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Effect of Intercropping Okra (*Hibiscus esclentus*) with Pumpkin (*Curcubita maxima* Dutch ex Lam) on Some Growth Parameters and Economic Yield of Maize (*Zea mays*) and Maximization of Land Use in a Fadama Soil

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Abstract: There is a need to harness fadama lands in Niger-delta as a result of dearth of fertile arable land due to soil infertility from little or no fallow period. This study was carried out, to determine the compatibility of okra, pumpkin and maize in a fadama soil. Oba super2 variety of maize, NHae 47-4 variety of okra and locally sourced pumpkin were sown in October, 2003 and repeated in October 2004, in a randomized complete block design with 4 replicates. Maize and okra were monitored weekly for 8 and 10 weeks respectively for plant height and number of leaves while pumpkin were accessed for % vine coverage. Observation were carried for weed biomass, economic yield, aggregate yield and land equivalent ratio were calculated from the economic yield. The result of the 2 year study showed, that growth parameters did not all follow a consistend trend, although sole crops performed better than in their crop associations. The presence of pumpkin significantly reduced weeds growth in the crop associations. The economic or relative economic yield was significantly higher ($p<0.05$) in sole crops than in the individual crops of the association, but the aggregate yield was higher in the crop association than in their sole crops plot. The land equivalent ratio was highest in 3 crop association (1.97) than 2 crop association and least in sole crops of 1.00.

Key words: Fadama soil, intercropping, crop association, weed biomass, economic yield, LER

INTRODUCTION

The much desired optimum food production in the humid tropics to feed the ever increasing human population is almost an illusion, with the deepening of socio-economic and food crisis. This have been compounded due to reducibility in arable land and decline in fertile arable lands and pressure from other land users. This has subsequently affected rotational bush fallow system, shifting cultivation with shortening or elimination of the fallow period leading to loss of soil fertility[1,2].

In Niger-Delta of Nigeria, cultivation of food crops is restricted to rainfed (agriculture) cropping season. Most of land has been degraded with attendant decline in crop productivity. In other to increase food production to meet the National food security, food sufficiency with few arable lands which has little or no fallow period results in soil infertility. There is a need to utilize marginal land such as fadama during the dry season which has been under-utilized.

Fadama soils are flood prone, low lying, slow drainage that possess fine texture[3] and may lie adjacent to a major river system[4]. They also have extensive exploitable aquifer suitable for vegetable crop production[5] which are more easily marketable and fetches higher income during the dry season[6].

The Bauchi State agricultural development project[7] reported that, about 4.9 million hectares of fadama land can be harnessed in Nigeria, for accelerated food production. In south-western Nigeria, the soil constitute about 15% of the total cultivatable land[8]. These areas are cropped due to high moisture content during the dry season and perhaps due to annual replenishment of plant growth resources by flood water. Fadama soils ranges from poorly to very poorly drained, silty clay loam top or sandy clay loam, to clayey subsoil[9,10].

Under traditional farming system in Nigeria, intercropping is widely practiced. In intercropping studies, sole crops yields higher than in their corresponding intercrops[11], but the aggregate yield per

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unit land area is higher in intercropping than sole crops[12]. This was attributed to better use of growth resources in space and time[13] and weed suppression[14].

The farmer popular crops in Niger-Delta of Nigeria, are cassava, pepper, sweet pepper, okra and pumpkin, where melon plays an important but unique role as a food crop as well as a cover crop in arable land cultivation. However, the compatibility of some of these food crops and maize has not been accessed in a fadama soil. The objective of this study was therefore to determine the compatibility of okra, pumpkin and maize, in a fadama soil.

MATERIAL AND METHODS

This experiment was conducted at Abbi in Ndokwa west local government area of Delta State, Nigeria between October 2004 and March 2005. Abbi is located at 05^0 43N and 06^0 15E of the equator. It is characterized by wet season between April to October in the year.

The experiment was a randomized complete block design with 4 replicates. Each plot measured 5×5 m with 1 m work path. There were seven treatments;

t1 maize
t2 okra
t3 pumpkin
t4 maize + okra
t5 maize + pumpkin
t6 okra + pumpkin
t7 maize + okra + pumpkin.

The crop varieties were Oba super 2 variety of maize and NH_{AE} 47-4 variety of maize, were sourced from Delta Agricultural Development Programme (DTADP), Ibusa and pumpkin were locally sourced. They were sown on 20th October, 2003 and replanted in 15th October 2004, respectively, in a row running east-west. Maize, okra were sown at the rate of 3 per hill at a spacing of 100 cm, while pumpkin was sown at a spacing of 2×2 m. The population of the crops in sole and mixed stand were indicated in Table 1.

Maize height was measured from the second week after planting (2WAP) to the flag leaf, while the number of leaves were monitored from 2WAP to 8th week after planting. Okra height and leaf number were measured and monitored respectively from 2WAP to 10th week after planting (10WAP) while % vine coverage of pumpkin was accessed within quadrant randomly located within each plot. Weeds were harvested, dried and weighed from within each quadrant, that was randomly located in each quadrant. Total weed per hectare were further calculated from the means of the quadrant sample/plot. Data were also collected from the central part of each plot for economic yield. The data were analyzed using analysis of variance (ANOVA) and means that were significant were separated using Duncan multiple range test. Also, Land Equivalent Ration (LER) were calculated from the economic yield of the crop.

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

Treatment	Maize	Okra	Pumpkin
t1 maize	30. 000		
t2 okra		30. 000	
t3 pumpkin			5. 000
t4 maize + okra	30. 000	29. 700	
t5 maize + pumpkin	30. 000		5. 000
t6 okra + pumpkin		30. 000	5. 000
t7 maize + okra + pumpkin	30. 000	29. 700	5. 000

Table 2: Preplanting soil analysis of the experimental site

Soil properties	values
% sand	54
% silt	30
% clay	21
bulk density g/cm^3	1.27
ph 1:1 water	4.3
% organic carbon	3.17
% total N	0.116
available P (ppm)	16.3
exchangeable Ca^{++} Cmol kg^{-1}	1.42
Mg mg kg^{-1}	0.41
K Cmol kg^{-1}	0.16
Mn Cmol kg^{-1}	0.05
Na Cmol kg^{-1}	0.32
Total acidity	0.65
Effective C.E.C. mg kg^{-1}	3.99

RESULTS AND DISCUSSION

Plant height: At 2 weeks after planting (WAP), there was no significant difference between sole maize crop and maize in association of 2 or 3 other crops, but maize in association of pumpkin was tallest. At final measurement (8WAP), sole maize crop was significantly taller ($p<0.05$) than maize in other crop associations. Within the 2 or 3 crop associations, maize in okra association was significantly taller ($p<0.05$) than maize in other crop association Table 3.

Okra height was significantly same ($p = 0.05$) in 2 crop association at 2 WAS, but significantly taller than sole crop and okra in 3 crop association Table 4. Between 6WAP and at final measurement (10WAP), sole okra was significantly taller than okra in 2 or 3 crop association Table 5.

The higher significantly difference observed in sole crops than in 2 or 3 association could be adduced to better utilization and less competition for plant growth resource for sole crops than in crop associations. This observation agrees with Lizarranga[15] who observed better growth parameters in sole crops than in their crop associations.

Table 3: Maize height as influenced by crop combination

	Time (weeks after planting)						
Treatment	2	3	4	5	6	7	8
t1maize	22.48a	36.40a	56.96a	86.97a	109.77a	149.03a	210.00a
t4 maize + okra	21.69a	34.11b	52.49b	80.77ab	101.95b	129.17b	191.26b
t7 maize + pumpkin	22.52a	36.62a	53.89b	79.28b	98.69b	124.10b	170.96c
t7 maize + okra + pumpkin	22.23a	35.52a	56.41a	84.72a	101.53a	128.58b	171.44c
Mean	22.25	35.66	54.99	82.93	102.98	132.72	185.92

Table 4: Maize leaf number as influenced by crop combination

	Time (weeks after planting)						
Treatment	2	3	4	5	6	7	8
t1 maize	6.30a	7.63a	9.66a	11.05a	11.90a	13.58a	11.02a
t4 maize + okra	6.06b	7.30ab	9.35a	10.45b	10.65ab	13.35a	10.78ab
t7 maize + pumpkin	5.95b	7.43ab	9.10a	9.83c	11.28b	12.20b	9.24c
t7 maize + okra + pumpkin	5.70b	7.15b	8.59b	9.73c	10.32b	11.86c	10.03b
Mean	6.00	7.38	9.18	10.26	11.04	12.75	10.27

Table 5: Okra height as influenced by crop combination

	Time (weeks after planting)								
Treatment	2	3	4	5	6	7	8	9	10
t2 okra	8.43b	10.99d	14.19c	19.16b	23.46a	32.94a	35.61a	38.01a	40.37a
t4 okra + maize	9.01a	13.59a	17.07a	20.35a	22.49b	27.76b	29.52b	34.61b	39.52b
t6 okra + pumpkin	9.05a	12.55b	16.29b	18.52c	19.55c	23.40c	27.73c	31.81c	37.56c
t7 okra + maize + pumpkin	8.94b	11.84c	16.08b	18.92c	19.95c	26.31b	20.99d	34.72b	37.64c
Mean	8.86	12.24	15.91	19.24	21.36	27.60	28.46	34.79	38.77

Number of leaves: At 2 WAP, number of leaves in maize crop was significantly higher in sole crop ($p<0.05$) than in 2 or 3 crop association Table 4. Within 2 and 3 crop associations, maize in 3 crop association was most significantly depressed. At final measurement (8WAP), sole maize crop had higher number of leaves than maize in 2 or 3 crop association. Within the 2 or 3 crop association, maize in pumpkin association was most significantly depressed Table 4.

The okra number of leaves at 2 WAP, was significantly same ($p = 0.05$) for sole crop and 3 crop association and was significantly higher ($p<0.05$) than okra in 2 crop associations Table 6. Between 5WAP to 9WAP, the number of leaves in sole crop and crop association was significantly same ($p = 0.05$). At final observation (10WAP), sole okra and okra in association with pumpkin was significantly same ($p = 0.05$) but was significantly taller than okra in other crop associations Table 6.

The higher significant number of leaves of sole crops observed than in their crop association agrees[15] observed better growth parameters in sole crops than in their crops associations.

The % vine coverage of pumpkin was significantly same ($p = 0.05$) throughout the period of observation except at 4WAP, when sole pumpkin crop and pumpkin in 3 crop association were significantly higher than in 2 crop association Table 7. Although the solar radiation reaching each crop association was not measured, it may appear that maize and okra may not have reduced solar radiation reaching the pumpkin crop significantly. This could probably account for the non-significant difference observed in the pumpkin's vine coverage.

Amongst the cropping system, weeds were highest in the sole crops at 6WAP and 10WAP save sole pumpkin crops. The presence of pumpkin significantly reduced weeds compared to other crops associations Table 8. The inclusion of other crops in association of pumpkin reduced weed dry matter significantly more than the sole crop of pumpkin. The highest weed count and dry matter was in the sole plots of maize and okra respectively Table 8. This development may be connected with the growth habit of pumpkin. It is a low, creeping plants with large leaves which has complete overlap of foliage and cover the surface of the soil and subsequently suppresses weed emergence and growth. This observation agrees with Rao and Shetty[16], who observed less weeds in crop associations than in their sole crops.

Relative economic yield: The yield of maize was higher in sole crop than maize in 2 or 3 crop associations. Within 2 or 3 crop associations, the yield of maize in 3 crop association was most significantly depressed Table 9. Similar yield trend, was observed in okra and in pumpkin sole crops and in their respective crop associations Table 9. The better performance of sole crops than in their corresponding crops associations is in agreement with Emuh and Agboola[11] who observed higher yield of sole crops than in their corresponding crop association or in their mixture.

Table 6: Okra leaf number as influenced by crop combination

	Time (weeks after planting)								
Treatment	2	3	4	5	6	7	8	9	10
t2 okra	4.10a	5.52a	6.11a	6.25a	6.29a	6.33a	6.94a	6.62a	6.72a
t4 okra + maize	3.95ab	4.82b	5.91b	6.10a	6.14a	6.18a	6.67a	6.49a	5.94b
t6 okra + pumpkin	3.80b	4.80b	5.74b	6.08a	6.12a	6.16a	6.74a	6.30a	6.33a
t7 okra + maize + pumpkin	4.07a	4.85b	5.86b	6.03a	6.07a	6.15a	6.66a	6.28a	6.08b
Mean	3.98	4.99	5.91	6.11	6.15	6.2	6.75	6.42	6.27

Table 7: Pumpkin vine % vine coverage as influenced by crop combination

	Time (weeks after planting)					
Treatment	2	3	4	5	6	7
t3 pumpkin	1.40a	1.80a	3.20a	3.95a	4.65a	5.0a
t5 pumpkin + maize	1.25a	1.90a	2.95b	3.60b	4.25a	5.0a
t6 pumpkin + okra	1.30a	1.75a	2.90b	3.53b	4.10b	5.0a
t7 pumpkin + maize + okra	1.25a	1.95a	3.15a	3.95a	4.60a	5.0a
Mean	1.3	1.85	3.05	3.76	4.4	5

Table 8: Effect of intercropping on weed suppression using weed count and short dry matter

Treatment	weed count at 6WAP	weed dry matter at 6WAP(t/ha)	weed dry matter at 10WAP (t/ha)
t1 maize	116.40a	31.69a	24.84a
t2 okra	99.40b	29.94b	25.04a
t3 pumpkin	42.40d	15.09c	9.40c
t4 maize +okra	97.85b	28.92b	19.82b
t5 maize + pumpkin	65.35c	14.71c	11.40b
t6 okra + pumpkin	58.60cd	10.23cd	9.08c
t7 maize + okra + pumpkin	56.10cd	6.89d	4.74d
Mean	76.58	19.63	14.9

Table 9: Relative economic yield of maize based cropping system (t/ha)

Treatment	Maize	Okra	Pumpkin	Total
Sole maize	3.40a			3.40d
Sole okra		0.20a		0.20e
Sole pumpkin			8.60a	8.60b
Maize + okra	2.80b	0.17b		2.97d
Maize + pumpkin	2.40bc		6.90b	10.30a
Okra + pumpkin		0.16b	6.30b	6.46c
Maize + okra + pumpkin	2.20c	0.13c	5.80c	8.13b
Mean	2.70	0.17	6.90	

Table 10: Land equivalent ratio (LER) of maize based cropping system

Treatment	Maize	Okra	Pumpkin	LER
Sole crops	1.00	1.00	1.00	1.00
Maize + okra	0.82	0.85		1.67
Maize + pumpkin	0.71		0.80	1.51
Okra + pumpkin		0.8	0.73	1.53
Maize + okra + pumpkin	0.65	0.65	0.67	1.97

The aggregate yield per unit land area was higher in crop association than in their sole crops. The higher the component sole crops in the crop association, the higher the aggregriate crop yield Table 8. This observation agrees with Willey[12] who observed higher yield from aggregriate yield per unit land area in crop associations or in intercrops than in their sole crops.

The Land Equivalent Ratio (LER) was highest in 3 crop association and least in sole crops Table 10. This implies that, the plant growth resources was intensively utilized, thus leading to higher aggregriate yield than sole crop yield and also higher LER in crop association than in their sole crops. This is in agreement with Emuh and Agboola[11], who observed higher yield in mixtures or crop associations than in sole crops. This was attributed to better use of growth resources in space and time[13] and better weed suppression in crop association than in this study in fadama soil, indicating that, there are some degree of interspecific competition in each crop associations. This could probably account for better performance of sole crops than in their crop associations.

The higher the number of crops in the association, the lower the crop performance and economic yields but the non-significant difference in some of the growth parameters irrespective of the crop association and also the higher aggregriate yield implies that the growth resources were effectively utilized. This agrees with Okpala-jose, Lucas, Onwubuya and Eneh[17] who reported that similar depression in oil palm cropping system but recommended intensive cropping due to higher LER.

A system with higher aggregriate yield, higher LER will benefit the farmers. This will also enhance crop diversity, reduce total crop failure due to pest, disease and vagaries of weather. Although, sole crops gave higher yield than in their corresponding crop association, crop associations with higher aggregriate, economic yield, higher land equivalent ratio is better, in the fadama soil.

To sustain a cropping system of maize/okra/pumpkin in a fadama soil, it is appropriate to support such cropping system with appropriate fertilizer recommendations.

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