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Effect of Egusi Planting Density on Productivity of Egusi/Turmeric Intercrops in Southeastern Nigeria

I.I. Akpan, C.O. Muoneke and D.A. Okpara

Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Nigeria

Corresponding Author: I.I. Akpan, Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Nigeria

ABSTRACT

Field trials were conducted at the Michael Okpara University of Agriculture Teaching and Research Farm, Umudike (Lat. 05°29'N, Long. 07°33'E), Southeastern Nigeria in 2008 and 2009 to determine the effect of egusi planting density on the productivity of component crops in egusi/turmeric intercropping system. Turmeric at 80, 000 plants ha⁻¹ was intercropped with egusi three planting densities of 20, 000; 40, 000 and 66, 670 plants ha⁻¹. The experiment was laid out as Randomized Complete Block Design (RCBD) with three replications. Across the planting densities, intercropping reduced egusi seed yield by 44% in 2008 and 43% in 2009. Similarly, on the average, intercropping reduced turmeric rhizome yield by 41, 53 and 57% at egusi planting densities of 20, 000; 40, 000 and 66, 670 plants ha⁻¹, respectively. There was yield disadvantage as depicted by LER below unity (0.995) when turmeric was intercropped with egusi at 20, 000 and 40, 000 plants ha⁻¹ and a yield advantage of 19% (LER = 1.19) when turmeric was intercropped with egusi at 66, 670 plants ha⁻¹. Economic analysis (gross monetary returns) showed that sole turmeric was more profitable than sole egusi or egusi/turmeric intercrop at lower egusi planting densities. Comparative assessment of the mixtures indicated that it was better to grow the two crops separately.

Key words: Egusi melon, turmeric, intercropping, plant density, Southeastern Nigeria

INTRODUCTION

Egusi (*Citrullus colocynthis* L. Schrad syn *Colocynthis vulgaris* Schrad) features prominently in the farming system of southeastern Nigeria while turmeric (*Curcuma longa* L.) is a new crop in the region. Egusi is cultivated as intercrop for its oil seed which is rich in protein, oil, essential amino-acids and minerals (Ndukauba, 1998). In the cropping system, egusi is always introduced as live mulch to control weeds as it provides early vegetative cover which naturally suppresses weed growth during the initial growth of the component crops (Anuebunwa, 2000). The reasons for practicing mixed cropping by farmers include the production of higher total yields from a given area of land, insurance against crop failure, reduction in the levels of insect pests, diseases and weeds and better use of growth resources among others (Okigbo and Greenland, 1976; Okpara and Omaliko, 1995; Njoku and Muoneke, 2008). Although, turmeric is a new crop, its integration in the farming system of southeastern Nigeria is particularly important for most of the farmers and low income earners for improved income and nutrition. Turmeric is used in many countries as a spice and cosmetic (Akanime *et al.*, 2007). Curcumin the main ingredient of turmeric functions as a

medicine with anti-inflammatory, anti-mutagenic anti-carcinogenic, anti-tumor, anti-bacterial, anti-oxidant, anti-fungal, anti-parasitic and detoxifying properties (Akanime *et al.*, 2007).

There is dearth of published information on mixtures involving turmeric in Nigeria. It is therefore, necessary to investigate the potentials of turmeric intercropping with a view to improving the system. Huxley and Maingu (1978) and Okpara *et al.* (2004) reported that maximum productivity in intercropping could be achieved when inter- and intra- crop competitions are minimal for growth limiting factors and the density of each crop adjusted to minimize competition between them. Maximization of yields in crop mixtures will always be on the basis of high species compatibility, optimum plant population (Baker, 1974) and the minimization of above and below ground competition for growth (Trenbath, 1976). The objective of this work was to evaluate the effect of egusi planting density on the productivity of egusi/turmeric intercropping system.

MATERIALS AND METHODS

The experiment was carried out during the wet cropping season of 2008 and 2009 on an ultisol of Michael Okpara University of Agriculture Umudike. Umudike is located at latitude 5°29'N longitude 7°33'E and 122 m above sea level. Annual rainfall of the site was 2395.4 mm in 2008 and 2061.7 mm in 2009. Mean monthly air temperature ranged from 26 to 29°C in both years. The soil was a sandy loam and the chemical properties are shown in Table 1.

Egusi (Bara variety) and 15 g of turmeric (NCL 2 variety) were planted the same day on 12 May, 2008 and 19 April, 2009. The experiment was laid out as Randomised Complete Block Design (RCBD) with three replications. Plots measured 3×3 m (9 m²). Treatments were seven and comprised: Sole turmeric at 80,000 plants ha⁻¹, sole egusi at 20,000 plants ha⁻¹, sole egusi at 40,000 plants ha⁻¹, sole egusi at 66,670 plants ha⁻¹, 20,000 egusi plants ha⁻¹ + 80,000 turmeric plants ha⁻¹, 40,000 egusi plants ha⁻¹ + 80,000 turmeric plants ha⁻¹, 66,670 egusi plants ha⁻¹ + 80,000 turmeric plants ha⁻¹. Egusi was sown at two seeds per hole on the crest of the ridges and the three egusi densities of 20,000; 40,000 and 66,670 were obtained with 1×1, 1×0.5 m and 1×0.3 m spacings, respectively. Turmeric rhizome was planted at both sides of the ridge (double row) at two per hole and at a spacing of 1×0.5 m to give a plant population of 80,000 plants ha⁻¹. They received NPK fertilizer (20:10:10) at 200 kg ha⁻¹ 4 Weeks After Planting (WAP). Weeding of the plots was done manually with hoes at 1 and 4 Months After Planting (MAP).

Records were taken on number of fruits m⁻², fruit weight and diameter, number of seeds/fruit, seed weight, seed yield (kg ha⁻¹) of egusi and number of rhizomes m⁻², rhizome weight and rhizome

Table 1: Some mechanical and chemical properties of the soil of the experimental area in 2008 and 2009 cropping seasons

Soil properties	2008	2009
Mechanical properties		
Sand (%)	70.60	68.60
Clay (%)	14.00	14.00
Silt (%)	15.40	17.40
Textural class	Sandy loam	Sandy loam
Chemical properties		
Soil pH (H ₂ O)	4.12	4.89
Organic matter (%)	1.07	2.21
Total nitrogen (%)	0.07	0.22
Available phosphorus (mg kg ⁻¹)	23.70	27.20
Potassium“	0.16	0.14

yield (kg ha^{-1}) for turmeric. The data were analysed according to the procedure of a randomized complete block design and treatment means were compared using least significant difference ($\text{LSD}_{0.05}$). Land Equivalent Ratio (LER) [the sum of the ratios of the yields of the intercrops to those of the sole crops (Mead and Willey, 1980) was used to determine the productivity of the intercropping system. Gross Monetary Returns (GMR) were determined based on the prevailing market prices of 120.00 and 100.00 kg^{-1} in 2008 and 2009, respectively for egusi seed and 1000 kg^{-1} for turmeric rhizome in 2008 and 2009 at the time of harvest. Genstat Release 4.23 Discovery Edition statistical software package was used for the statistical analyses of the data.

RESULTS

Yield of component crops: Intercropping significantly reduced number of fruits m^{-2} , fruit weight, number of seeds/fruit, weight of seeds/fruit, 100-seed weight and seed yield in both years (Table 2). Egusi seed yield reduction due to intercropping was 44 percent in 2008 and 43% in 2009. While number of seeds per fruit decreased, fruit weight and seed yield increased significantly as egusi plant density was increased up to 66, 670 plants ha^{-1} in the two cropping seasons. On the average, egusi seed yield at 66, 670 plants ha^{-1} was higher than the yield at 20, 000 and 40, 000 plants ha^{-1} by 123 and 54%, respectively. Interactions were significant for fruit weight and fruit diameter in 2009 but not significant for seed yield in both years. In both cropping systems in 2009, fruit weight was lower at 20,000 plants ha^{-1} compared to the higher densities of 40,000 and 66,670 plants ha^{-1} . However, fruit diameter in 2009 was higher at 20,000 plants ha^{-1} than 66,670 plants ha^{-1} .

In both cropping seasons, intercropping with egusi drastically reduced the number and weight of mother, primary, secondary and total number of rhizome m^{-2} as well as rhizome yield/ha of turmeric (Table 3). Total number of rhizome m^{-2} was on the average, significantly decreased by 40,49 and 55% by intercropping at 20, 000, 40, 000 and 66, 670 plants ha^{-1} . Intercropping reduced average rhizome yield by 41, 53 and 57% at egusi planting densities of 20,000, 40, 000 and 66, 670 plants ha^{-1} , respectively compared to sole cropping. Rhizome yield was generally higher in 2009 in which planting was done in April and the soil was more fertile than 2008.

Table 2: Effect of egusi density on yield and yield components of egusi in egusi and turmeric intercrops at Umudike in 2008 and 2009 cropping seasons

Treatment	Fruit diameter (cm)		No. of fruits (m^{-2})		Weight of fruit (g m^{-2})		No. of seeds /fruit		Weight of seeds (g/fruit)		Weight of 100 seeds (g)		Seed yield (kg ha^{-1})	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Cropping system														
Sole egusi	12.16	11.11	2.19	3.67	6.31	6.01	651.8	622.2	88.1	73.3	9.48	9.00	972	814
Intercropped egusi	11.94	9.03	1.50	2.17	4.56	5.05	461.6	387.4	71.1	57.8	8.16	7.21	542	462
LSD 0.05	NS	0.74	0.67	0.99	0.54	0.47	20.59	30.84	6.21	7.02	0.35	1.17	0.19	79.3
Egusi planting density (plants ha^{-1})														
20,000	12.22	11.55	3.00	3.17	4.00	3.83	646.3	586.2	90.7	75.7	9.42	8.85	473	470
40,000	12.18	10.08	2.08	2.42	5.30	5.03	554.3	498.3	80.7	66.3	8.87	8.35	707	643
66,670	12.05	8.58	1.50	3.17	7.00	7.33	469.3	430.0	67.5	54.7	8.17	7.12	1092	800
LSD 0.05	NS	0.19	0.70	NS	0.66	0.58	25.21	37.77	7.61	8.59	0.43	NS	236	97.1
System x egusi	NS	*	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS

planting density LSD 0.05

NS: Non significant, *Significant at 5%

Table 3: Effects of egusi planting density on yield and yield components of turmeric in egusi and turmeric intercrops at Umudike in (2008) and (2009) cropping seasons

Treatment	No. of rhizomes per m ²								Weight of rhizomes per m ²								Rhizome yield (kg ha ⁻¹)	
	Mother		Primary		Secondary		Total		Mother		Primary		Secondary		Total			
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Sole turmeric	16.2	17.5	67.7	71.9	47.41	68.7	131	158	50.8	86.3	175.2	186.7	69.2	96.3	295.1	369.3	2951	3693
Turmeric+20,000 plants ha ⁻¹ egusi	12.0	16.9	22.0	58.5	15.1	49.6	49	125	39.2	59.5	93.3	104.8	39.7	58.2	172.2	222.5	1722	2225
Turmeric+40,000 plants ha ⁻¹ egusi	6.9	9.7	17.2	54.4	11.3	48.3	35	112	25.2	51.5	75.2	90.6	27.8	44.4	128.1	186.5	1281	1865
Turmeric+66,700 plants ha ⁻¹ egusi	5.5	8.2	13.7	49.3	9.2	42.9	28	100	20.6	41.9	65.9	80.4	25.9	49.3	112.4	171.5	1124	1715
LSD 0.05	1.33	1.36	9.14	8.3	3.44	8.24	9	13	4.9	5.6	44.1	51.6	5.1	25.9	44.0	54.3	440	542.9

Table 4: Effect of egusi planting density on land equivalent ratio and gross monetary returns on sole and intercropped egusi and turmeric intercrops in (2008) and (2009)

	Land equivalent ratio							Gross monetary returns (N/kg)						
	Partial							Partial						
	Egusi		Turmeric		Total			Egusi		Turmeric		Total		
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Sole egusi	1.0	1.0	-	-	1.0	1.0	116640	94,400	-	-	116,640	94,400		
Sole turmeric	-	-	1.0	1.0	1.0	1.0	-	-	5,0030,000	4,799,000	5,030,000	4,799,000		
Turmeric+20,000 plants ha ⁻¹ egusi	0.40	0.41	0.58	0.60	0.98	1.01	18,576	15,867	998,760	1,335,000	1,017,336	1,350,867		
Turmeric+40,000 plants ha ⁻¹ egusi	0.52	0.53	0.43	0.51	0.95	1.04	313,872	26,659	550,830	951,150	864,702	977,809		
Turmeric+66,700 plants ha ⁻¹ egusi	0.76	0.78	0.38	0.46	1.14	1.24	672,144	57,486	427,120	788,900	1,099,264	846,386		

Egusi and turmeric were at prevailing market prices of N120/kg and N1000/kg, respectively in (2008) and (2009)

Efficiency of the mixtures: There were yield disadvantages of growing egusi and turmeric at lower egusi densities, especially in 2008 as depicted by the total LER 0.98 at 20,000 egusi plants ha⁻¹ and 0.95 at 40,000 egusi plants ha⁻¹ (Table 4). On average, LER at 20,000 and 40,000 egusi plants ha⁻¹ was below unity (0.995). Intercropping at higher egusi planting density of 66,670 plants ha⁻¹ resulted in slight yield advantage with average total LER of 1.19. The contribution of egusi to the LER was more at higher egusi planting densities of 40,000 and 66, 670 plants ha⁻¹ but lower at the lower density of 20,000 plants ha⁻¹.

The gross monetary return of sole turmeric was substantially higher than that of sole egusi or egusi/turmeric intercrop. The average gross return of sole turmeric was higher than that of sole egusi by 45.6%. When averaged over both years, sole cropping of turmeric gave higher economic returns than intercropping at egusi planting densities of 20,000, 40,000 and 66,670 plants ha⁻¹ by 315, 433 and 405%, respectively. Under intercropping, gross returns were lower at the higher egusi densities of 40,000 and 66,670 plants ha⁻¹ compared with the lower density of 20,000 plants ha⁻¹. The total monetary returns in intercropping were contributed considerably by the turmeric component as depicted by its higher partial monetary returns.

DISCUSSION

In both cropping seasons, seed yield of egusi was a reflection of the number of fruits m⁻², weight of fruits or seeds and was significantly influenced such that the monoculture yields were

consistently higher than those of the intercrop. This agrees with findings on other crops (Muoneke and Ndukwe, 2008; Njoku and Muoneke, 2008; Okpara, 2000; Manga *et al.*, 2003; Ojikpong *et al.*, 2008), in which intercropping reduced yields due to competition for growth resources. The observed increasing trend in seed yield of egusi with planting density up to 66,670 plants ha⁻¹, supports the findings of Okpara *et al.* (2004), Mohdnor (1980) and Ezedinma (1974). Egharevba and Abede (1986) attributed the superior yields at high planting densities to better water utilization as a result of less evaporation, better weed control through canopy shading, better radiant energy utilization, increased photosynthesis and improved leaf distribution. Ikeorgu *et al.* (1981) had reported that egusi melon reduced soil temperature, soil moisture stress and provided complete soil cover to check erosion when intercropped with cassava and maize. Across planting densities, intercropping reduced egusi yield by 44% in 2008 and 43% in 2009. Makinde and Alabi (2002) reported 60% reduction in melon seed yield in maize/melon intercropping.

Similarly, intercropping reduced rhizome yield of turmeric, with the magnitude of depression depending on egusi planting density. For instance, intercropping turmeric with 20,000 egusi plants ha⁻¹ gave average rhizome yield of 1973.5 kg ha⁻¹ and a yield reduction of 41% when compared to average sole crop yield of 3322 kg ha⁻¹. However, increasing egusi density to 66,670 plants ha⁻¹ reduced turmeric yield by 51%. The magnitude of turmeric, therefore, increased with egusi planting density. Although turmeric was the taller component in mixture, yield depressions were high. Muoneke and Ndukwe (2008) had reported that when components are grown together, severe mingling of their roots and the quest for below ground resources would be high and that yield would be lower at high population because of severe competition when the number of plants demanding the scarce resources was high. Rhizome yield was generally higher in 2009 in which the soil was more fertile and the planting date was earlier in April, indicating that soil fertility and planting date may have played a role determining turmeric yield.

The LER is the land area that would be required for monocrops to produce the yields achieved in intercropping. Using the LER as a means of determining the productivity of the land, intercropping turmeric and egusi at the lower populations of 20,000 and 40,000 plants ha⁻¹ gave a yield disadvantage, with average total LER lower than unity (0.995). However, when turmeric was intercropped with egusi at 66,670 plants ha⁻¹, a yield advantage of 19 percent was obtained as reflected in average total LER of 1.19. Muoneke and Ndukwe (2008) obtained similar results in okra/*Amaranthus* intercropping system.

The gross monetary returns further showed that sole cropping of turmeric was more profitable than sole egusi or turmeric/egusi intercrop. With intercropping, gross monetary returns dropped as egusi density was increased from 20,000 to 66,670 plants ha⁻¹ on the average. The average gross monetary returns of 4,914,500 obtained with sole turmeric was 315 percent higher than in the intercrop when egusi was sown at its best density of 20,000 plants ha⁻¹ (1,184,102). The implication of the monetary yield disadvantage is that it is more profitable to grow the two crops separately. Similar findings were reported by Chiezey *et al.* (2005) in sorghum soybean mixture, with sole cropping of soybean being more profitable than sole sorghum or sorghum/soybean intercrop.

CONCLUSION

The results of the study showed that it is more productive and more profitable to grow sole turmeric in the study area.

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