Influence of Yam /Cassava Based Intercropping Systems with Legumes in Weed Suppression and Disease/Pest Incidence Reduction

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Abstract: The research showed that intercropping significantly suppressed weeds, reduced pest/disease infestation and thereby can play a leading role in integrated pest management. However, no pests and diseases were observed in all plots at 4WAP while low incidence of termite and stem borers were observed at 8 and 12 WAP respectively. Although, there were heavy weed weights at 4 and 8 WAP, indicating weed troublesome nature and how it constitutes a major limiting factor to food production if not checked. Early canopy cover shading the land area on stakes and fast spread of the landrace legumes covering the ground reduced weed incidence at 12 WAP and beyond while timely weeding also reduced weed and host for pest and diseases syndrome prevalent in unweeded farms in rainforest zones. [The Journal of American Science. 2007;3(1):49-59].

Keywords: Weed suppression; diseased pest incidence; yam/cassava/legume; intercropping systems

1. Introduction

Intercropping plays a significant role in integrated pest management. Intercropping with yam and or cassava is vital in weed, pest and disease reduction (Wolfe 2000). Weeds are found in our cropping systems and they make up part of the agro-ecosystems in field crop production. All farmers in their different languages and cultures know weeds and their troubles and hence device ways and means of adequately controlling them to increased crop yield. One of the major problems limiting crop production is weed infestation (Fadayomi 1979). Some weeds serve as host for pests and disease in cropped field. In Nigeria, weed control is a serious problem confronting farmers in their efforts to feed the nations teeming population in the absence of adequate technologies (FDA 1994).

Following this, the total land area a farmer cultivates is determined to a great extent by how much labour is available for weed control. Therefore, weeds determine the farm size and limit of crop production potentials of resource poor farmers and indirectly affect the well being of farm families (Akobundu 1987) thus reducing their food production capacities. The fact remains that weeds to some extent affect all crops but how serious this may be depends on species and circumstances (Lavabre 1991). Weeds cause losses estimated at 25% but may be as high as 50-80% with certain food crops (Nangju 1980) and can exceed 80% (Kurt 1984). According to Ibeawuchi and Ofoh (2000) four and five crop combination controlled weeds better than either two or three crop combination. Also Ibeawuchi (2004) reported that intercropping depressed pest and disease effects by distributing its pressure through its diverse crop species and morphology, keep low its attack and destructive tendencies since some of the intercrop species may be resistant to the pest and or disease.

This research was carried out to look into the influence of yam/cassava based cropping systems with landrace legumes in weed suppression and disease/pest incidence reduction. This done, will go a long way in improving the cropping systems of resource poor farmers with a view to reducing the money spent by farmers in weed, pest and disease control.

2. Materials and Method

(1) Location

The experiment was carried out in the teaching and research farm of the school of Agriculture and Agricultural Technology, Federal University of Technology Owerri (FUTO), located on latitude 5^0 27' 50.23" North and longitude 7^0 02' 49. 33" East at a height above sea level of 55m (Handheld Global positioning system). Owerri has a rain forest agro ecology characterized with more than 2500 mm annual rainfall, 27-29^{O}C annual temperatures and 89-93% relative humidity. The soil of Owerri belong to the soil mapping unit number 431 that is Amakama – Orji - Oguta Soil Association (Federal Department of Agricultural and Land Resources 1985) and derived from classification the coastal plain sands, Lekwa and Whiteside (1986). The site was a 3-year fallow bush after planting cassava and maize of which no fertilizer was applied.

(2) Planting materials:

This is as described by Ibeawuchi (2004)

(3) Land preparation:

For the two years (2001 and 2002) of the research work, land preparation was done manually with machetes, spades and rakes since minimum tillage was used. In each case, the site after clearing was left to dry. The stick and woody parts of the dry matter were later picked and removed from the site. The field was thereafter marked out for planting.

(4) Experiment:

Yam-based and Cassava-based Cropping systems with landrace legumes. Intercropping of the three-landrace legumes with yam, cassava and maize was carried out in 2001 cropping season and was repeated in 2002 cropping season.

The experiment was laid out in a randomized complete block design with 18 treatments replicated 3 times. This gave a total of 54 plots. Each plot measured 3 x 4 m with a space of 1m between each plot and 2 m between each block. There was a 1m guard area round the experimental area, this gave a total of $1209m^2$ or 0.12 1 ha. The treatments included sole crops of the individual crops and their combinations as follows (Table 1):

Table 1. The treatments included sole crops of the individual crops and their combinations

Yam-Based:	**Yam/cassava-based**
1. yam/maize/mucuna (Y/M/Mp)	9. yam/maize/cassava/mucuna (y/m/mp).
2. yam/maize/lima (Y/M/L).	10. yam/maize/cassava/lima (y/m/c/l)
3. yam/maize/African yam bean (Y/M/Ayb)	11. yam/maize/cassava/African yam bean (y/m/c/Ayb)
4. yam/maize, (Y/M).	12. yam/maize/cassava (y/m/c)
Cassava - based	Sole Cropping
5. cassava/maize/mucuna (C/M/L)	13. yam (y)
6. cassava/maize/lima (C/M/L)	14. cassava (C)
7. cassava/maize/African yam bean (C/M/Ayb)	15. maize (M)
8. cassava/maize (C/M).	16. Mucuna (Mp)
	17. Lima bean (L)
	18. African yam beans (Ayb

(5) Planting and spacing:

Planting was done in the first week of April 2001 as was also repeated in 2002. Seeds of the land race legumes were planted in holes at a depth of 2-5 cm at 50 x 50 cm spacing each. These were later thinned down to 1 per hole after germination giving a plant population of 40,000 plants per hectare for sole and intercropped plots of each of the three legumes.

Maize was the TZSR-yellow, purchased from Imo ADP, Owerri. Two maize seeds were planted per hole at a depth of 2-5 cm at 1 x 1m spacing. This was thinned down after germination to 1 plant per stand giving a plant population of 10,000 plants per hectare.

(6) Yam:

Dioscorea rotundata (white) obiaeturugo local variety was purchased from Relief Market Owerri. Seed yams weighing 200-300 g were planted in holes measuring 30 x 30 x 30 cm at a spacing of 1 x 1m on the flat. This gave a plant population of 10,000 plants per hectare.

(7) Cassava:

(TMS 30555). The cassava cuttings were purchased from Imo ADP, Owerri. Cassava cuttings measuring 20cm long were planted on the flat at 1 x 1m spacing giving a plant population of 10,000 plants/ha.

(8) Agronomic practices:

The land was cleared and the treatments were randomly laid out in each plot. No fertilizer or agrochemical was applied since the study involved soil fertility enhancement.

(9) Staking:

The yams were staked as and when due. The land race legumes shared the same stake with yam. In cassava-based system, the legumes utilized the cassava stems as stake support.

(10) Weeding and Weed weight measurement:

Weeding was done 3 times with hoe at 4, 8 and 12 WAP for all the plots in the experiment. After each weeding, the soil adhering on to the weeds were carefully removed and the weed material weighed with a weighing balance. In each case, the weed fresh weight was collected.

(11) Training:

Training of the yam and legume vines started immediately after staking and continued up to 12WAP**.**

(12) Percent pest infestation:

Sample counts using visual observation were made and used to assess the incidence of pest attack and disease infestation on the crops. This was carried out at 4, 8 and 12 WAP. The formula used is as follows:

$$\textbf{\%Infestation} = \frac{\text{No of plants infested/plot}}{\text{Total No. of plants /plot}} \times \frac{100}{1}$$

(13) Harvesting:

Harvesting was done at the maturity of each test crop.

(14) Maize:

Dried maize cobs in the field were harvested at 15 weeks after planting (WAP) when 99% of all the maize stands had dried. The cobs were sun dried and dehusked, shelled and the grain weight was obtained. .

(15) African yam bean:

The long pods of the beans ripened and dried at different intervals. Harvesting of the dried pods were spread over a period of two weeks from 20 – 22 WAP. The pods were further sun-dried and split open and the seeds collected. The seeds were weighed with a Salter scale.

(16) Lima bean:

The dry pods of the bean ripened at different times. Harvesting was spread over three weeks from 19 – 22 WAP. The pods were split, the seeds collected and their weight obtained

(17) Mucuna (Black-seed utilis):

The pods matured 17 WAP and drying started two weeks later. Harvesting of the pods, which matured and dried at different intervals began from the 18 WAP and lasted till 23 WAP. The pods were split open by applying some pressure with a small stick. The black seeds were gathered and weight obtained.

(18) Yam harvest:

The yams were harvest at 35 WAP with spade. The tubers were gathered and weighed and the weight recorded. The yam tubers were later separated into seriously disease or pest infested ones, ware and small tubers. The percentage pest infestation on the yam tubers were calculated and recorded.

(19) Cassava:

The cassava stands were harvested 60 WAP. The cassava cuttings were gathered plot by plot at 20/bundle. Cassava tubers per plot were weighed and recorded.

(20) Data analysis:

The data collected were collated and statistically analyzed using the SPSS (2004) packages and Wahua 1999 was used to help in data p and interpretation.

3. Results

(1) Weed fresh weight.

Table 2 [a], shows the effect of yam –based cropping system on weed suppression at 4, 8 and 12 weeks after planting. The results show that at 4 and 8 WAP, none of the cropping systems were able to suppress weeds and hence a rather high dry weed weights ranging from 1.13t / ha – 1.19t / ha at 4WAP and 0.98t / ha to 1.14t / ha at 8 WAP were recorded. However, after the first and second weeding, the crop combination with yam / maize/mucuna had the lowest weed weight (0.83t / ha) and was significantly different ($P \geq 0.05$) from the sole yam and yam/maize crop combinations at 12WAP with 1.09 and 1.02 t/ha, respectively.

Table 2 [b], shows the effect of yam / cassava – based cropping system on mean weed weight and suppression at 4, 8 and 12WAP. The results show that at 4 and 8WAP there were no significant differences and that the weed weights ranged from 1.01 – 1.12 t/ha at 4WAP and 0.95 – 0.99 t/ha at 8WAP. After the second weeding, yam/maize/ cassava/mucuna with 0.80t /ha was significantly different ($P \geq 0.05$) from the other cropping systems compared.

Table 2[c], shows the effect of cassava – based cropping system on mean weed weight and suppression at 4, 8 and 12 WAP. The results show that there were high weed tonnage at 4 and 8WAP and these were not significant in suppressing weeds. However, at 12WAP, after the second weeding was done, cassava/maize/mucuna (0.96t/ha) cassava/maize/Lima (0.98t/ha) and cassava/maize/African yam bean (0.98t/ha) had the lowest weed weight which were statistically significantly different ($P \geq 0.05$) from the other crop combinations compared.

Table 2 [d], shows the effect of sole cropping the three-landrace legumes on mean dry weed weight and suppression at 4, 8 and 12 WAP. The results indicated that Mucuna plots had low weed dry weight 1.09 t/ha and 1.03 t/ha at 4 and 8 WAP and 0.09 t/ha at 12WAP. Thus, Mucuna was statistically significantly different ($P \geq 0.05$) and can suppress weeds more than any of the other two-landrace legumes–lima bean and African yam bean including sole yam, maize and cassava at 8 and 12 WAP, respectively.

(2) Pest and Disease Tolerance.

Table 3, shows the mean percentage pest and disease infestation at 4, 8 and 12 after planting (WAP). The results show that pests and diseases were not observed in the plots at 4 WAP, but at 8 WAP low incidents of termites were observed in sole maize plots. At 12 WAP, there were incidents of stem borer (SB) on maize in the yam-based cassava-based and maize sole cropping systems. The percentage incidents ranged from 1.3-2.7% in the intercropped plots and 16.9% in maize sole cropping. In a few plots evidence of leaf rollers (LR) activities were observed mainly in cassava-based cropping system and in sole cropping of the legumes. Termites and some disease incidents were observed in case of sole Lima and African Yam bean, respectively. All these were not statistically significant at 12 WAP. However, at harvest, no disease was observed, but termites (TM) infested the yam tubers - Figure 1 in almost all the plots. The least destruction was observed in *yam/maize/Mucuna pruriens*, *yam/maize/lima* and in yam/cassava-based with 8.3% in each case while the highest percentage of 35. 3% was observed in sole yam crops. The termite infestation among the plots that carried yam was significantly higher ($P \geq 0.05$) compared with other plots. The destruction was estimated to have attained economic injury level. The elegant grasshopper (GH) was observed in almost all the plots, and the infestation %ranged from 0.3% in y/m/c to 8.3% in sole cassava. Figure 2 shows the elegant grasshopper feeding on Mucuna leaves. The heavy canopy cover or shading (Figure 3**)** by the landraces when staked helped to suppress weeds as the landrace legumes are mainly climbers though some can spread fast on the ground when there is no stake given to them. Therefore, heavy canopy of the Mucuna also depressed the growth and yield of the component crops in the cropping systems.

Table 4 showed the results of the yield t/ha of the various crops in the cropping systems. On individual basis, the sole cropping had higher yield than the intercrops. However, when measured in terms of yield advantage or with land equivalent ratio (LER), intercropping had greater LER and yield advantage over sole cropping. In intercropping a piece of land is use to produce many crops and if landrace legumes are used they developed nodules that help to fix nitrogen helping in building soil fertility. Although, the heavy canopy cast of most intercropping systems involving mucuna depressed the yield of yam and maize in most plots (Table 4).

4. Discussions

(1) Weed Weight and Suppression

The high quantity of weed weight at 4 and 8 WAP in most plots is an indication that weed constitutes a major limiting factor to crop production especially to the resource poor farmers because of the absence of adequate techniques to suppress or control weeds. This is in line with the report by FDA, (1994), Ibeawuchi (2004), Ibeawuchi and Ofoh (2003). Intercropping also, suppressed weeds by reducing the weed weight with its many crop components per crop combination. Ibeawuchi (2004) and Kurt (1984) agreed with this report. The researchers observed that heavy canopy cover or shading by the landraces legumes when staked helps to suppress weeds as most of the crop component like Mucuna in the sole mucuna and yam / maize / cassava / mucuna. As it is fast growing it covers the ground when not staked forming a thick canopy covering the ground and helps to suppress weeds, This agreed with the report by Ibeawuchi and Ofoh (2003), and Evans (1960) who reported that most crop combinations suppress weed growth by providing an early ground cover and due to high plant population or fast growing component crop. The significant effect ($P \geq 0.05$) of yam / cassava – based cropping system with four crop combinations, suppressed weeds better than most other cropping systems with two or three crop combinations. This agreed with the report of Ibeawuchi (2004)and Ibeawuchi and Ofoh (2003) that weed weight decreased from 3 – 20 WAP with maize / cassava being the highest and maize / cassava / cow pea / groundnut / African yam bean being the lowest in weed weight and suppressed weeds better.

(2) Pest / Disease Tolerance

The result showed that intercropping significantly influenced reduction of pest/disease incidence**.** This could be attributed to the heavy and diverse morphology of the intercropped species, which must have helped to reduce the pest / disease pressure. There are as many crop species as possible in the inter-cropping system, and some crop species could be highly resistant to invading pest/disease thus reducing their attack and injury levels on the plots. This observation agreed with that by Kurt (1984) that a great number of intercropping systems enable the farmer to spread the risk of crop losses due to insect attack better. Also the timely weeding must have helped to keep the plots weed free and clean thereby restricting the host alternative of aerial pests which could carry diseases to infest the cropping systems. This is in line with reports of Altieri and Whitcomb (1979). However, inter-cropping reduced diseases/pests incidence. This could be as a result of the number of crop species in one crop combination per plot and some of the crops species could have resistance to some pests / disease pathogens prevalent in cropped fields and thus keeping their presence low as against sole cropping. This agreed with the view by Burdon, (1978). Again, intercropping produced diverse foliage and most of which may have medicinal potentials that can dispel the advance of pests that may hitherto serve as host for primary disease infection and other major pest capitalization for attack and destruction of cropped fields.

Although, intercropping reduces the yield per component crop (Table 4), the land equivalent ration (LER) is greater than that of sole cropping. This agreed with Ibeawuchi and Ofoh (2000, 2003) respectively.

Intercropping with legumes is more advantageous (Okpara *et al* 1995) since the legume component help to fix biological nitrogen in the soil of which the estimate of its soil fertility contribution is immeasurable. It of note that good soil fertility helps crop plants to grow well and healthy. Pests and diseases rarely attack healthy crop plants.

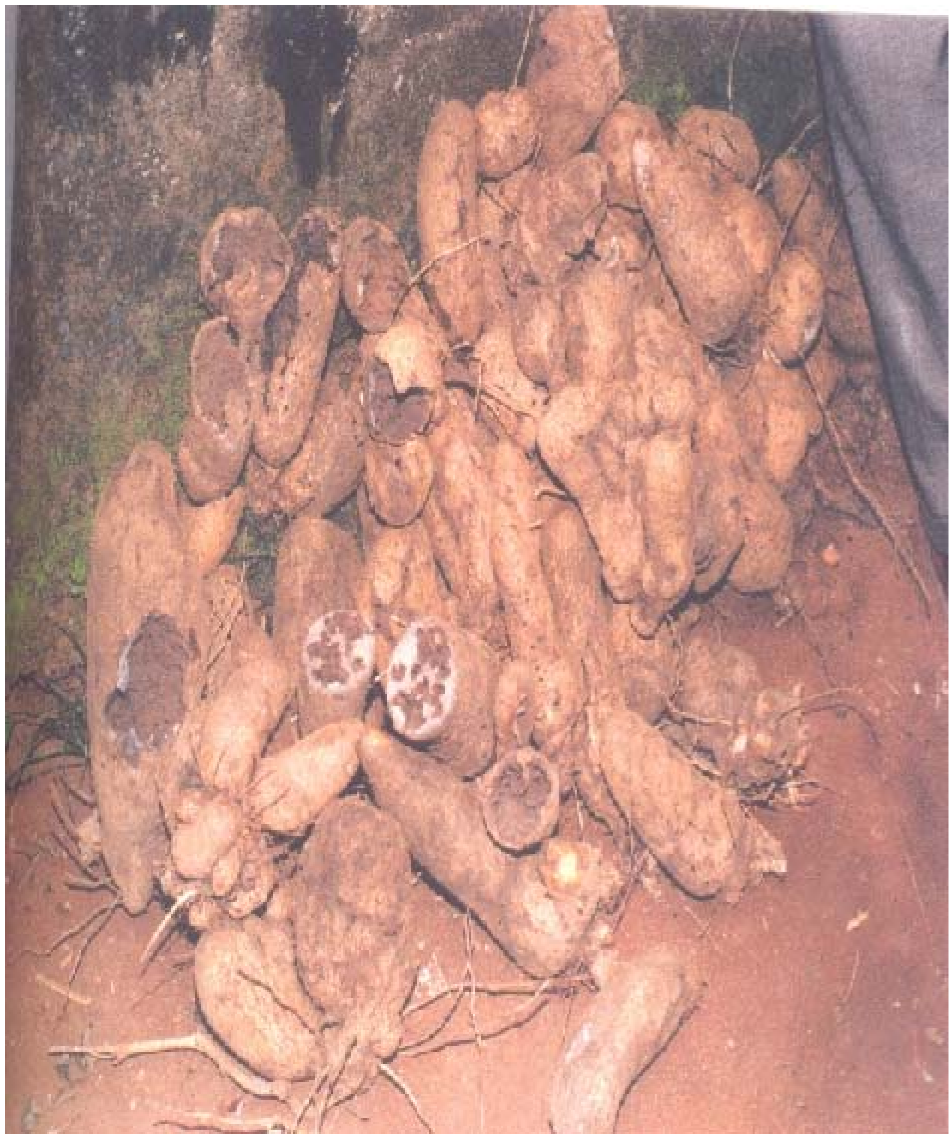

Figure 1. Samples of termite-infested yam tubers.

Figure 2. The Elegant Grasshopper Feeding on Mucuna leaves.

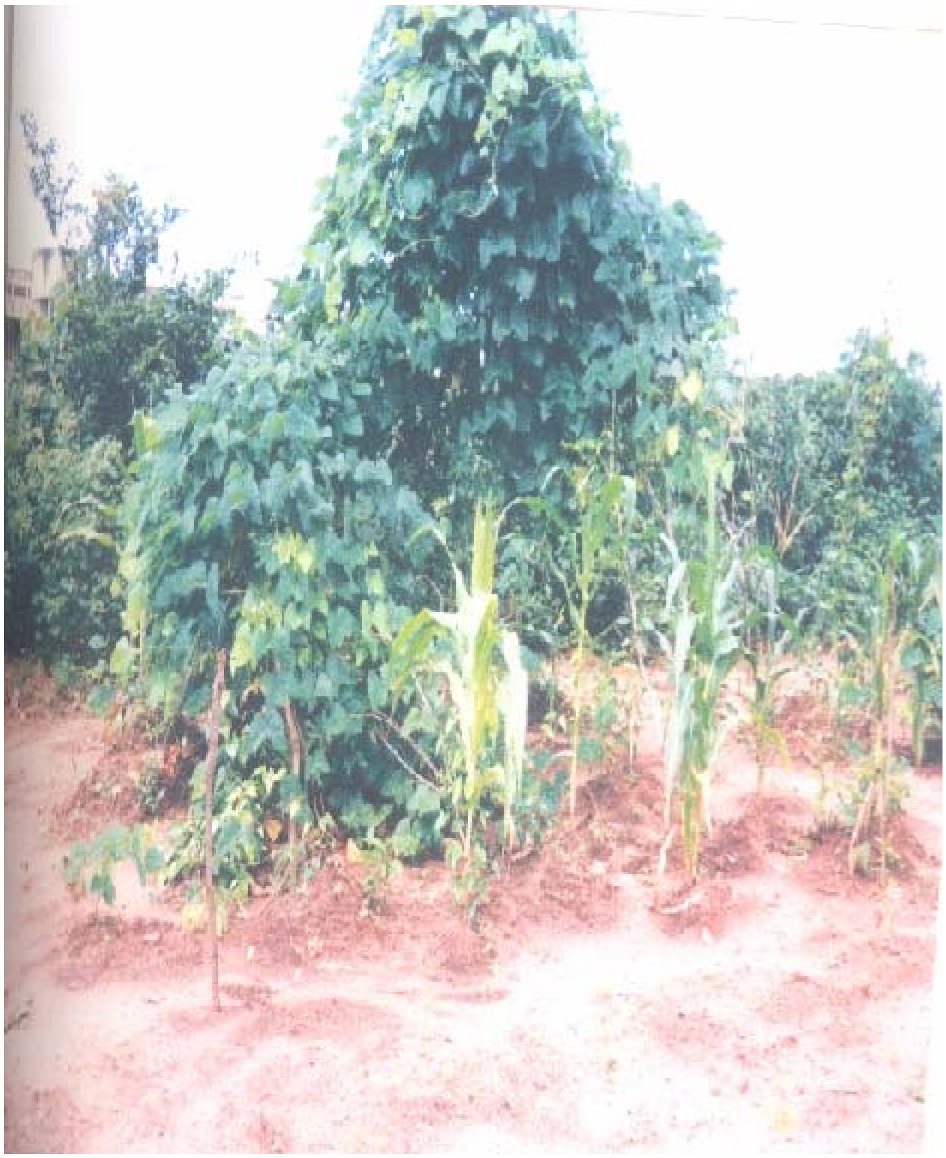

Figure 3. Heavy mucuna canopy shading other crop components in the plot.

Table 2. Effect of tuber-based cropping system on mean dry weed weight (t/ha) at 4, 8, & 12 weeks after planting, in 2001/2002

	4-WAP	8-WAP	12-WAP
[a] yam-based cropping system			
Sole yam	1.18	1.14	1.09
Yam/maize/mucuna	1.13	0.98	0.82
Yam/maize/lima	1.19	0.99	0.86
Yam/maize/African yam bean	1.17	0.99	0.85
Yam/maize	1.18	1.11	1.02
LSD(0.05)	**NS**	**NS**	**0.08**
[b]Yam/cassava-based cropping system			
Yam /cassava	1.14	1.11	1.01
yam /cassava/maize	1.12	0.99	0.89
yam/cassava/maize/mucuna	1.01	0.95	0.8
yam/cassava/maize/lima	1.01	0.98	0.84
yam/cassava/maize/African yam bean	1.06	0.96	0.84
LSD(0.05)	**NS**	**NS**	**0.18**
[c] Cassava-based cropping system			
sole cassava	1.45	1.16	1.11
cassava/maize/mucuna	1.28	1.1	0.96
cassava/maize/lima	1.32	1.12	0.98
cassava/maize/african yam bean	1.3	1.14	0.98
cassava/maize	1.29	1.2	1.1
LSD(0.05)	**NS**	**NS**	**0.05**
[d] Sole cropping system.			
Yam	1.28	1.14	1.09
Cassava	1.15	1.16	1.09
Maize	1.58	1.45	1.35
Mucuna	1.09	1.03	0.09
Lima	1.09	1.05	1.02
African yam bean	1.1	1.17	1.09
LSD(0.05)	**NS**	**0.41**	**0.4**

NB: WAP =weeks after planting.

Table 3. Mean Percentage Pest & Disease Infestation at 4, 8, 12 weeks after planting and harvest, 2001/2002

Cropping Systems	4-WAP					8-WAP					12-WAP					HARVEST				
	SB	LR	GH	TM	D	SB	LR	GH	TM	D	SB	LR	GH	TM	D	SB	LR	GH	TM	D
y/m/mp	-	-	-	-	-	-	-	-	-	--	2.7	-	2.7	--	--	-	-	-	8.3	-
y/m/l	-	-	-	-	-	-	-	-	-	-	2.7	-	5.4	-	-	-	-	-	8.3	-
y/m/ayb	-	-	-	-	-	-	-	-	-	-	2.7	-	5.4	-	-	-	-	-	12.5	-
y/m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-
c/m/mp	-	-	-	-	-	-	-	-	-	-	1.3	2.3	2.7	-	-	-	-	-	-	-
c/m/l	-	-	-	-	-	-	-	-	-	-	2.7	2.3	6.3	-	-	-	-	-	-	-
c/m/ayb	-	-	-	-	-	-	-	-	-	-	2.7	2.6	2.3	-	-	-	-	-	-	-
c/m	-	-	-	-	-	-	-	-	-	-	-		8.3	-	-	-	-	-	-	-
y/m/c/mp	-	-	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	8.3	-
y/m/c/l	-	-	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	8.3	-
y/m/c/ayb	-	-	-	-	-	-	-	-	-	-	-	2.3	2.3	-	-	-	-	-	12.5	-
y/m/c	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	16.7	-
Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.3	-
M	-	-	-	-	-	-	-	-	15	-	16.9	-	-	10	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	-
Mp	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-	-	-	-	1.3	2.3	-	2.5	-	-	-	-	-
Ayb	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-	2.5	-	-	-	-	-
LSD(0.05)	N	O	T		S	I	G	N	I	F	I	C	A	N	T	NS	NS	NS	9.45	NS

Note: SB =Stem borer; LR = Leaf Rollers; GH = Grasshoppers; TM = Termites; D = diseases.

Table 4. Overall yield t/ha of the various crops in the cropping system.

Cropping system	Various crops{t/ha}					
Sole cropping	Yam	Maize	cassava	Mucuna	Lima	African yam bean
Yam	10.65a					
Maize		0.82a				
Cassava			17.43a			
Mucuna				4.78a		
Lima					0.64a	
African yam bean						0.58a
Yam-based						
yam/maize	9.49ab	0.64				
Y/M/Mp	3.34d	0.19d		2.52b		
Y/M/L	9.26b	0.70b			0.50b	
Y/M/Ayb	10.39a	0.73b				0.46b
Cassava-based						
Cassava/Maize		0.67b	9.80c			
C/M/Mp		0.21	9.97b	2.02b		
C/M/L		0.69b	12.75b		0.49b	
C/M/Ayb		0.68b	14.46ab			0.43b
Yam/Cassava-based						
Yam/Maize/Cassava	7.29c	0.63c	6.25d			
Y/M/C/Mp	3.33d	0.14d	6.36d	1.18c		
Y/M/C/L	7.79c	0.64c	8.75cd		0.32c	
Y/M/C/Ayb	8.04b	0.66bc	9.25c			0.25c

Means followed by the same alphabet{s} are not significantly different at 5% probability Duncan's Multiple Range Test.

5. Conclusion

Intercropping is a better proposal for the resource poor farmers since it depressed weeds, pests/diseases and gives reasonably higher yield over sole cropping. Since farmers are poor and weed, pests/diseases are major problems in production systems, they are encouraged to practice intercropping with landrace legumes as they are indigenous to the land, cheaper to procure and have been found to suppress weeds and tolerate pest/disease infestations. It is recommended that timely harvesting of yam fresh tubers in the field should be done to avoid termite infestation which damage the economic yield and reduces market values.. Lima bean and African yam bean are already being used in most cropping systems in southeastern Nigeria, therefore efforts should be geared toward improving them genetically thereby making them candidate legumes for the humid tropics. However, *mucuna pruriens* is a crop of the future because of its great potentials in food, feed and health industries.

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