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INFLUENCE OF RELATIVE SOWING TIME ON THE PERFORMANCE AND YIELD OF MAIZE AND EGUSI MELON IN INTERCROP

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ABSTRACT

The effect of variations in relative sowing time of the component crops in maize (Zea mays L.)/egusi melon (Colocynthis citrullus L Schrad) intercropping system was examined in 2011 and 2012 cropping seasons. Maize was either sown on the same day as egusi melon, or two, four and six weeks before or after egusi melon. Intercropping reduced maize and melon seed yields compared to their sole crops. Melon seed yield was depressed by maize; maize out competed egusi melon for most growth factors. Time of sowing affected the yields of the component crops; generally, the yields of the component crops increased when sown earlier, but decreased when introduced later than the earlier sown component. Usually, the earlier sown component had initial competitive advantage over the later one. When melon was introduced early into the mixture, it checked weeds growth; Land Equivalent Ratio (LER) were greater than one in all intercropping situations, except when egusi melon was sown 4 or 6 weeks before or after maize. LER values also showed that the crop that was introduced early into the mixture also contributed more to the mixture. Optimum productivity was however achieved when maize and egusi melons were sown on the same day.

Keywords: Relative sowing time, intercropping, egusi melon, maize

INTRODUCTION

In the traditional farming system of the tropics, including Nigeria, maize and egusi melon are usually intercropped in the early season (March/April) so as to free the land in August/September for second cropping in the season. The purpose of intercropping according to Singh and Ajeiber (2003) is to maximize soil and climate resources (by producing species of crop) despite the unpredictable rainfall and other environmental conditions in the tropics. In the selection of crops for intercropping, attention is usually given to the compatibility as well as the spatial and temporal differences in the growth pattern of the crops (Willey, 1979: Petu-Ibikunle *et al;* 2010). Rezende and Romalho (1994) stated that enhancing the productivity of crops in intercrop requires improving the interspecies complementarity or reducing the competition effects. This might be achieved through the manipulation of plant arrangement, plant densities and by planting compatible cultivars (Rao and Mitra 1990) or by varying the time of production of the component crops (Willey, 1979; Muoneke, *et al.*, 1997). But in mixed intercropping system, the time of

introduction of the component crops have been a matter of conjecture; Ikeorgu and Ezulike (1999) obtained the best results when melon, maize and yam minisette were sown on the same day. Mouneke *et al*, (1997) recommended that for best results, maize should be introduced at the podding stage of Okra. Remison (1982) recommended the inter-planting of cowpea with established maize plants in relay.

Egusi melon is a popular crop in Nigeria. It is perhaps the most cultivated crop in the *Cucurbitacaea* family (Ehigiator, 1994). It is grown mainly for its seeds which contain protein (36%), oil (45%), essential amino acids and minerals (Huang *et al*; 1994, Nduka Uba, 1998). The seed provide popular condiment in stew and soup and is consumed throughout Nigeria.

Maize on the other hand is a herbaceous annual crop. It ranks second following wheat in the world production of cereal crops (NRC, 1988; Onwueme and Sinha, 1991). It is used for human and live stock consumption. Ater *et al* (2011) states that maize as a crop has significant role to play in food security and industrial growth of developing economies.

This study therefore was taken to:

i) Determine the most appropriate time of introduction of the component crops into the mixture for high yields of maize and egusi melon
ii) Evaluate the efficiency of the mixture.

MATERIALS AND METHODS

The experiment was conducted during the 2011 and 2012 cropping seasons at the National Cereals Research Institute, Owot Uta Sub station near Uyo. Owot Uta lies on latitude $04^{O}23^{1}$ and $05^{O}31^{1}$ N and Longitude 08^{O} and $07^{O}32^{1}$E. It received annual rainfall of about 1888.1mm in 2011 and 2697.8mm in 2012. The chemical properties of the upper 15cm of the soil profile are presented in Table 1:

The experiment consisted of nine treatments:

i) Sole maize
ii) Sole egusi melon
iii) Maize and egusi melon intercrop sown on the same day.
iv) Egusi melon sown 2 weeks before maize
v) Egusi melon sown 4 weeks before maize
vi) Eguis melon sown 6 weeks before maize
vii) Maize sown 2 weeks before egusi melon
viii) Maize sown 4 weeks before egusi melon
ix) Maize sown 6 weeks before egusi melon

Treatment 1, 2 and 3 were sown on 13 March, 2011. The component crops were sown relative to the sole crop planting date, according to the treatment schedules.

In 2012 the sole crops and the plots sown the same day were sown on 18th March. Other intercrop treatments were sown relative to dates according to the treatment schedules.

Each subplot measured 6 x 3.75cm and consisted of 6 rows of maize and 5 rows of egusi melon. The maize seeds were sown at 75cm x 25cm, equivalent to 53,330 plants/ha. The egusi melon seeds were sown between the maize rows at 75 x 100cm corresponding to 13,330 plants/ha. The sub plots were separated by paths measuring 1.2m. The experimental design was RCBD replicated three times. Lime at the rate of 0.5 tons/ha was incorporated into the soil two weeks before planting as results of soil analysis indicated high acidity.

Table 1: Physico-chemical Properties of the Upper 15cm of the Experiment Soil

SOIL PROPERTIES	2011	2012
Physical Properties		
Sand (%)	78.3	79.0
Clay (%)	17.5	16.9
Silt (%)	4.2	4.1
Texture	**Sandy Loam**	**Sandy Loam**
Chemical Properties		
pH (1:2.5 Soil:Water)	5.10	6.4
Organic matter (%)	2.23	2.34
Total N (%)	0.04	0.06
Available P ($Mgkg^{-1}$)	173	172
Exchangeable Bases ($c.molkg^{-1}$)		
Ca	1.70	1.90
K	0.14	0.11
Na	0.08	0.06

Hybrid maize (Oba super - 2) and local egusi melon (*Sewere*) seeds were used for the experiment. The plots were kept weeds-free by hoe weeding as necessary. NPK fertilizer (20:10:10) at the rate of 300kg/ha, was applied at 2 WAS.

Five plants each of maize and egusi melon from the inner rows were randomly selected and tagged for the purpose of data collection. Data were taken on plant height and leaf area indices (for maize), and length of vine, and flowering to fruiting interval (for egusi melon). Data on yield and yield components were also taken from the five crops each of maize and egusi melon from the inner rows. The grain yield of maize was taken at 15% moisture contents. Land equivalent ratio (LER) was computed to ascertain the productivity of the intercropping system. This was calculated using the equation:

$$LER = \frac{\text{Yield of intercropped maize}}{\text{Yield of sole maize}} + \frac{\text{Yield of intercropped egusi melon}}{\text{Yield of sole egusi melon}}$$

Data were analyzed separately on each crop using the procedure of RCBD as outlined by Steel and Torrie (1980), and significant treatment mean differences were separated using Fishers Least Significant Difference (F-SLD) at probability of 0.05.

RESULTS

The height of maize plants was not affected by the cropping system except AT 6 WAP in 2011, when sole maize were taller than intercropped maize (Table 2). Tarselling was hastened in 2011 due to intercropping; but in 2005 there was no effect of the cropping system on tarselling and silking.

Relative sowing time affected the growth, yield and yield components; the height of maize at all stages of growth was affected by the time of sowing; the tallest maize plants were produced when maize was sown 6 weeks before melon in 2012. These were 6.93% taller than maize sown same day with melon. In 2012, the tallest maize plants were produced when maize and egusi melon were sown on the same day. Silking and tarselling in maize were affected by the time of sowing. Maize

sown 6 weeks after egusi melon did not tarsell while maize sown 2 or 4 weeks after egusi melon had tarselling delayed by 2-3 days, and silking by 2 – 5 days.

The vine length of melon was not affected by the cropping system up to the 8th week even though sole egusi melon consistently produced longer vines (Table 3). But the vine length of egusi melon was affected by the relative sowing time. The longest vines were produced when maize and egusi melon was sown on the same day. When egusi melon was sown 4 or 6 weeks after maize they were stunted, although the melon plants produced flowers, they could not bear fruits due to the interspecific competition with, and the shading effect of maize. When egusi melon was sown two weeks after maize, the length of vines decreased (33% in 2011 and 38% in 2012) relative to when maize and egusi melon were sown on the same day.

Table 2: Effects of Relative Sowing Time on the Height Tarselling and Silking of Maize in 2011 and 2012 Cropping Seasons.

	Plants height (cm)					Days to 50%	Days to 50%
	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP	Tarselling	Silking
2011							
System:							
Sole	26.40	51.80	96.27	133.13	153.67	61.39	68.44
Intercrop	22.55	41.59	79.66	110.10	128.18	59.67	65.33
LSD 0.05	N.S	10.01	N.S	N.S	N.S	1.55	2.38
Relative sowing time:							
Maize sown 2 weeks before egusi melon	19.87	33.54	75.67	122.33	147.80	60.33	67.33
Maize sown 4 weeks before egusi melon	24.53	35.42	80.53	120.87	142.00	60.33	67.33
Maize sown 6 weeks before egusi melon	28.18	45.20	105.20	128.67	154.95	61.33	67.33
Maize and egusi melon sown same day	25.47	51.47	94.93	122.80	144.20	61.33	67.67
Maize sown 2 weeks after egusi melon	24.75	47.27	75.47	91.07	108.00	61.33	68.67
Maize sown 4 weeks after egusi melon	24.93	86.67	46.13	65.07	72.13	63.33	72.00
Maize sown 6 weeks after egusi melon	10.20	*	*	*	*	*	*
LSD 0.05	3.72	9.10	27.68	24.55	22.56	1.45	1.73
2012							
System:							
Sole	38.60	81.20	114.80	164.33	183.80	55.67	64.33
Intercrop	24.57	59.36	106.03	133.58	155.81	56.94	66.11
LSD 0.05	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Relative sowing time:							
Maize sown 2 weeks before egusi melon	28.27	59.20	127.93	142.53	146.93	58.33	68.00
Maize sown 4 weeks before egusi melon	30.13	64.73	128.33	166.40	183.47	56.00	65.33
Maize sown 6 weeks before egusi melon	35.47	77.33	142.07	162.47	186.87	56.67	66.33
Maize and egusi melon sown same day	27.13	62.67	144.93	168.67	191.52	56.00	64.67
Maize sown 2 weeks after egusi melon	30.40	66.67	84.87	106.33	122.73	57.33	66.33
Maize sown 4 weeks after egusi melon	12.17	25.53	88.07	55.07	85.33	57.33	66.00
Maize sown 6 weeks after egusi melon	4.40	*	*	*	*	*	*
LSD 0.05	12.03	32.03	78.62	56.29	50.69	2.77	3.11

*Maize plants were smoldered by melon plants at 6WAP.

Table 3: Effects of Relative Sowing Time on the Vine Length of Melon in 2011 and 2012 Cropping Season

	Plants height (cm)			Days to 50%	Flowering to fruiting
	4 WAP	6 WAP	8 WAP	Flowering	Interval (Days)
2011					
System:					
Sole	49.80	145.53	310.33	27.40	15.33
Intercrop	34.91	94.95	198.04	26.67	15.47
LSD 0.05	N.S	N.S	N.S	N.S	N.S
Relative sowing time:					
Maize sown 2 weeks before maize	47.60	137.20	287.22	25.67	14.67
Maize sown 4 weeks before maize	42.80	126.93	274.33	27.67	15.00
Maize sown 6 weeks before maize	48.93	136.87	281.20	27.33	15.333
Maize and egusi melon sown same day	50.40	137.40	291.80	28.67	16.33
Maize sown 2 weeks after maize	41.13	103.07	195.80	27.67	16.33
Maize sown 4 weeks after maize	7.13	15.50	47.27	-	-
Maize sown 6 weeks after maize	6.40	7.76	8.69	-	-
LSD 0.05	5.69	26.13	29.86	1.94	1.99
2012					
System:					
Sole	44.02	11.95	273.95	25.50	12.20
Intercrop	46.08	144.15	255.53	26.40	13.20
LSD 0.05	N.S	N.S	N.S	N.S	N.S
Relative sowing time:					
Maize sown 2 weeks before maize	46.47	164.33	277.87	26.00	14.00
Maize sown 4 weeks before maize	45.27	158.93	273.80	26.33	-
Maize sown 6 weeks before maize	45.40	147.07	266.67	25.67	13.13
Maize and egusi melon sown same day	74.88	161.08	279.80	26.60	14.00
Maize sown 2 weeks after maize	42.27	78.87	174.73	26.67	12.00
Maize sown 4 weeks after maize	-	-	-	-	-
Maize sown 6 weeks after maize	-	-	-	-	-
LSD 0.05	N.S	N.S	N.S	N.S	N.S

Table 4: Effects of Relative Sowing Time on the Yield and Yield Components of Maize

	Cob length (cm)	Number of grains per cob (g)	Grains weight (g)	100 grains weight (g)	Grain yield (kg/ha)
2011					
System:					
Sole	16.63	411.67	124.23	24.78	2188.10
Intercrop	14.50	277.38	86.50	19.87	1465.60
LSD 0.05	NS	N.S	N.S	N.S	N.S
Relative sowing time					
Maize sown 2 weeks before egusi melon	15.58	368.53	116.31	23.80	2005.9
Maize sown 4 weeks before egusi melon	15.90	295.33	120.34	23.51	2077.0
Maize sown 6 weeks before egusi melon	16.56	403.60	122.06	24.36	2269.6
Maize and egusi melon sown same day	15.46	359.40	114.39	23.65	1986.7
Maize sown 2 weeks after egusi melon	13.67	331.93	105.97	22.41	1595.5
Maize sown 4 weeks after egusi melon	9.87	82.87	26.44	23.51	324.4
Maize sown 6 weeks after egusi melon	0.00	0.00	0.00	0.00	0.00
LSD 0.05	1.54	37.26	13.95	0.87	303.96
2012					
System:					
Sole	20.11	418.60	116.64	25.80	2201.5
Intercrop	17.52	314.44	89.84	24.28	1442.1
LSD 0.05	NS	N.S	NS	N.S	N.S
Relative sowing time:					
Maize sown 2 weeks before egusi melon	19.07	390.87	113.73	25.80	2201.5
Maize sown 4 weeks before egusi melon	19.51	400.13	113.09	25.24	1879.98
Maize sown 6 weeks before egusi melon	19.33	397.27	133.79	25.62	2238.50
Maize and egusi melon sown same day	18.56	400.53	113.07	24.02	1893.32
Maize sown 2 weeks after egusi melon	17.57	380.60	107.80	23.73	1789.61
Maize sown 4 weeks after egusi melon	11.10	231.67	65.45	22.39	428.14
Maize sown 6 weeks after egusi melon	0.00	0.00	0.00	0.00	0.00
LSD 0.05	1.10	34.76	11.59	2.15	179.03

Table 5: Effects of Relative Sowing time on the Yield and Yield Components of Melon

	Fruit diameter (cm)	Number of fruits per plant (g)	Number of seeds per fruit (g)	Weight of 100 seeds (g)	Seed yield (kg/ha)
2011					
System:					
Sole	13.89	2.95	394.2	11/99	708.10
Intercrop	13.48	1.57	258.9	8.06	375.0
LSD 0.05	NS	N.S	N.S	N.S	N.S
Relative sowing time					
Egusi melon sown 2 weeks before maize	13.56	2.24	377.27	11.70	536.30
Egusi melon sown 4 weeks before maize	13.83	2.30	392.0	11.40	576.30
Egusi melon sown 6 weeks before maize	14.17	2.55	393.87	11.96	648.89
Egusi melon and maize sown same day	13.03	2.07	358.20	11.01	475.56
Egusi melon sown 2 weeks after maize	12.83	1.87	291.0	10.32	388.15
Egusi melon sown 4 weeks after maize	0.00	0.00	0.00	0.00	0.00
Egusi melon sown 6 weeks after maize	0.00	0.00	0.00	0.00	0.00
LSD 0.05					
2012					
System:					
Sole	16.27	4.36	411.82	12.03	649.2
Intercrop	13.97	2.80	316.56	11.50	307.3
LSD 0.05	NS	N.S	NS	N.S	N.S
Relative sowing time:					
Egusi melon sown 2 weeks before maize	13.83	5.50	304.80	11.47	415.56
Egusi melon sown 4 weeks before maize	14.05	4.77	319.87	11.78	502.67
Egusi melon sown 6 weeks before maize	15.57	4.46	367.73	11.89	556.44
Egusi melon and maize sown same day	15.52	4.07	374.92	11.34	576.86
Egusi melon sown 2 weeks after maize	11.24	5.14	234.53	11.45	177.78
Egusi melon sown 4 weeks after maize	0.00	0.00	0.00	0.00	0.00
Egusi melon sown 6 weeks after maize	0.00	0.00	0.00	0.00	0.00
LSD 0.05	0.96	0.83	39.28	N.S	133.07

Table 6: Effect of Relative Sowing time on the Land Equivalent Ratio (LER) and Gross Monetary Returns (GMR) in Sole and Intercropped Maize and Melon

Cropping System (₦/kg)	Land equivalent ratio			Gross Monetary Returns		
	Partial		Total	Partial		Total
	Maize	Melon		Maize	Melon	
2011						
Sole maize	1.00		1.00	196,929.00		196,929.00
Sole egusi melon		1.00	1.00	-	106,215.00	106,215.00
Relative sowing time						
Egusi melon sown 2 weeks before maize	0.73	0.75	1.48	143,595.00	80,445.00	224,040.00
Egusi melon sown 4 weeks before maize	0.15	0.81	0.96	29.196.00	86,445.00	115,641.00
Egusi melon sown 6 weeks before maize	0	0.92	0.92	-	97,333.50	97,333.50
Egusi melon and maize sown same day	0.91	0.65	1.56	178.803.00	71,334.00	250,137.00
Egusi melon sown 2 weeks after maize	0.92	0.55	1.50	180,531.00	58,222.50	238,735.50
Egusi melon sown 4 weeks after maize	0.95	0	0.95	186.930.00	0	238,930.00
Egusi melon sown 6 weeks after maize	1.04	0	1.04	204,254.00	0	204,264.00
2012						
Sole maize	1.00	0	1.00	196.929.00	-	196,929.00
Sole melon	0	1.00	1.00	-	106,215.00	106,215.00
Relative sowing time:						
Egusi melon sown 2 weeks before maize	0.81	0.59	1.40	178,961.00	49,867.20	228,828.20
Egusi melon sown 4 weeks before maize	0.19	9.72	0.91	42,814.00	60,320.40	103,134.40
Egusi melon sown 6 weeks before maize	0	0.79	0.79	0	66,772.80	66,772.80
Egusi melon and maize sown same day	0.86	0.82	1.68	189,332	69,223.20	259,555.20
Egusi melon sown 2 weeks after maize	0.85	0.25	1.10	186,517.00	21,333.60	207,850.60
Egusi melon sown 4 weeks after maize	0.85	0	0.85	187,998.00	0	187,998.00
Egusi melon sown 6 weeks after maize	1.02	0	1.02	223,850.00	0	223,850.00

Maize and Egusi Melon were at prevailing market prices of ₦ 90/kg and ₦ 150/kg respectively in 2011 and ₦ 100/kg and ₦ 120/kg in 2012

Yield

The yields of intercropped maize were not significantly different from those of sole maize, even though sole maize out-yielded intercropped maize (33% in 2011 and 34% in 2012) (Table 4).

Maize yield and yield components were affected by the relative sowing time; the highest mean yield of maize was produced when maize was sown 6 weeks before egusi melon. The mean yield for the two cropping seasons was 14% higher than mean yield produced when maize and egusi melon were sown on the same day. Maize yield was severely depressed when maize was sown 2 or 4 weeks after melon. Maize introduced 6 weeks after melon were smothered by the melon plants, and could not tarsel, and so yielded no grains. Grains weight per cob, number of grains per cob and cobs length decreased by 7%, 8% and 12% respectively when maize was sown two weeks after egusi melon. But when it was sown 4 weeks after egusi melon, it decreased by 77%, 49% and 36% in 2011 (relative to plots in which egusi melon and maize were sown on the same day).

Melon seed yield was reduced due to intercropping (47% in 2011 and 39% in 2012) (Table 5). The cropping system however had no effect on fruit size, 100 seeds weight and number of seeds per fruit.

Relative sowing time affected egusi melon seed yields and yield components (except fruit size in 2011 and weight of 100 seeds in 2012). When egusi melon was introduced 4 or 6 weeks after maize, the melon plants were smothered by the maize plants, and so could not bear fruits. However, the highest mean yield for the two cropping seasons was obtained when egusi melon was sown 6 weeks before maize. This was 87% higher than mean yield obtained when maize and egusi melons were sown on the same day. The number of seeds per fruit and fruit size were similarly affected.

The total LER values were above one in all intercrop situations except when egusi melon was sown 4 or 6 weeks before or after maize (Table 6). The highest LER values were however obtained when egusi melon and maize were sown on the same day. The partial LER showed that the crop that was earlier introduced into the mixture usually contributed more to the mixture.

DISCUSSION

Results from this experiment show that the height of maize plants was not affected by the cropping system. It was expected however that the intercropped maize should be taller than sole maize in their bid to expose their leaves to sunlight (Ofori and Stern, 1987; Muoneke *et al*; 1997). Maize being a C^4 plant is characterized by high efficiency of light utilization and rapid growth rate (Uzo, 1983; Wolley and Smith, 1992). But in this experiment it seems maize was suppressed by the melon at the early stages of growth. However, taller maize plants were produced in 2012, compared to 2011 cropping season. This result could be attributed to the improved precipitation recorded in 2012 cropping season. The rains started late in 2011 and was poorly distributed. The situation did not improve until mid-May (about seven weeks after sowing). Skovegard and Pats (1997) stated that maize is water sensitive; and that drought lasting more than two weeks could cause moisture stress and severe losses. Maize height was affected by the relative time of introduction of the component crops. Results show that it is better to sow maize 2 or 4 weeks before egusi melon, otherwise the two crops should be sown on the same day.

The yield of the component crops were reduced in intercrop (compared to the sole crop situation). The reduction in yield could be attributed to the intraspecific and interspecific competition in the growth environment, similar results have been reported by Okaka and Remison (1999). Relative sowing time also affected the yield of maize; maize yield was depressed when maize was sown 2 or 4 weeks after egusi melon. Generally, the yields of component crops increased when sown earlier, but decreased when introduced later than the other component. Muoneke *et. al*; (1997), Francis *et*

al; (1982) and Remison (1982) reported similar findings and were of the view that when one crop occupies the ground earlier than another component, it had competitive advantage over the other component. It was expected however, that intercropped melon, being the under-storey crop in this experiment would present with increased inter-node elongation, reduced branching and long vines as observed by Keating and Carberry (1993). Carr *et al*; (1995) also observed that lentils produced longer vines when it was intercropped with wheat, the reverse was the case in this experiment, perhaps due to the poor growth environment (low pH, low rainfall in the early season and impoverished soil). The maize plants were severely stressed and much stunted, and so could not develop heavy canopy. This condition allowed more radiation to penetrate within the canopy enabling the intercrop to receive adequate sunlight. Ennin *et al*; (2002) stated that one of the conditions in which intercrops intercept more radiation than sole crop is moisture stress. It seems melon plant when sown same day with maize were able to compete favourably with maize for the growth factors.

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