EFFECT OF STAKING HEIGHTS AND INTERCROPPING PRODUCTIVITY IN A YAM BASED CROPPING SYSTEM

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ABSTRACT

There is a dearth of information on staking height of yam and its intercropping potentials in Southern Nigeria. The study was therefore to evaluate the effect of different staking heights and intercropping productivity in a yam cropping system. Two field experiments were conducted in 2008 and in 2009. The experiment was arranged in a randomized complete design with four replicates. Yam with different staking heights as treatments {1.5m (short), 2.5m (medium) and 3.5m (tall)} were intercropped with egusi-melon and sweet pepper (tatase). Yam and sweet pepper leaves were counted; primary vine length of yam and sweet pepper plant height were measured while the percentage (%) vine coverage of egusi-melon was accessed with a quadrant. The result of the study showed that the number of leaves and tuber of yam were ($P < 0.05$) higher in tall stakes than in medium or short staked yam. Pepper leaves and height were ($P = 0.05$) similar in sole crops or 2 crops association and were ($P < 0.05$) higher than leaves in 3 crops association. Weeds were ($P < 0.05$) least in sole egusi-melon plots and egusi-melon in crop association(s). RY was highest in sole crops while LER was highest in 3 crop associations. Association of 3 crops with high stakes produced the highest LER and LEC. It is hereby concluded that in Southern Nigeria, tall stakes in yam farms as sole or in crop associations are hereby recommended.

INTRODUCTION

Intensification of cropping in time and space is an old practice in the humid tropics of Africa (Andrew and Kasim, 1976). It is prevalent on a small scale land holders. It is achieved by associating crops with different growth habits and duration on the same piece of land. This system offers higher aggregate yield per unit land area (Willey, 1979; Emuh and Agboola, 2000), through better use of growth resources in time and space (Agboola,1989),but however, sole crops yield were higher than their corresponding mixed stands yield (Lizarranga,1980; Emuh and Agboola, 2000).

With the ever increasing human population and pressure on arable land for housing and other developments, fallow period is reduced and results in low yield of crops. This situation can be circumvented by adopting a multi-storey cropping, which has capabilities of controlling erosion, weed suppression and increasing water holding capacity of the soil (Lal, 1975; IITA, 1979), by fell and decomposition of aerial parts of current and subsequent crops (Degras, 2005) and better management in improving the yield of crops. The farmer's most popular crop is yam. Yam is a man's crop and is associated with socio-economic and cultural signifance and plays a unique role in many festivals and ceremonies and is indispensible part of the bride price in most part of Nigeria (Hahn *et al.*, 1987; Ajayi and Aniaku, 2007).

Yam staking is a major concern for yam planters (Degras, 2005). Staking is required for optimum development, increasing height capture by the plant and enhances photosynthetic and biological efficiency of the crop (Orkwor and Asadu, 2000). Increasing the height of yam stakes leads to higher display of leaves and reduces the incidence of overlapping and mutual shadings of leaves (Peter, 2008). Higher stakes of yam translates to higher tuber yield of yam (Hahn *et al*, 1987; Osiru and Hahn, 1994). Staking of yam increases leaf area duration and is an important factor in increasing total tuber yield of yam (Enyi, 1972). Staked yam occupy the top most layer of the multi-storey cropping to intercept ample solar radiation (Orkwor and Asadu, 2000), while the associated component crop

occupies the lower strata in the multi-storey cropping.

Yam is intercropped with maize, pepper, ground nut, egusi-melon, leafy vegetables among others, which are grown in different combinations. However, the compatibility of some of these food crops with yam at different staking heights has not been accessed, since there is no standard staking height in Niger-Delta of Nigeria. Thus the objective of this study is to determine the effect of different staking heights of yam and its productivity in yam, pepper and egusi-melon intercropping system.

MATERIALS AND METHODS

The study involved two trials, which were conducted at Abbi, in Ndokwa west local Government area of Delta State. Abbi is located on latitude 050 43 1N and longitude 060 151E of the equator. The physico-chemical analyses of the soil at the experimental site were as follows: pH in water, 6.2; % organic carbon, 0.60%; total N, 0.28 and Available P, 14.00mg/kg. The exchangeable cations were: Ca, 6.80cmol/kg; Mg, 1.40g/kg; K, 0.51cmol/kg and Na, 0.13cmol/kg. The sand was 53%, while the silt and clay fractions were 29% and 18% respectively. Thus textural class was sandy loam.

The two trials were conducted in March to December 2008 and repeated in March to December 2009. The experiment was a randomized complete block design with four replicates. Each plot size measured 6m x 6m with 1m as interplot and interblock spaces. The treatments are underlisted as:

T1 Yam short staked
T2 Yam medium staked
T3 Yam tall staked
T4 Sweet pepper
T5 Yam short staked + sweet pepper
T6 Yam medium staked + sweet pepper
T7 Yam tall staked + sweet pepper
T8 Egusi-melon
T9 Yam short staked +egusi-melon
T10 Yam medium staked + egusi-melon
T11 Yam tall staked + egusi-melon
T12 Sweet pepper + egusi-melon
T13 Yam short staked + sweet pepper + egusi-melon
T14 Yam medium staked + sweet pepper + egusi-melon
T15 Yam tall staked + sweet pepper + egusi-melon

The crop varieties were yam (*Dioscorea rotundata* Poir cv Obiatorugo), pepper [(*Capsicum annum* L) (tatase)] and egusi-melon [(*Citrullus lunatus*) (Thumb) Mansf.]. Yam and egusi-melon were sown on 21st April 2008 and repeated on 15th April 2009. Yam was planted at a spacing of 1m x 1m, at the rate of 1 seed yam per hole while egusi-melon was spaced 100cm x 100cm, at a rate of 3 seeds per hole. Sweet pepper (tatase) was transplanted at 4 weeks old, at a spacing of 60cm x 60cm and at a rate of one seedling per stand. The crops population in pure stands and in their mixtures are presented in Table 1. The yam stands were staked 1.5m for short stake, 2.5m for medium stake and 3.5m for tall stake. The different staking heights were chosen for convenience in trailing the yam vines and for higher tuber yield. The primary vine length of yam was measured with a tape rule while yam leaves were counted at 2, 4 and 6 months after planting (MAP). The sweet pepper (tatase) height was measured with 1m rule and the leaves were counted at 4, 8 and 12 weeks after transplanting (WAT) while the % vine coverage was accessed within each plot. The weeds were accessed with a quadrant. The quadrants were randomly thrown into each plot and weeds were counted, harvested, dried and weighed at 6 and at 14 weeks after planting. The total weed weight per hectare was extrapoliated from the mean weight of four quadrant samples/plot. Data were also collected from the net stands of fruit yield of tatase, seed yield of egusi-melon and tuber yield of yam per plot. Harvesting of tatase fruit was done when the fruits were ripe while yam and egusi-melon were when the leaves were senescenced. The two years data were pooled and subjected to analysis of variance and means showing significant differences were separated using Duncan multiple range test (Duncan, 1955).

RESULTS

Number of leaves

The number of leaves of yam as influenced by different staking heights and crop combination are presented in Table 2. Yam

leaf production increased (P < 0.05) from 2 to 6 MAP, across the treatments and it ranged between 260 – 810 leaves (Table 2). At 4 MAP, leaf production was highest with tall stakes while leaf productions for medium and short stakes were similar. At 6MAP, leaf production in short staked yams were most significantly depressed (Table 2).

In pepper, the numbers of leaves as influenced by treatments are presented Table 3. The number of leaves were similar (P = 0.05) at one month after transplanting (MAT). At 2 and 3 MAT, the leaf production were similar (P = 0.05), at sole sweet pepper plot and sweet pepper in association of short, medium or tall staked yams (t4, t5, t6 and t7) with 8.7 to 9 leaves (Table 3). These leaf productions were higher (P < 0.05) than leaf productions in pepper and in egusi-melon plots and pepper in 3 crops association (t12, t13, t14 and t15) of 6.8 leaves to 7.1 leaves (Table 3). At 3MAT, the number of leaves ranged from 11.5 to 16. The leaf production was highest in sole plot of sweet pepper as 16 leaves (Table 3).

Plant height

The plant heights of sweet pepper (tatase) are presented in Table 4. Plant heights of sweet pepper were similar (P = 0.05) at one month after transplanting (MAT). It ranged from 13.2cm to 15.16cm (Table 4). At 2 MAT, the height of sole sweet pepper and sweet pepper in 2 crops association (t4, t5, t6 and t7) were (P < 0.05) taller than sweet pepper in 3crops association (t12, t13, t14 and t15) irrespective of staking heights. At 3MAT, sole crop of sweet pepper was tallest (36.61cm) but were similar to sweet pepper height in 2 crops association (Table 4).

Vine length

The primary vine lengths of yam are presented in Table 5. The vine length of staked yam increased (P < 0.05) from 2 to 6 months after planting (MAP). The vine length ranged from 195 to 270cm (Table 5). At 6MAP, the primary vine lengths of yam with tall stakes were (P < 0.05) longer than primary vine length of medium or short stakes. Within medium or short stakes, the primary vine length were (P = 0.05) similar (Table 5). The longest primary vine length was observed at sole crop of tall staked yam as 270cm (Table 5).

Percentage (%) vine coverage

The percentage (%) vine coverage of egusi -melon is presented in Table 6. At 2 weeks after planting (WAP), the vine coverage were similar (P = 0.05) for sole crop of egusi-melon and egusi-melon in 2 or 3 crops association (Table 6). Similar trend were observed at 4, 6 and at 8WAP (Table 6).

Weed suppression

The effects of weeds in the yam based cropping system are presented in Table 7. The weed count and shoot dry matter was highest in sole yam plots irrespective of staking heights and sole sweet pepper plots (Table 7). The treatments involving sole egusi-melon, egusi-melon with sweet pepper and egusi-melon with yam at different staking height and sweet pepper had (P < 0.05) least weed count and shoot dry matter at 6 and 14WAP (Table 7). The least dry weed matter was observed in tall staked yam/sweet pepper/egusi-melon plot as 9.81g/m^2(Table 7).

Yield

The tuber yields of yam, fruit yields of sweet pepper and seed yields of egusi-melon are presented in Table 8. Yam tubers were (P < 0.05) higher in tall staked yam than in medium or short staked yams either as a sole crop or yam in crop associations. The tuber yield ranged from 10.60 to 11.40t/ha (Table 8). The tuber yield of yam in medium or short stakes (P = 0.05) were similar (Table 8).

The Fruit yield of pepper was (P<0.05) higher in sole plots (4.9t/ha) and sweet pepper (4.5t/ha) in association of egusi-melon than sweet pepper in any other crop associations (Table 8). The fruit yield of sweet pepper in tall staked yam with egusi-melon association was most significantly depressed as 3.10t/ha (Table 8).

The seed yield of egusi-melon was (P<0.05) highest in sole plot (0.16t/ha) than egusi-melon in any crop association (Table 8). Within the crop associations' seed yields of egusi-melon in sweet pepper and yam at different staking heights was most significantly depressed (Table 8).

The relative yield (RY) was higher in sole crops than in their crop associations (Table 9). The RY of staked yam was in the order of tall > medium > short staked yams (Table 9). The land equivalent ratio (LER)

was higher in the order of 3crops association (3 crops mixture) > 2crops association (2crops mixture) > 1 or sole crops (Table 9). Within the 3 crops association, tall staked yam had higher LER than medium or short staked yam (Table 9). The land equivalent coefficient (LEC) was highest in sole crops than in their respective crop associations (Table 9). Within the same level of crop associations, the higher the LEC, the higher the productivity of such crop associations (Table 9). Thus, at 3 crop associations, tall staked yam/sweet pepper/ egusi-melon association had higher LEC of 0.32.

Table 1: Plant population per hectare in a yam based cropping system

Treatments	Yam with different Staking heights	Sweet pepper	Egusi-melon
Sole crops	10,000	27,778	30,000
Yam + sweet pepper	10,000	27,478	
Yam + egusi-melon	10,000		29,700
Sweet pepper + egusi-melon		27,778	29,700
Yam + sweet pepper +egusi-melon	10,000	27,378	29,400

Table 2: Number of yam leaf as influenced by staking and crop association Months after planting (MAP)

Treatments	2	4	6
t1 Yam short stake	278^{c}	720^{c}	670^{c}
t2 Yam medium stake	320^{b}	710^{c}	710^{b}
t3 Yam tall stake	480^{a}	800^{a}	810^{a}
t5 Yam short stake + sweet pepper	270^{c}	690^{c}	610^{c}
t6 Yam medium stake + sweet pepper	318^{b}	720^{c}	640^{c}
t7 Yam tall stake + sweet pepper	390^{a}	800^{a}	780^{a}
t9 Yam short stake + egusi-melon	300^{b}	670^{c}	610^{c}
t10 Yam medium stake + egusi-melon	331^{b}	720^{c}	710^{b}
t11 Yam tall stake + egusi-melon	410^{a}	760^{a}	790^{a}
t13 Yam short stake + sweet pepper +egusi-melon	260^{c}	710^{c}	610^{c}
t14 Yam medium stake + sweet pepper+ egusi-melon	328^{b}	740^{c}	650^{c}
t15 Yam tall stake + sweet pepper +egusi-melon	398^{a}	800^{a}	730^{a}

Means in the same row with similar letter superscript are not significantly different at 5% level of probability according to Duncan Multiple Range Test.

Table 3: Sweet pepper (tatase) number of leaves as influenced by crop associations

Treatment	Months after transplanting (MAT) 1	2	3
t4 Sweet pepper	3.8[a]	9.0[a]	16.0[a]
t5 Sweet pepper + yam short stake	3.4[a]	8.7[a]	15.0[a]
t6 Sweet pepper + yam medium stake	3.4[a]	8.7[a]	14.0[a]
t7 Sweet pepper + yam tall stake	3.5[a]	9.0[a]	15.0[a]
t12 Sweet pepper + egusi-melon	3.3[a]	7.0[a]	12.8[b]
t13 Sweet pepper + yam short stake +egusi-melon	2.8[a]	6.8[a]	11.8[b]
t14 Sweet pepper + yam medium stake +egusi-melon	2.8[a]	7.1[a]	11.8[b]
t15 Sweet pepper + yam tall stake + egusi-melon	2.8[a]	6.8[a]	11.5[b]

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan Multiple Range Test

Table 4: Sweet pepper (tatase) height (in cm) as influenced by crop associations

Treatment	Months after transplanting (MAT) 1	2	3
t4 Sweet pepper	15.16[a]	32.59[a]	36.61[a]
t5 Sweet pepper + yam short stake	13.37[a]	30.80[a]	34.00[a]
t6 Sweet pepper + yam medium stake	13.91[a]	28.14[ab]	30.68[ab]
t7 Sweet pepper + yam tall stake	14.25[a]	31.56[a]	32.60[a]
t12 Sweet pepper + egusi-melon	13.80[a]	27.40[ab]	28.00[ab]
t13 Sweet pepper + yam short stake +egusi-melon	13.37[a]	26.91[b]	26.91[b]
t14 Sweet pepper + yam medium stake +egusi-melon	13.40[a]	23.14[b]	24.50[b]
t15 Sweet pepper + yam tall stake + egusi-melon	13.12[a]	24.80[b]	24.00[b]

Means in the same row with similar letter superscript are not statistically different at 5% level of probability acc Duncan Multiple Range Test

Table 5: Primary vine length (in cm) yam leaf as influenced by staking and crop association

Treatments	Months after planting (MAP) 2	4	6
t1 Yam short stake	199[a]	230[a]	252[b]
t2 Yam medium stake	201[a]	228[a]	250[b]
t3 Yam tall stake	200[a]	232[a]	275[a]
t5 Yam short stake + sweet pepper	195[a]	231[a]	248[b]
t6 Yam medium stake + sweet pepper	198[a]	230[a]	250[b]
t7 Yam tall stake + sweet pepper	201[a]	234[a]	264[ab]
t9 Yam short stake + egusi-melon	202[a]	228[a]	249[b]
t10 Yam medium stake + egusi-melon	201[a]	231[a]	255[b]
t11 Yam tall stake + egusi-melon	198[a]	234[a]	271[a]
t13 Yam short stake + sweet pepper +egusi-melon	198[a]	228[a]	246[b]
t14 Yam medium stake + sweet pepper +egusi-melon	196[a]	230[a]	258[b]
t15 Yam tall stake + sweet pepper +egusi-melon	200[a]	231[a]	262[ab]

Means in the same row with similar letter superscript are not significantly different at 5% level of probability ac to Duncan Multiple Range Test.

Table 6: Percentage vine coverage of egusi-melon as influenced by crop association

Treatment	Weeks after planting (WAP) 2	4	6	8
t8 Egusi-melon	1.45[a]	3.20[a]	4.72[a]	5.00[a]
t9 Egusi-melon + yam short stake	1.40[a]	3.21[a]	4.38[a]	5.00[a]
t10 Egusi-melon + yam medium stake	1.41[a]	3.20[a]	4.41[a]	5.00[a]
t11 Egusi-melon + yam tall stake	1.43[a]	3.20[a]	4.35[a]	5.00[a]
t12 Egusi-melon + sweet pepper	1.41[a]	3.21[a]	4.45[a]	5.00[a]
t13 Egusi-melon + yam short stake +sweet pepper	1.42[a]	3.31[a]	4.63[a]	5.00[a]
t14 Egusi-melon + yam medium stake +sweet pepper	1.44[a]	3.34[a]	4.52[a]	5.00[a]
t15 Egusi-melon + yam tall stake +sweet pepper	1.46[a]	3.34[a]	4.61[a]	5.00[a]

Means in the same row with similar letter superscript are not statistically different at 5% level of probability according to Duncan Multiple Range Test

Table 7: Effect of crop association on weed suppression using weed count and shoot dry matter in yam based cropping system

Treatment	Weed count 6WAP	14WAT	Dry weed matter in g/m^2 at 14WAP
t1 Yam short stake	160.2[a]	50.31[a]	27.30[a]
t2 Yam medium stake	161.4[a]	50.00[a]	26.80[a]
t3 Yam tall stake	161.8[a]	48.20[a]	27.40[a]
t4 Sweet pepper	155.8[a]	48.30[a]	20.79[a]
t5 Yam short stake + sweet pepper	138.0[ab]	32.40[b]	21.00[a]
t6 Yam medium stake + sweet pepper	126.4[b]	31.30[b]	20.40[a]
t7 Yam tall stake + sweet pepper	120.6[b]	35.00[ab]	18.90[b]
t8 Egusi-melon	85.3[c]	21.40[c]	10.01[c]
t9 Yam short stake + egusi-melon	96.3[c]	20.10[c]	9.90[c]
t10 Yam medium stake + egusi-melon	94.8[c]	18.60[c]	10.00[c]
t11 Yam tall stake + egusi-melon	97.0[c]	19.40[c]	10.00[c]
t12 Sweet pepper + egusi-melon	93.0[c]	21.00[c]	9.41[c]
t13 Yam short stake + sweet pepper +egusi-melon	96.5[c]	20.00[c]	9.36[c]
t14 Yam medium stake + sweet pepper +egusi-melon	84.3[c]	19.40[c]	9.10[c]
t15 Yam tall stake + sweet pepper +egusi-melon	85.0[c]	18.30[c]	9.81[c]

Means in the same row with similar letter superscript are not significantly different at 5% level of probability according to Duncan Multiple Range Test.

Table 8: Yield in a yam based cropping system

Treatment	Yam tuber (t/ha)	S/pepper (fruit) (t/ha)	Egusi-melon (seed) (t/ha)
t1 Yam short stake	9.92[b]		
t2 Yam medium stake	10.20[b]		
t3 Yam tall stake	11.40[a]		
t4 Sweet pepper		4.90[a]	
t5 Yam short stake + sweet pepper	9.30[b]	3.31[b]	
t6 Yam medium stake + sweet pepper	10.10[b]	3.30[b]	
t7 Yam tall stake + sweet pepper	11.15[a]	3.30[ab]	
t8 Egusi-melon			0.16[a]
t9 Yam short stake + egusi-melon	9.40[b]		0.12[ab]
t10 Yam medium stake + egusi-melon	10.00[b]		0.12[ab]
t11 Yam tall stake + egusi-melon	11.00[a]		0.12[ab]
t12 Sweet pepper + egusi-melon		4.50[a]	0.13[ab]
t13 Yam short stake + sweet pepper +egusi-melon	9.10[b]	3.20[ab]	0.10[b]
t14 Yam medium stake + sweet pepper +egusi-melon	9.60[b]	3.17[ab]	0.95[b]
t15 Yam tall stake + S/pepper +egusi-melon	10.60[a]	3.10[b]	0.09[b]

Means in the same row with similar letter superscript are not significantly different at 5% level of probability According to Duncan Multiple Range Test

Table 9: Relative yield and land equivalent ratio (LER) of a yam based cropping system as influenced by staking height.

		Yam	S/pepper	Egusi-Melon	LER	LEC
t1	Yam short stake	0.87			0.87	0.87
t2	Yam medium stake	0.89			0.89	0.89
t3	Yam tall stake	1.00			1.00	1.00
t4	Sweet-pepper		1.00		1.00	1.00
t5	Yam short stake + sweet-pepper	0.81	0.67		1.48	0.54
t6	Yam medium stake + s/pepper	0.88	0.67		1.55	0.58
t7	Yam tall stake +sweet- pepper	0.97	0.67		1.64	0.64
t8	Egusi-melon			1.00	1.00	1.00
t9	Yam short stake + egusi-melon	0.82		0.75	1.57	0.61
t10	Yam medium stake + egusi-melon	0.88		0.75	1.63	0.66
t11	Yam tall stake + egusi-melon	0.96		0.75	1.71	0.72
t12	Sweet pepper + egusi-melon	0.92		0.81	1.73	0.74
t13	Yam short stake + egusi-melon +sweet pepper	0.79	0.65	0.62	2.06	0.31
t14	yam medium stake +sweet- pepper + egusi-melon	0.84	0.64	0.59	2.07	0.31
t15	Yam tall stake +sweet pepper + egusi-melon	0.92	0.63	0.56	2.11	0.32

DISCUSSION

The number of leaves of *Dioscorea rotundata* Poir (white yam) increased from 260 to 810 at 2 to 6MAP. This can be ascribed to positive development in the growth and maturity of the white yam crop. This agrees with the findings of Akambi *et al.* (2007), who reported an increase from 316.7 to 1003.7 leaves from 2MAP to harvest at Ogbomosho, South-Western Nigeria. Similarly, Law-Ogbomo and Remison (2008), reported an increase in the number of yam leaves from 350 to 1110 and mean of 541 to 965 at 4MAP (16 weeks) to 6MAP (24 weeks after planting). The higher the yam stake, the higher the leaf production agrees with the findings of Degras (2005), who reported that, staking increased light capture and enhances the photosynthetic efficiency of yam leaves. Similarly, Peter (2008) reported that, the taller the yam stakes, the greater the display of leaves with minimal mutual shading and overlap. However, Hahn *et al.* (1988), Osiru and Hahn (1994) reported a staking of up to 4m.

The leaf production of sweet pepper (tatase) increased from one to three months after transplanting (1 – 3MAT), of which ranged from 11.5 to 16 at 3MAT. This leaf production agrees with the findings of Law-Ogbomo and Law-Ogbomo (2010), who reported a similar range of 11.83 to 18.17 per plant at 3MAT. The leaf production in sole crop than in their crop associations agrees with the findings of Emuh and Agboola (2000), who reported higher leaf production in sole crops than in their crop association.

The plant height of sweet pepper showed a consistent trend in 2 and 3MAT. Sole crop of sweet pepper had the highest height, while sweet pepper in 3 crop association was most significantly depressed. This congruent the findings of Olasantan (1987), who reported higher growth parameters in sole crops than in their intercrops. At 3MAT, sweet pepper plants height ranged from 24 to 36.61cm agrees with the findings of Law-Ogbomo and Law-Ogbomo (2010), who reported a similar height of pepper plant of 36.60cm.

The primary vine length of yam increased from 2 to 6MAP at a range of 195 to 270cm at harvest. This agrees with the findings of Akambi *et al,*(2007), who reported an increase of primary vine length of white yam, and a range of 112.7 to 338.0cm at harvest in Ogbomosho, South-western Nigeria. The tall stake had higher vine length than medium or short stakes indicates that, there is a correlation between vine length and staking height.

The percentage (%) vine coverage of egusi-melon was similar within the egusi-melon treatments at the various period of measurement. This indicates the supressability of weeds in sole crops of egusi-melon or egusi -melon in association with other crops. Thus, crop associations without egusi-melon had higher weed count and shoot dry matter. The presence of egusi-melon, which is a live-mulch with its spreading habit, reduced weeds in the yam based cropping system. This congruent the findings of Emuh and Agboola (2000), on weed supressability by sweet potato (a live-mulch) as a sole crop and in crop associations, in Ibadan, South Western Nigeria. Similarly, Ojeifo and Emuh (2005) reported the reduction of weeds in crops associated with live mulch, in okra production in South- Western Nigeria.

The fruit yield of sweet pepper, seed yield of egusi-melon and tuber yield of yam were significantly higher in sole crops than in their respective crop associations. Whereas, the aggregate yield of the crop associations were higher than their sole crops. Similarly, the RY was higher in sole crops than in their individual crop associations while LER was higher in crop associations than sole crops. This agrees with the findings of Willey (1979), Ibeawuchi and Ofor (2003) and Ibeawuchi *et al* (2005),who reported higher aggregate yield in crop associations than in sole crops. This is most probably due to better use of resources through space and time (Agboola, 1989).

Within the same level of crop associations, the higher the LEC, the higher LER, and at different levels of crop associations, the lower the LEC, the higher the LER, agrees with the findings of Adetiloye (1983), who reported similar observation on LEC and LER for crop mixtures.

The general trend shows that, the taller the yam stake, the higher the tuber yield in this study. This congruent the findings of Okigbo (1973), Hahn *et al* (1987), Osiru and

Hahn (1994) who reported that tall yam stake led to higher tuber yield. Similarly, Peter (2008) posited that higher yield associated with tall yam stake was due to greater display of leaves than overlapping and mutual shading. This could have probably led to enhanced capture of solar radiation and higher production of photosynthate and net assimilate.

CONCLUSION

There is a need to grow egusi-melon/ sweet pepper/ yam with tall stake for weed reduction, higher aggregate yield, higher LER, higher LEC on the same level of crop association and lower LEC for 3 crops association than in 2crops association and sole crops. Thus an association of egusi-melon/sweet pepper/yam with tall stake is hereby recommended for higher productivity.

REFERENCES

Adetiloye, P.O., Ezedinma, F.O.C. and Okigbo, B.N. (1983). A land equivalent coefficient (LEC) concept for evaluating of competitive and productive interactions in simple to complex crop mixtures. *Eco. Modelling* 19:27- 39

Agboola, A.A. (1989). *Good soil management and appropriate farming practices .Key to soil productivity and food sufficiency in Nigeria* (inaugural lecture). University of Ibadan, Ibadan.

Ajayi, A.R. and Aniaku, L.O. (2007). Beliefs and Rituals in yam production: Evidence of change in Igbo- Etiti local Government area of Enugu State, Nigeria. *Journal of Rural Development* **26 (1):** 45-64

Akambi, W.B. Olaniran, O.A. and Olaniyan, A.B. (2007). Effect of integrated use of organic and inorganic nutrient sources on the growth and tuber characteristics of white yam (*Dioscorea rotundata*) cv ehuru. *African crop science proceedings* **8:** 359-363.

Andrew, D.J. and Kasim, A.H. (1976). The importance of multiple cropping in increasing world food supplies .Pp 1-10. In: *Multiple cropping* (Papendick, R.I. Sanchez, P.A. and Triplett, G.B. eds). American Society of Agronomy, Madison, Spec Pub. No 27, Pp 1-10.

Degras, L.O. (2005). The yam. A tropical root crop. Macmillan publisher, London.

Duncan, R.D.(1955). Multiple Range and multiple F test. *Biometrics* **11:** 25-40..

Emuh, F.N. and Agboola, A.A. (1999). Effect of intercropping sweet potato (*Ipomea batatas*) with pigeon pea (*Cajanus cajan*) and okra (*Hibiscus esculenta*) on economic yield of maize and maximization of land use. *Indian Journal of Agricultural Science* **69 (3):** 172-174

Emuh, F.N. and Agboola, A.A. (2000). The effect of intercropping sweet potato and pigeon pea on some growth parameters and yield of maize. *The Nigerian Agriculture Journal* **31:**1-12.

Enyi, B.A.C. (1972). Effect of staking, nitrogen and potassium on growth and development of lesser yam: *Dioscorea esculenta. Annals of Applied Biology* **72 (2):** 211-219.

Hahn, S.K., Osiru, D.S.O., Akoroda, M.O. and Otoo, J.A. (1987). Yam production and its future prospects. *Outlook on Agriculture* **16(3):** 105- 110

Ibeawuchi, I.I., Nwufor, M.I., Obasi, P.C. and Onyeka, U.P. (2005). Sustainable Agriculture as a tool for poverty alleviation: A review of strategies for crop production in South Eastern Nigeria. *JASR* **5 (2):** 11-19

Ibeawuchi, I.I. and Ofor, M.C. (2003). Effect of maize/cassava/food legume mixture in soil nutrient status and weed control. *Bionature* **23 (2):** 59-64

IITA (1979). *Annual report,* International Institute of Tropical Agriculture, Ibadan.

Lal, R.B. (1975). *Role of mulching technique in tropical soils and water management.* Technical bulletin No. 1. International Institute of Tropical Agriculture (IITA), Ibadan.

Law-Ogbomo, K.E. and Law-Ogbomo, J.E. (2010). Characterization and Evaluation of some cultivars of sweet pepper (*Capsicum annum*). *Notulae Scirntia Biologicae* **2 (1):** 49-54.

Law-Ogbomo, K .E. and Remison, S.U. (2008). Growth and yield of white guinea yam (*Dioscorea rotundata* Poir) influenced by NPK fertilization on a for-

est site in Nigeria. *Journal of Tropical Agriculture* **46 (1-2):** 21- 24

Lizarranga, H. N.A. (1980). *Evaluation of sweet potato and its association with cassava and maize.* M.sc. Thesis, Universidad de Costa Rica

Ojeifo, I.M. and Emuh, F.N. (2005). Evaluation of live mulch in Okra production in South Western Nigeria. *African Journal of Information Technology* **9 (1):** 77-85

Okigbo, B. N. (1973). *Effects of cultivation and heights and direction on staking on yield and general performance of Eight yam cultivars.* Proceedings of the 3rd symposium of International Society of Tropical Crops. (Leakey, C.L.A. Ed.), IITA, Ibadan.

Okoli, O.O. (1980). *Parameters for selecting parents for yam hybridization.* Proceedings of the first Triennial roots crops symposium of the International Society of Tropical Root Crops. Africa Branch held on 8th -12th Sept. 1980, in Ibadan, Nigeria.

Olasantan, F.O. (1987). The effect of soil temperature and moisture content on the growth and yield of intercropped maize and melon. *Experimental Agriculture* **24:** 67-74

Orkwor, G.C. and Asadu, C.L.A. (2000). Agronomy. In: *Food yams, Advances in Research.* (Orkwor, G.C., Asiedu,R. and Ekanayake, I.J eds.) IITA, Ibadan. 238pp.

Osiru, D.S.O. and Hahn, S.K. (1994). Effect of mulching materials on the growth, development and yield of white yam. *African Crop Science Journal* **2 (2):**153-160.

Peter, K.V. (2008).Underutilized and underexploited Horticultural crops. Vol. 1. New India publishing company, 392pp.

Willey, R.W. (1979). Intercropping. Its importance and Research needs. 1. Competition and yield advantages. *Field Crop* Abstract **32:** 1-10