.

CONCLUSION

The results of the study showed that intercropping pumpkin with cassava is a viable cropping option to diversify production and improve the soil micro environment. Intercropping reduced supra-optimal soil temperature, increased soil moisture, light interception and earthworm activity which subsequently increased total yield. When pumpkin is to be used for both live mulch and apical shoot and fruit production, intercropping it with TMS 30572, a less competitive, early maturing, high yielding with a moderately high leaf area index, cassava is recommended.

REFERENCES

Anonymous, 1988. Annual Report for 1987, IITA, Ibadan, Nigeria.

Dahniya, M.T., Jalloh, A. 1995. Relative effectiveness of sweet potato, melon and pumpkin as live-mulch in cassava. *Proceeding of the sixth Triennial Symposium of the International society for Tropical Root crops- Africa Branch*. 22-28 October 1995. pp 353-355.

F.A.O. 2000. Production year book, F.A.O of the United Nations, Rome, Italy.

Hulugalle, N.R., Ezumah, H.C 1991. Effect of cassava-based cropping system on physico-chemical properties and earthworm casts in a tropical Alfisol. *Agric. Ecosyst. Environ,* 35: 55-63.

Ikeorgu, J.E.G. Wahua, T.A.T., Ezumah, H.C. 1989. Effects of melon (*Citrillus lanatus* Thumb) and okra (*Abelmoschus esculentus* (L.). Moench) on soil moisture and leaf- water status of intercropped cassava/ maize in Nigeria. *Tropical Agriculture* (Trinidad), 66: 78-82.

Mead, R., Willey, R.W. 1980. The Concept of a 'Land equivalent ratio and advantages in yield from intercropping *Experimental Agriculture,* 16: 217 – 218.

Nnodu, **E.C. J.E. Okeke., A.G.O. Dixon**. 1995. Evaluation of newly improved cassava varieties for Nigeria ecologies. *Proceedings of the sixth Triennial Symposium of the International Society for Tropical Root Crops Africa Branch*. 22-28 October 1995. PP 207-216.

Okigbo, B.N. 1980. The importance of mixed stands in tropical agriculture, *In: Proceedings of 75th Anniversary Meeting of the Association of Applied Biology,* 17-21 September, 1979 (Eds. R.G Hurd, P.V. Biscoe and C. Dennis), pp 237-245, University of Reading.

Olasantan, **F. O.** 1988. The effects of soil temperature and moisture content on crop growth and yield of intercropped maize with melon. *Experimental Agriculture*, 24: 67-74.

Olasantan, F.O. 1992. Vegetable production in traditional farming system in Nigeria, *Outlook on Agriculture,* 21: 117-127

Olasantan, F.O. 1994. Nutrient requirement of cassava (*Manihot esculenta* Crantz) maize (*Zea may* L.) intercrop. Ph.D. thesis, University of Ibadan, Nigeria.

Olasantan, F.O. 1999. Effect of time of mulching on soil temperature and moisture regime and emergence, growth and yield of white yam in western Nigeria. *Soil and Tillage Research,* 50: 215-221.

Olasantan, **F.O.** 2001. Optimum plant populations for okra (*Abelmoschus esculentus)* in a mixture with cassava (*Manihot esculenta*) and its relevance to rainy season-based cropping systems in south-western Nigeria. *Journal of Agricultural Science, Cambridge*, 136: 207-214.

Olasantan, F.O. 2007. Effect of population density and sowing date of pumpkin on soil hydrothermal regime, weed control and crop growth, in a yam-pumpkin intercrop. *Experimental Agriculture,* 43: 365-380.

Olasantan, **F.O. Ezumah H.C., Lucas E.O.** 1996. Effects of intercropping with maize on the micro-environment, growth and yield of cassava. *Agriculture, Ecosystem and Environment,* 57: 149-158.

Purseglove. J.W. 1977. Tropical Crop Dicotyledons Vols.1 & 2 combined 2d edition. Boon Hua Printing Company PP. 100-138.

Ramanujam, T., Indira, P. 1978. Linear measurement and weight methods for estimation of leaf area in cassava and sweet potato, *Journal of Root Crops,* 4: 47-50

Salau, A.W., Olasantan F.O. 2006. Rapid leaf area estimation in pumpkin (*Cucurbita maxima) ASSET 6*(1): 255-258.

Schippers, R.R. 2000. African Indigenous Vegetables, An overview of the Cultivated Species. Chatham, UK: Natural Resources Institute/ACP-EU Technical Centre for Agricultural and Rural Cooperation. Pp. 16-31.

SAS, 1990. Statistical Analyses System (SAS).

Tsay, J.D, Fukai, S., Wilson, G.L. 1987. The response of cassava (*Manihot esculenta)* to spatial arrangement and to soybean inter-crop. *Field Crops Research,* 16: 19-31.

Wahua, T.A.T. 1985. Effects of melon (*Colocynthis vulgaris*) population density on intercropped maize (*Zea mays*) and melon. *Experimental Agriculture,* 21: 281-289.

Zuofa, K., Tariah, N.M., Isirimah, M.O. 1992. Effects of groundnut, cowpea and melon on weed control and yield of inter-cropped cassava and maize. *Field Crops Research,* 28: 309-314.

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