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COMPATIBILITY OF COCOYAM *(Xanthosoma sagittifolium* (L.) Schott), EGUSI MELON *(Colocynthis citrullus L.)* AND PUMPKIN *(Cucurbita pepo L.)* IN INTERCROPPING SYSTEM.

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ABSTRACT

Field experiments were conducted in 1997 and 1998 at the Teaching and Research Farm, University of Ibadan, to assess the compatibility of cocoyam (*Xanthosoma sagittifolium (L)* Schott) in intercrop with 'egusi' melon (*Colocynthis citrullus (L)*) and pumpkin (*Cucurbita pepo (L)*). The experimental layout was a 2 x 5 factorial fitted in a randomized complete block design with four replications. The treatment combinations were: heap + cocoyam + melon, heap + cocoyam + pumpkin, heap + cocoyam, heap + melon, heap + pumpkin no-tillage + cocoyam + melon, no-tillage + cocoyam + pumpkin, no-tillage + cocoyam, no-tillage + melon and no-tillage + pumpkin.

Growth and yield of cocoyam as well as the yields of melon and pumpkin were similar on both heaped and no-tillage seedbeds. Pumpkin had greater competition with cocoyam on heaped seedbeds resulting in significantly lower (P=0.05) number of leaves per cocoyam plant at 12 weeks after planting (WAP) than other heaped treatments in 1997. Intercropping pumpkin with cocoyam on heap resulted in reduction of leaf area index (LAI) of cocoyam by 53.8% at 12 WAP compared to heap with no cover crop (control). Averaged over both years, cormel number per cocoyam plant was 9.2, 8.4 and 6.0 for melon, no cover crop and pumpkin treatments respectively. Melon enhanced cocoyam yield by 13.2 and 18.9% in 1997 and 1998 respectively whereas pumpkin depressed cocoyam yield by about 17.6% in both years. Land equivalent ratio (LER) values for all intercropped systems were greater than one, the values of which ranged from 1.71 and 1.59 for cocoyam/pumpkin on heap to 2.07 and 2.34 for cocoyam/melon on heap in 1997 and 1998 respectively. Results of this study showed that intercropping cocoyam with cover crops in a derived savanna ecology could be more productive than sole cropping but melon is more compatible with cocoyam than pumpkin.

Key Words: Cocoyam, 'Egusi' melon, pumpkin, tillage, cover crop, *Xanthosoma sagittifolium, Colocynthis citrullus.*

INTRODUCTION

The need for increased food production to meet the demand of the ever-increasing population in sub-saharan Africa (SSA) where population growth rate is higher than the rate of increase in agricultural production (World Bank, 1992) poses a great challenge to the people of the sub-region. The SSA region has the highest proportion of eroded land and highest percentage of people suffering from severe malnutrition compared to other parts of the world (UNDP, 1994). There is therefore an urgent need for the development of crop production systems that will boost yields and sustain the quality of the soils (Bradar, 1995).

Tropical tuber crops are the second most important source of carbohydrate, especially in the developing countries (Srinivasan and Maheshwarappa, 1993). Cocoyam is widely cultivated and eaten in Africa. Reports indicated that Africa accounted for about 60% of the world production of cocoyam in 1993 (FAO, 1994). Although Nigeria, the largest producer of cocoyam, witnessed increase in output in the 1990s (Central Bank of Nigeria, 1996), world-wide production trend of this important crop has been declining since the 1980s (FAO, 1994).

Constraints to cocoyam production have been reported to include, among others: lack of adequate research attention, pests and diseases, limited ecology and poor cultural practices (IITA, 1992; Hahn, 1994). Onwueme (1984) indicated that yields of cocoyam vary from place to place depending on the method of production.

Tillage and intercropping with cover crops such as 'egusi' melon (*Colocynthis citrullus L.*) are among the major production practices that affect the performance of cocoyam. Research reports indicate contrasting findings on the influence of different tillage methods on the growth and yield of cocoyam. Villanuva (1986) and Hulugalle et al. (1985) found no significant differences in cocoyam yield between harrowing once or twice and between planting on flat or on ridges. On the other hand, Enyi (1967) recorded higher leaf area and corm yield in *Xanthosoma* sp grown on ridge than flat.

This study was therefore conducted to assess the performance of cocoyam under different seedbed and cover crop mixtures.

MATERIALS AND METHODS

Field experiments were carried out in the 1997 and 1998 cropping seasons in Ibadan, South Western Nigeria. The area has a bimodal rainfall pattern. The average annual rainfall is about 1,220 mm. The soil of the area is well drained sandy-loam belonging to Iwo series (Smyth and Montgomery,

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Table 1: Pre-plant soil physico-chemical properties at the surface 0-15 cm at the experimental site.

Properties	Value
Sand (%)	85.80
Silt (%)	5.40
Clay (%)	8.80
PH (H_2O)	6.58
Organic Carbon (g/kg)	0.09
Total N (g/kg)	0.08
AVP (Ug/g)	4.80
K(%)	0.21
Ca(%)	0.11
Mg (%)	0.05
Na (%)	0.04

1962) (Table 1). The field was under *Panicum maximum* Jacq and *Chromolaena odorata* R.M. King & Robinson fallow for about 3 years before it was used for the experiments.

A 2 x 5 factorial experiment was set up in a randomized complete block design (RCBD) with four replications. The factors were seedbed preparation at 2 levels: heap and no-tillage, and cropping systems at 5 levels: melon intercropped with cocoyam, pumpkin intercropped with cocoyam; sole melon, sole pumpkin and sole cocoyam (control). The treatment combinations were: Heap + cocoyam + melon, heap + cocoyam + pumpkin, heap + cocoyam, heap + melon, heap + pumpkin, no-tillage + cocoyam + melon, no-tillage + cocoyam + pumpkin, no tillage + cocoyam, no-tillage + melon and no-tillage + pumpkin.

The field was manually cleared with cutlass and the debris packed. Plots measuring each 4 x 6m were laid out with 1 m and 2 m border rows between plots and between blocks respectively. Mounds of about 200 cm basal circumference, 75 cm high spaced 1 m x 1 m at the top were made for heaped treatments. Holes about 20 cm deep were dug 1 m x 1 m apart on no-tillage seedbeds. Cocoyam corm setts were planted into the heaps and holes at one corm per stand, giving a population

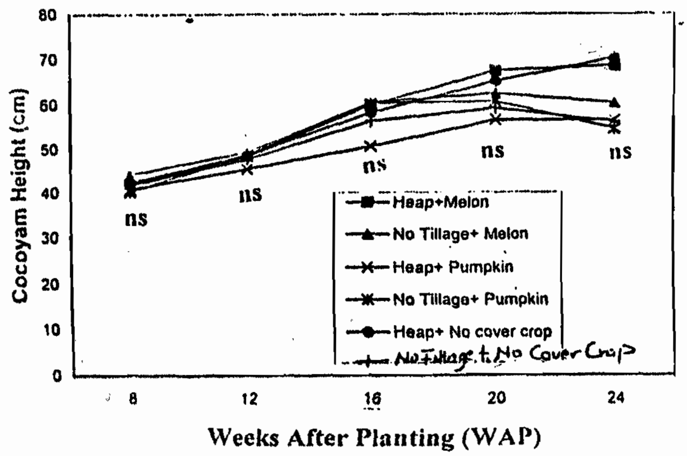

Figure 1(a): Effect of tillage and cover crops on cocoyam height in 1997.

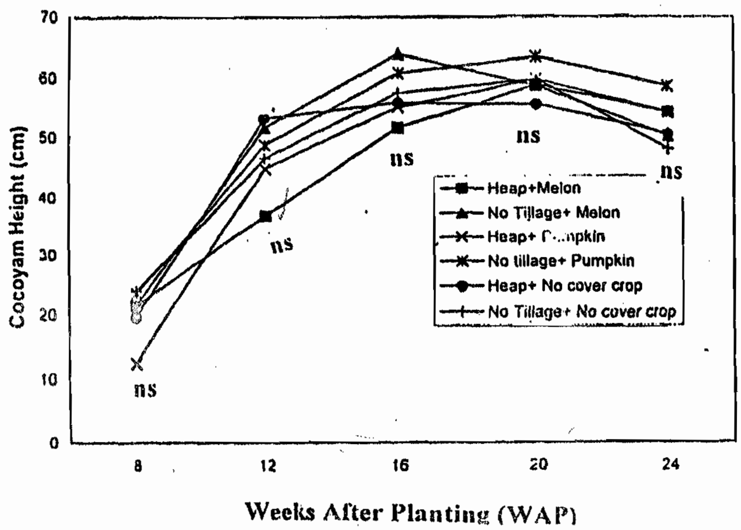

Figure 1(b): Effect of tillage and cover crops on cocoyam height in 1998.

of 24 plants per plot and 10,000 plants per hectare. Melon and pumpkin were sown at 4 seeds per hole, 1 m x 1 m apart at the base of the heaps and in alternate rows with cocoyam on flat seedbeds. Melon and pumpkin were thinned to 2 seedlings per stand at two weeks after planting (WAP), giving a population of 48 plants per plot (20,000 plants per hectare). Hand weeding was done at 6 and 14 weeks after planting. Cocoyam plant height was measured using a metre tape. The leaf area was determined using the non-destructive estimation method described by Agueguia (1993). The leaf area index (LAI) was expressed as the leaf area per plant divided by the area occupied by the plant.

Table 2: Yield and LER values for sole and intercropped cocoyam, melon and pumpkin under heaped and flat seedbeds.

Seedbed/Cropping System	1997			1998		
	Yield (t ha^{-1})	Partial LER	LER	Yield (t ha^{-1})	Partial LER	LER
COCOYAM						
Heap: Cocoyam Sole	6.9ab	-	-	7.0ab	-	-
Cocoyam intercropped with melon	7.9a	1.14a	2.07a	9.4a	1.34a	2.34a
Cocoyam intercropped with pumpkin	5.2b	0.75b	1.71b	5.2c	0.74b	1.59b
No-tillage: Cocoyam Sole	6.6ab	-	-	7.8ab	-	-
Cocoyam intercropped with melon	7.4a	1.12a	2.03a	8.1ab	1.04a	2.04a
Cocoyam intercropped with pumpkin	5.9ab	0.89b	1.86b	6.9bc	0.88b	1.75b
MELON						
Heap: Melon Sole	0.30	-	-	0.20	-	-
Melon intercropped with Cocoyam	0.38	0.93	2.07	0.20	1.0	2.34
No-tillage Melon Sole	0.32	-	-	0.19	-	-
Melon intercropped with Cocoyam	0.29 ns*	0.91 ns	2.03 ns	0.19 ns	1.0 ns	2.04 ns
PUMPKIN						
Heap: Pumpkin Sole	0.72	-	-	0.67	-	-
Pumpkin intercropped with cocoyam	0.69	0.06	1.71	0.57	0.85	1.59
No-tillage: Pumpkin Sole	0.69	-	-	0.62	-	-
Pumpkin intercropped with cocoyam	0.67 ns	0.97 ns	1.86 ns	0.54 ns	0.87 ns	1.75 ns

*NS = Not significant at 5% level of probability (Comparisons are within cropping systems).

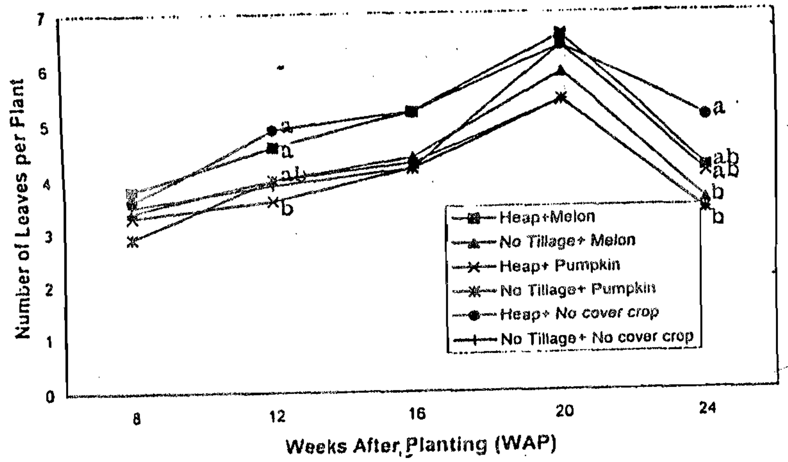

Figure 2(a): Effect of tillage and cover crops on number of leaves per cocoyam plant in 1997.

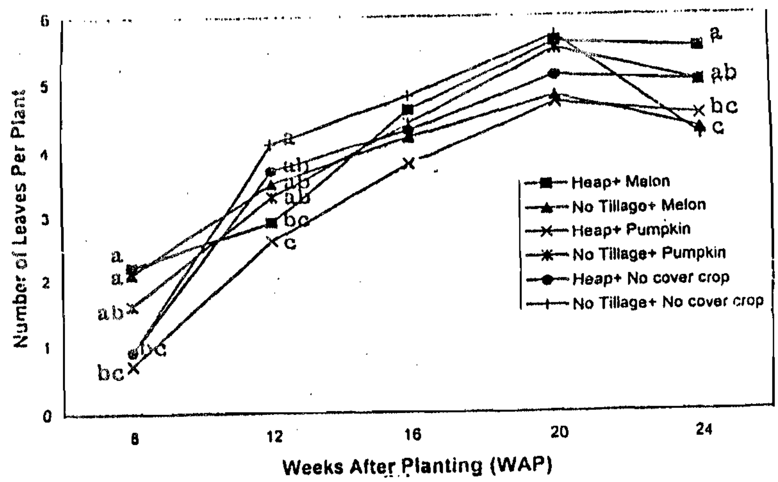

Figure 2(b): Effect of tillage and cover crops on number of leaves per cocoyam plant in 1998.
Means in the same column followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

Cocoyam was harvested at 26 WAP and the number of cormels per plant counted. Fresh total (corm + cormel) yield was expressed in tonnes per hectare. Melon and pumpkin fruits were harvested at 16 and 24 WAP, respectively. The processed seeds were sun-dried for 3-5 days, weighed and expressed in kilograms per hectare.

All data were subjected to analysis of variance using Statistical Analysis System (SAS, 1985). The means were separated using Duncan's Multiple Range Test Method at 5% level of probability. Mixture productivity was determined by means of Land Equivalent Ratio (LER) (Mend and Willey 1980).

RESULTS

All growth parameters of cocoyam increased from 8 WAP to a peak at 20 WAP in 1997 and 1998 (Figures 1, 2, 3). There were no significant differences between heaped and no-tillage seedbeds in cocoyam plant height, number of leaves and leaf area index at all sampling periods in both years irrespective of the type of cover crop. At 24 WAP however, no-tillage seedbeds had lower plant height and leaf number. No-tillage plots also had lower LAI than the heaped plots in 1997. There was no significant difference in height between sole and cocoyam plots intercropped with melon or pumpkin (Figure 1).

Heaped plots with pumpkin had the least number of leaves per cocoyam plant at 12 WAP, being significantly lower (P=0.05) than other heaped treatments in 1997 and all other treatments except heaap + melon in 1998 (Figure 2). Significant differences were not found in LAI of cocoyam among the different tillage by cover crop combinations except at 20 and 12 WAP in 1997 and 1998 respectively. At 20 WAP in 1997, heap + cocoyam + melon and heap + cocoyam (control) had 37.8 and 42.5% higher LAI than the corresponding treatments on no-tillage plots. At 12 WAP in 1998, heap + cocoyam had significantly higher (P=0.05) LAI than heap + cocoyam + melon

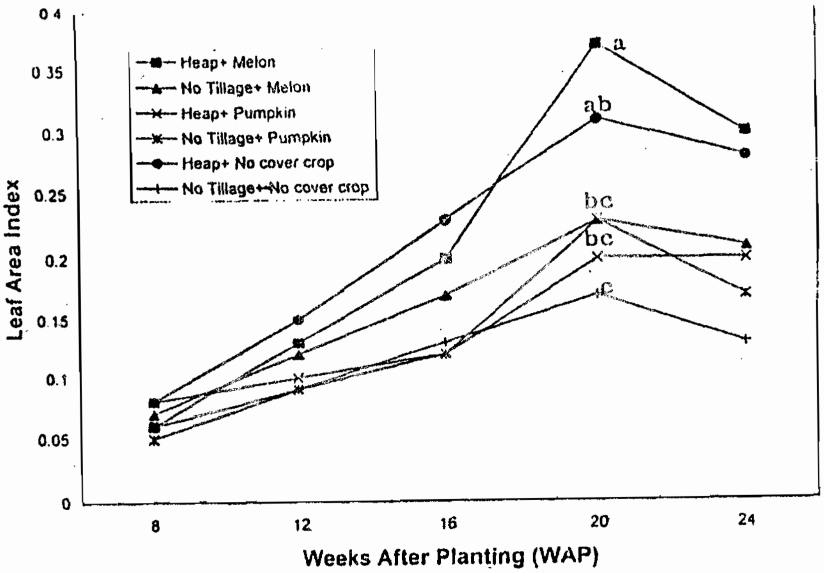

Figure 3(a): Effect of tillage and cover crops on cocoyam leaf area index in 1997.

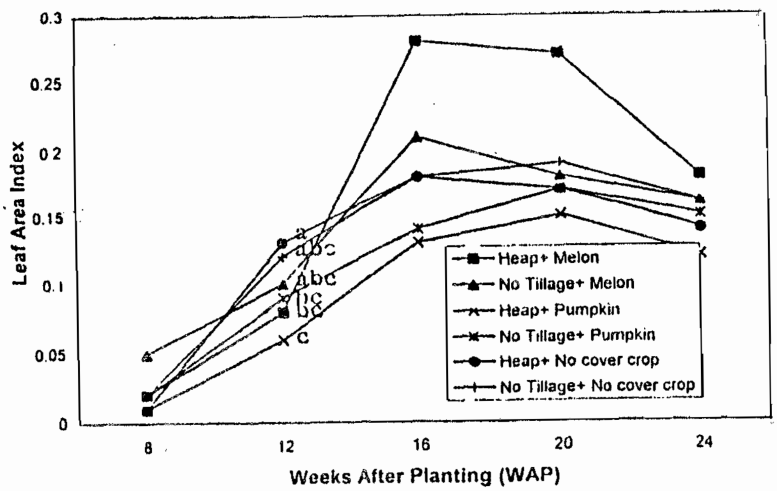

Figure 3(b): Effect of tillage and cover crops on cocoyam leaf area index in 1998.

Means in the same column followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

and heap + cocoyam + pumpkin, the difference being 38.5 and 53.8% respectively. Except at 8 and 12 WAP in 1997 and 1998 respectively, LAI of cocoyam was in the order, melon > control (no cover crop) > pumpkin.

Figure 4 shows the influence of tillage and cover crops on number of cormels per cocoyam plant. Heaped plots with melon yielded 118.6 and 74.1% (P=0.05) more cormels per plant than heaped plots with pumpkin in 1997 and 1998 respectively. Untilled plots with melon had 56.3% more cormels per plant than untilled plots with pumpkin in 1998. Pooled over the two years, cormel number per cocoyam plant was 9.2, 8.4 and 6.0 for plots with melon, no cover crop and pumpkin in that order.

Total (corm + cormel) yield of cocoyam ranged from 5.2 in heap + cocoyam + pumpkin in both years to 7.9 and 9.4 t ha^{-1} in heap + cocoyam + melon treatments in 1997 and 1998 respectively. This gave higher cocoyam yields of 2.7 and 1.7 t ha^{-1} in 1997 and 4.2 and 1.8 t ha^{-1} in 1998 for heap + cocoyam + melon and heap + cocoyam respectively, than heap + cocoyam + pumpkin treatments. Averaged over cover crops in both years, cocoyam yield was highest for plots with melon being 18.8 and 41.4% greater than the control and plots with pumpkin respectively. Tillage methods resulted in cocoyam yields of 6.9 t ha^{-1} for heap and 7.1 t ha^{-1} for no-tillage on the two year average.

Seed yield was 0.3 and 0.2 t ha^{-1} for melon and

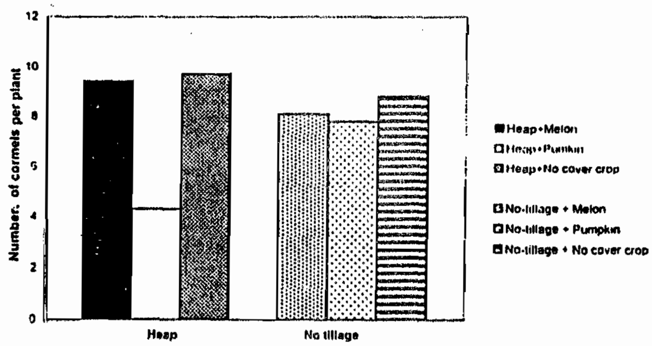

Figure 4(a): Effect of tillage and cover crops on number of cormelsper cocoyam plant in 1997. Bars with the same letter(s) are not significantly different (DMRT, p=0.05)

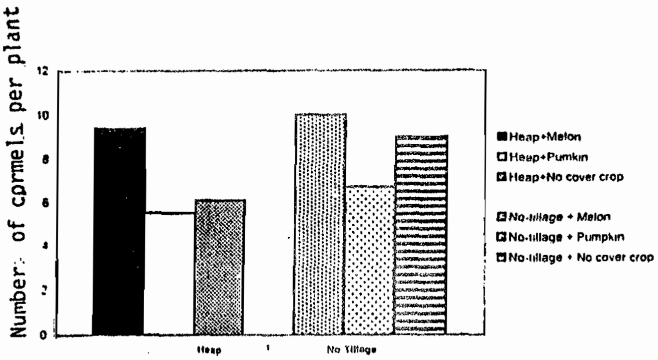

Figure 4(b): Influence of tillage and cover crops on number of cormels per cocoyam plant in 1998 Bars with the same letter(s) are not significantly different (DMRT, p=0.05)

0.7 and 0.6 t ha^{-1} for pumpkin in 1997 and 1998 respectively (Table 3). No significant differences were found between sole and intercropped yields of each of melon and pumpkin across the tillage systems in both years. However, the yields of melon and pumpkin were generally lower in 19ʕ than 1997. Pumpkin outyielded melon by 230 ar 300% in 1997 and 1998 respectively.

LER values for all intercropped systems we greater than one in both years. The values rangɛ from 1.71 and 1.59 for heap + cocoyam pumpkin to 2.07 and 2.34 for heap + cocoyam melon in 1997 and 1998 respectively. Irrespectiv of tillage method, partial LER of cocoyam wa greater than one in cocoyam/melon crop mixture but less than one in cocoyam/pumpkin mixtures i both years.

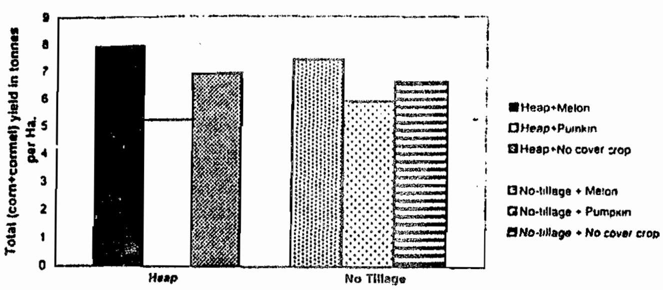

Figure 5(a): Influence of tillage and cover crops on total (corm+cormel) yield of cocoyam in 1997. Bars with the same letter(s) are not significantly different(DMRT, p=0.05)

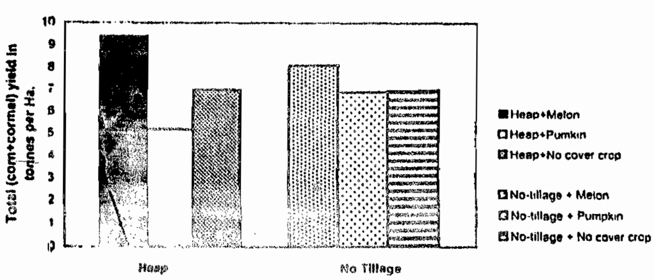

Figure 5(b): Influence of tillage and cover crops on total (corm+cormel) yield of cocoyam in 1998. Bars with the same letter(s) are not significantly different(DMRT, p=0.05)

DISCUSSION

The three growth phases observed in cocoyam i this study: the slow early growth, the rapid growt and senescence, are in agreement with the finding of Igbokwe (1983). Tayo (1982) noted tha decrease in LAI with advancement in age o cocoyam was due to senescence of older leaves and out-growth of smaller ones.

Vegetative and yield performance of cocoyam o heap and flat were similar in both years. This may be attributed to the sandy loam nature of the soi (Table 1). Hullugale et al. (1985) found nc significant differences in cocoyam yield betweer conventionally tilled and untilled plots when both were not mulched on a sandy Ultisol in easterr Nigeria. However, the lower plant height, number of leaves and leaf area index of cocoyam on flat than heaped seedbeds at 24 WAP suggests faster cocoyam senescence on flat than heap, probably because heaps conserved moisture better. Ezumah and Plucknett (1973) indicated that adequate moisture reduces the rate of leaf senescence in cocoyam.

Intercropping with pumpkin tended to suppress cocoyam growth and yield especially on heaped seedbeds whereas melon emhanced cocoyam yield. This suggests that pumpkin has greater competitive ability than melon when intercropped with cocoyam. The suspected greater competitiveness of pumpkin than melon could be attributed to differences in their morphology, growth habit and life span. Hairy leaves and vines of pumpkin are probably less palatable to rodents and birds than the smooth vines and leaves of melon. Consequently, melon seeds and seedlings were sporadically eaten or dug up by birds and rodents whereas the pumpkin was undisturbed. This must have enabled pumpkin attain greater ground coverage and hence compete more vigorously with cocoyam than melon. The wider leaf morphology of pumpkin may have enabled it intercept more sunlight than melon which may have effected the amount of solar radiation available to the cocoyam. Teasdale (1996) noted that cover crops with large leaf surfaces and less stem extincted light more than those with less leaves and large stems. Furthermore, pumpkin had longer life span (20-22 weeks) than melon (14-16 weeks). The life-span of pumpkin falls close to that of tannia cocoyam (24-28 WAP) implying greater period of competition for growth resources between pumpkin and cocoyam. Heaping appeared to have encouraged climbing habit in pumpkin. This may have resulted in greater competition of pumpkin with cocoyam on heap than flat hence, marked reductions in vegetative and yield performances of cocoyam on heap with pumpkin compared to heap with melon or no cover crop.

Intercropping with melon enhanced cocoyam yield' above sole cocoyam and cocoyam/pumpkin intercrop. Two possible reasons could be advanced for this. Firstly, the shorter life span, less coverage and indented leaf morphology of melon appeared to favour less competition with cocoyam. Secondly, it has been reported that melon leaves a high residual nitrogen in the soil (Mba, 1983). Thus, the quicker senescence of melon and subsequent decay may have provided additional nutrients and improved soil conditions for cocoyam at its rapid growth and production (8-14 WAP) stage (Igbokwe, 1983). The ability of melon to enhance the performance of other tropical crops such as cassava and plantain has been demonstrated (Obiefuna, 1989; Kolo, 1995; Akinyemi and Tijani-Eniola, 1997).

The greater seed yield of pumpkin than melon may be attributed to less pest damage sustained by pumpkin during vegetative growth phase which probably enabled it to establish, spread and give better performance. The absence of any appreciable reductions in the seed yield of melon and pumpkin intercropped with cocoyam underscores their compatibility with cocoyam. The LER values further support this.

CONCLUSION

Results of this study have indicated that intercropping cocoyam with melon or pumpkin is more productive than sole cropping because of the ability of the crop mixtures to use available resources more efficiently. Melon is however more compatible with cocoyam than pumpkin because of its less competition, shorter life span and quick release of nutrients to the companion crop. There is need for further research into the density, time of introduction and management of pumpkin to reduce its competitiveness with other crop mixtures.

The additional food and/or income supplied by egusi melon and pumpkin and their weed suppressive abilities should make intercropping them with cocoyam acceptable to farmers.

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