PERFORMANCE OF JUTE MALLOW, EGUSI-MELON AND PIGEON PEA IN JUTE MALLOW/ EGUSI-MELON/ PIGEON PEA INTERCROPPING SYSTEM IN ABBI, DELTA STATE, NIGERIA

F.N. EMUH

Department of Agronomy,
Delta State University, Asaba Campus
P.M.B. 95074 Asaba, Nigeria

fnemuh@yahoo.com

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Abstract

A two year study was carried out in the wet seasons of 2012 and 2013 to evaluate the performance of jute mallow, egusi-melon and pigeon pea under jute mallow/ egusi-melon/pigeon pea intercropping system in Abbi, Ndokwa West Local Government Area of Delta State, Nigeria. The two - year experiment was laid in a randomized complete block design with four replicates. Data were collected on plant height of jute mallow and pigeon pea by measuring with a tape rule calibrated in centimetres, plant/stem girth of jute mallow and pigeon pea with the use of veneer calliper, leaf yield of jute mallow and seed yields of pigeon pea and egusi- melon while the percentage (%) vine coverage of the egusi melon were assessed with a 5 point scale. The relative yield (RY) and land equivalent ratio (LER) were calculated from the yields. The result of the study showed that plant height and plant girth increased ($P < 0.05$) from 2 weeks after planting (WAP) to final measurement. Pigeon pea height and girth were statistical similar ($P = 0.05$) at 2 – 8 WAP and 2 -- 6 WAP respectively while jute mallows' height and girth were significantly enhanced at sole plots at 6 to 8 WAP. The percentage vine coverage were ($P = 0.05$) at 2, 3 and 8 WAP. RY was highest in sole crops (1.00) and least in 3 crop intercrop, while LER was highest in 3 crop intercrop (2.25) and least in sole crops (1.00). Conclusively, a 3 crops association with highest aggregate yield and LER of 2.25 is hereby recommended.

Keywords: Plant height, girth, vine coverage, yield, RY, LER.

Introduction

The growing of 2 or more crops at the same time or in a relay fashion is a traditional agriculture that had been a common practice for centuries around the world (Papanastasis *et al.,* 2004). This is mostly on a small scale land holders with crops having different growth habits and durations. These crops share the same available space in such a way that they are given common managerial practice and shares a significant part of their life cycle together (Agboola 1987, 1988, 1989; Emuh and Agboola, 2000). This system offers higher aggregate yield per unit land area (Willey 1979; Emuh and Agboola, 2000) but sole crops yield were higher than their corresponding mixed stands yield (Lizarranga, 1980; Emuh and Agboola, 2000).

With high demand of land for non-agricultural purpose and other developments and with the ever increasing human population growth, the pressure on arable land is very high and the fallow period is reduced (Nortcliff, 2011). Thus, intensive cultivation will be practiced with little or no fallow period, causing nutrient depletion, soil degradation,

soil infertility and soil resilience (Ogban and Edem, 2005; Lawal *et al*, 2011). Consequently, the arable land cannot rejuvenate its productive capacity thus there is decline in soil fertility. This situation can be beguiled by adopting a cropping system, which has different duration, height, root development, light requirements and having capacity and capability to recycle nutrient, spreads and cover the soil surface, controlling erosion and increasing water holding capacity of the soil (IITA, 1979; Emuh and Agboola, 1999; Emuh, 2010). Egusi melon is an annual herbaceous creeping plant often cultivated for its high socio-cultural values, rich in protein and oil, spreads and covers the soil and can be used for soil fertility restoration (Adewusi *et al*, 2000; Schippers, 2004). Pigeon pea is a leguminous crop with high protein value which has nitrogen fixing ability and its supply to associated crop (Odeny, 2007), has been suggested for soil fertility sustenance. Jute mallow a leafy vegetable and a fibre plant can be intercropped with tomato, pepper, pigeon pea, ground nut, egusi-melon, leafy vegetables among others, which may be grown in different combinations. However, the compatibility of some of these food crops with pigeon pea has not been accessed in the Niger-Delta of Nigeria, which is known for crude oil exploration and exploitation with its attendant effects on land and water. Thus the objective of this study was to determine the effect of pigeon pea and its productivity on jute mallow and egusi-melon intercropping system.

Materials and methods

The experiments were conducted during the 2012 and 2013 wet seasons at Abbi, Ndokwa West local Government area of Delta State, Nigeria. Abbi is located at longitude 05^0 43 ^{1}N and latitude 060 15^1Eof the equator. The physico-chemical analyses of the soil at the experimental site were: pH in water was 6.2; Organic carbon was 1.06g/kg; % total N, 0.073 and Available P was 21.48mg/kg. The exchangeable cations were: Ca, 4.25 cmol/kg; Mg, 0.41cmol/kg; K, 0.57cmol/kg and Na, 10.42 cmol/kg, while H^+ and Al^{3+} were 0.12 and 0.24 cmol/kg. The sand, silt and clay fractions were 788 g/kg, 182 g/kg and 30 g/kg respectively and thus sandy loam in texture.

The experiment was a randomized complete block design with four replicates. Each plot size measured 5m x 5m with 1m as interplot and interblock spaces. The treatments were: T_1 Pigeon pea alone, T_2 Jute-mallow alone, T_3 Egusi-melon alone, T_4 Pigeon pea + jute-mallow, T_5 Pigeon pea + egusi-melon, T_6 Jute-mallow +egusi-melon and T_7 Pigeon pea + jute-mallow + egusi-melon.

The crop were egusi-melon (*Citrullus lunatus*) (Thumb) Mansf, jute-mallow (*Corchorus olitorious* L.) and pigeon pea (*Cajanus cajan*). Pigeon pea and egusi-melon were sown on 23rd April 2012 and repeated on 19th April 2013. Pigeon pea and egusi-melon were sown at a rate of 3 seeds per hole at a spacing of 100 cm X 100 cm while jute-mallow was sown at a rate of 3 seed per hole and at a spacing of 100 cm X 30 cm. The crops population in pure stands of pigeon pea and egusi-melon were 30,000 each while jute mallow was 90.000 per hectare. In the various crop associations/mixtures pigeon pea was 30,000 and egusi-melon was 29,700 while jute mallow was 89,100 per hectare. The plants height of pigeon pea were measured with a tape rule calibrated in centimetres while the plant girth were measured with a veneer calliper at 2, 4, 6, 8 and 10 weeks after planting (WAP). Similarly, the plant height and plant girth of jute-mallow were measured with tape and a meter rule and veneer calliper at 2, 4, 6 and 8 WAP respectively. % vine coverage of egusi-melon were accessed in a 5 point scale as 1= 0 – 24%, 2 = 25 – 49%, 3 = 50%, 4 = 51- 80% and 5 as 81 -100%. Data were also collected from the net stands for, seed yield of egusi-melon, jute mallow

and pigeon pea per plot. Harvesting of jute-mallow from 8 WAP by cutting above the soil level and egusi-melon leaves were dried and seeds extracted from the fruits while pigeon pea pods were dry. All the data were pooled and subjected to analysis of variance and means showing significant differences were separated using Duncan multiple range test, as cited by Wahua (1999). Each of the sole crops and crop associations/intercrops were evaluated for productivity using relative yield (RY) and land equivalent ratio (LER) (Willey, 1979). RY and LER are thus,

$$RY = ya/YA$$

$$LER = ya/YA + yb/YB + yc/YC + yd/YD + ... yn/YN$$

Where y is the crop association/ intercrop yield and Y is the sole crop yield.

Results

Plant height

The effects of crops association on plant heights of pigeon pea are presented in Table 1. Plant heights of pigeon pea and in crop associations were similar ($P = 0.05$) at 2 – 8 weeks after planting (WAP). It ranged from 13.40 cm to 48.75 cm (Table 1). At 10 WAP, the height of sole pigeon pea (62.05 cm) was ($P < 0.05$) taller than pigeon pea in crop associations. Within the crop associations, pigeon pea in 2 crops associations was most significant depressed as 54.90 cm in height (Table 1). The jute mallows plant height as influenced by crop associations are indicated in Table 3. At 2 – 4 WAP, the sole crop height of jute mallow and in crop association were similar ($P = 0.05$), while at 8 WAP, jute mallow in associations of 2 other crops was most significantly depressed (53.80 cm). Within 2 or 3 crop associations, jute mallow in 2 crops association were ($P < 0.05$) taller than in 3 crops association (Table 3).

Table 1: Effects of crops association on pigeon pea's plant height (in cm)

	Weeks after planting (WAP)				
Treatment	2	4	6	8	10
Pigeon pea	13.65[a]	6.69[a]	37.14[a]	48.75[a]	62.05[a]
Pigeon pea + jute-mallow	13.72[a]	27.86[a]	36.20[a]	48.50[a]	56.60[b]
Pigeon pea + egusi-melon	13.40[a]	27.70[a]	36.80[a]	48.65[a]	57.41[b]
Pigeon pea + jute-mallow + egusi-melon	13.60[a]	27.75[a]	36.60[a]	48.60[a]	54.90[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 2: Effects of crops association on **p**igeon pea's plant girth (in cm)

	Weeks after planting (WAP)				
Treatment	2	4	6	8	10
Pigeon pea	2.10[a]	4.05[a]	5.02[a]	6.10[a]	8.50[a]
Pigeon pea + jute-mallow	2.05[a]	3.20[a]	4.00[a]	5.15[b]	7.40[b]
Pigeon pea + egusi-melon	2.20[a]	3.50[a]	4.40[a]	5.80[a]	7.40[b]
Pigeon pea + jute-mallow + egusi-melon	2.10[a]	3.50[a]	4.30[a]	4.80[b]	7.15[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 3: Effects of crops association on jute-mallow height (in cm)

	Weeks after planting (WAP)			
Treatment	2	4	6	8
Jute-mallow	13.65[a]	37.14[a]	54.75[a]	65.05[a]
Jute-mallow + pigeon pea	13.72[a]	37.20[a]	48.50[b]	58.60[b]
Jute-mallow + egusi-melon	13.40[a]	36.80[a]	48.65[b]	60.41[a]
Jute-mallow + pigeon pea + egusi-melon	13.60[a]	37.80[a]	45.20[c]	53.80[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 4: Effects of crops association on jute-mallow's girth (in cm)

	Weeks after planting (WAP)			
Treatment	2	4	6	8
Jute-mallow	0.43[a]	1.88[a]	3.05[a]	4.20[a]
Jute-mallow + pigeon pea	0.43[a]	1.60[a]	3.05[a]	3.60[b]
Jute-mallow + egusi-melon	0.42[a]	1.60[a]	2.70[b]	3.30[bc]
Jute-mallow + pigeon pea + egusi-melon	0.43[a]	1.30[a]	2.30[c]	3.10[bc]

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

Plant girth

The pigeon pea girth as influenced by crop associations are presented in Table 2. The plant girth increased progressively from 2 – 10 WAP and ranged from 2.05 cm - 8.50 cm. Between 2 - 6 WAP, the pigeon pea girth in all the treatments were similar ($P = 0.05$). At 10 WAP, plant girth in sole crop pigeon pea of 8.50 cm was ($P < 0.05$) longer than in crop associations. Within the 2 or 3 crops association, the plant girths were similar ($P = 0.05$) (Table 2). The effects of crops association on jute mallow's plant girth are indicated in Table 4. The plant girths in sole crop and in crops association ranged from 0.42 cm to 4.20 cm at 2 to 8 WAP (Table 9). At 8 WAP, plant girth of sole crop was ($P < 0.05$) enhanced. Within in crops association, plant girth in 2 or 3 crops association were statistically similar (Table 4).

Percentage (%) vine coverage of egusi-melon

The effects of crops association on percentage (%) vine coverage of egusi-melon is presented in Table 5. At 2 and 3 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 5). At 4 to 7 WAP, there was no consistent trend in percentage vine coverage of egusi-melon while at 8 WAP percentage vine coverage in sole crop and egusi-melon in crops association were similar (Table 5).

Table 5: Effects of crops association on % vine coverage egusi-melon

	Weeks after planting (WAP)						
Treatment	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Egusi-melon	1.50[a]	1.90[a]	3.25[a]	3.60[a]	4.05[a]	4.10[ab]	5.00[a]
Egusi-melon + pigeon pea	1.25[a]	1.65[a]	2.40[c]	2.80[c]	3.45[bc]	4.05[b]	5.00[a]
Egusi-melon + jute-mallow	1.20[a]	1.50[a]	2.35[c]	2.90[bc]	3.20[b]	4.10[ab]	5.00[a]
Egusi-melon +pigeon pea + j/mallow	1.30[a]	1.54[a]	2.90[c]	3.20[b]	3.90[ab]	4.30[a]	5.00[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

Yield

The effects of crops association on seed yields of pigeon pea and egusi-melon and leaf yield of jute mallow are indicated in Table 6. The seed yield ranged from 0.39 to 0.47 t/ha (Table 6). Pigeon pea seed yield was ($P < 0.05$) higher in sole crop than in their crop associations. The seed yield of pigeon pea in crop associations were statistically similar and ranged from 0.39 to 0.41 t/ha (Table 6). The leaf yield of jute mallow ranged from 10.28 to 15.10 kg/ha and significantly increased with decrease in crops association (Table 6). Within the 2 and 3 crops association, jute mallow in 3 crops association was most significantly depressed (10.28 kg/ha).

The seed yield of egusi-melon was significantly higher ($P < 0.05$) in sole plot (810.0 kg/ha) than egusi-melon in any crop(s) association (Table 6). Within the crop associations' seed yields of egusi-melon in jute mallow and pigeon pea crop associations was least as 600.10 kg/ha (Table 6).

The relative yield (RY) was lower in crop associations than in their sole crops (Table 7). The RY of pigeon pea, jute mallow and egusi-melon were higher in the order of sole crops (1.00) > 2 crops association >3 crops association (Table 7). The land equivalent ratio (LER) was higher in the order of 3 crops association (2.25) > 2 crops association (1.67; 1.68; 1.76) > sole crops of 1.00 (Table 7).

Table 6: Economic yields of the sole crops and the intercrops in the cropping system

Treatment	Pigeon pea (t/ha)	Jute mallow (Kg/ha)	Egusi-melon (Kg./ha)
Sole crops	0.47[a]	15.10[a]	810.00[a]
Pigeon pea + jute mallow	0.40[b]	12.50[b]	
Pigeon pea + egusi-melon	0.41[b]		720.50[b]
Jute-mallow +egusi-melon		12.28[b]	700.70[b]
Pigeon pea + jute-mallow + egusi-melon	0.39[b]	10.28[c]	600.10[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 7: Relative yield (RY) and land equivalent ratio (LER) of the of the sole crops and the intercrops in the cropping system

Treatment	Relative yield			
	Pigeon pea	Jute mallow	Egusi-melon	LER
Sole crops	1.0000	1.0000	1.0000	1.00
Pigeon pea + jute mallow	0.8511	0.8288		1.68
Pigeon pea + egusi-melon	0.8723		0.8895	1.76
Jute-mallow +egusi-melon		0.8132	0.8650	1.67
Pigeon pea + jute-mallow + egusi-melon	0.8297	0.6807	0.7408	2.25

Discussion

The higher plant height of sole crops of pigeon pea and jute mallow than in 2 and in 3 crops association may be adduced to inter space competition for crop associations. This can be ascribed to little or no competition for growth resources in sole crops as opposed to intercrops or in crop associations. This result is in agreement with the findings of Lizarranga (1980) and Emuh (2009).

The higher plant girth in sole crops than in their crops association and significant increase with decrease in crops association of jute mallow in 2 or 3 crops association may be due to intercropping competition for growth resources and perhaps shading effect of the higher storey crop. The statistical similar plant girth in pigeon pea of 2 or 3

crops association may be adduced to pigeon pea being taller than other crops in the association with little or no competition for above soil level resources. This agreed with the findings of Katsaruware and Manyanhaire (2009) who found out that the presence of interspecific competition in crop associations or intercropping lead to better growth and development in sole crops than in intercropping or in crop associations.

The statistical similar percentage (%) vine coverage of egusi-melon at 2, 3 and 8 WAP of egusi-melon in sole plots and in crop association indicates the supressability of weeds in sole crops of egusi-melon or egusi-melon in crops association. The presence of egusi-melon, which spreads and cover the soil surface, had a similar effect in the pigeon pea based cropping system. This result is in consonance the findings of Akintoye *et al.*(2011), who reported that fluted pumpkin, spreads and covered some parts of the soil surface and suppressed the growth of weeds in okra intercropping system.

The leaf yield of jute mallow and seed yields of pigeon pea and egusi-melon were significantly higher in sole crops than in their respective crop associations and the sole crops relative yields were one and were higher than in their crop associations. This may be attributed to absence of interspecific competition. This agreed with the findings of Katsaruware and Manyanhaire (2009) who reported that interspecific competition in crop associations/intercrops led to better access to growth resources to support plant growth, development and yield in sole crops than in crop associations/intercrops.

The total or aggregate yield of the crop associations in each plot were higher than their sole crops while the land equivalent ratio were higher in 3 > 2 crops association than sole crops may be adduced to better and more efficient utilization of growth resources. This agrees with the findings of Ibeawuchi *et al.* (2008), who worked on productivity of yam- cassava based/land –race legumes in intercropping systems and reported higher aggregate or total yield in crop associations than in sole crops. The higher LER in the crop associations indicated a better utilization of growth resources and higher aggregate yield than in sole crops and this is in tandem with the findings of Willey (1979), Emuh and Agboola (2000) and Dhima *et al.* (2007) who variously reported higher LER for crop associations.

The general trend shows that intercropping of egusi-melon, jute mallow and pigeon pea with different crops height, duration and diversification enhanced crop varieties and higher aggregate or total yields indicating intercropping advantages. This corroborates the findings of Ghanbari *et al.* (2010), who reported that increased crop yields through improved conservation, reduced water evaporation and light reception when compared to sole crops alone. This could have probably led to higher LER in the intercrop which indicated yield advantage of the intercropping system. This is in conformity with the findings of Dhima *et al.* (2007).

Conclusion

Based on these findings, there is a need to grow jute mallow/egusi-melon/pigeon pea for higher aggregate yield, variety of crops, higher LER with similar growth effect of egusi-melon which spreads and covered the soil surface to enhance weed reduction in Delta State of Nigeria.

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