academicJournals

Vol. 9(52), pp. 3789-3796, 25 December, 2014
DOI: 10.5897/AJAR2014.8596
Article Number: 3C70A9749240
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Effect of organic fertilizer (cocoa pod husk) on okra and maize production under okra/maize intercrop in Uhonmora, Edo State, Nigeria

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Received 7 February, 2014; Accepted 18 November, 2014

The study determined effects of cocoa pod husk (CPH) fertilizer rates on okra and maize performance in okra/maize intercrop at Uhonmora, Edo State, Nigeria. Four levels of fertilizer: 0, 1.0, 2.0 and 4.0 t ha^{-1} and seven cropping patterns: okra sole at 0.60×0.75 m, 0.90×0.75 m, 1.20×0.75 m, sole maize at 0.3×0.75 m, okra intercropped with maize at 0.60×0.75 m, 0.90×0.75 m, 1.20×0.75 m with 1, 2 and 3 maize stands respectively between 2 okra stands for 28 treatments in a split plot design in three replicates. Fertilizer resulted to significant (p≤0.05) increased okra and maize yields that were optimum at 0.90×0.75 m with CPH applied at 1.0 t ha^{-1}. The land equivalent ratio (LER) values were higher than unity in okra/maize intercrop but the aggressivity values were negative when okra was planted at 1.20×0.75 m, which indicates unhealthy competitions between the component crops. The monetary values (MV) were optimum when okra was planted at 0.90×0.75 m and was recommended.

Key words: Cropping patterns, economic value, growth factors, optimum revenue, soil fertility maintenance.

INTRODUCTION

Maize (*Zea mays*) ranks third after sorghum and millet in importance in human food and livestock feed supply among the cereal crops in Nigeria (Uzozie, 2001) while okra is among the foremost fruit vegetable crops in terms of production and consumption level (Iremiren and Okiy, 1999). Okra fruits are popular health food materials with high fibre, Ca, K, vitamin C, foliate and anti-oxidant contents. The seed contains about 15% oil which is high in unsaturated fats such as oleic and linoleic acids (Yadev and Dhanker, 2002). However, the vegetative and reproductive growths of the crops are affected by spacing, soil fertility, species of weeds and climatic factors (Iyagba et al., 2012).

Late flowering and late maturing genotypes of West Africa okra with long growth cycle are common in Nigeria farming practices (Adeniji, 2007). One of the late maturing West African okra accessions is *Abelmoschus caillei* [A. Chev] Stevols which is commonly called *Ila Iroko* in southwestern Nigeria. It has well-developed root system, good drought and heat tolerance as well as tolerance to root-knot nematodes. Though late maturing, it has sweet and spineless light-green pods. The plants

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Table 1. Okra/maize plant population ha^{-1} in okra/maize cropping systems.

Cropping pattern	Okra stands ha^{-1}	Maize stands ha^{-1}
Sole okra at 0.60 m x 0.75 m	22,222	-
Sole okra at 0.90 m x 0.75 m	14,814	-
Sole okra at 1.20 m x 0.75 m	11,111	-
Sole maize at 0.30 m x 0.75 m	-	44,444
Okra/maize at 0.60 m x 0.75 m	22,222	22,222
Okra/maize at 0.60 m x 0.75 m	14,814	29,628
Okra/maize at 0.60 m x 0.75 m	11,111	33,333

are 5 ft high, well-branched with an open growth habit (Bamire and Oke, 2003).

Okra production in Nigeria is of two distinct seasons namely - the thick and lean seasons. The lean season falls toward the dry season when late maturing okra varieties are common, hence okra fruits are produced in low quantities, scarce and expensive (Bamire and Oke, 2003). Majority of okra producers/growers in Nigeria plants okra on a small-scale probably due to the problem of small land holdings, unavailable of storage, processing and preservation facilities (Agbede and Kalu, 1995). Processing and preservation are carried out using traditional techniques of slicing, sun-drying and grounding using mortar and pestle (Farinde et al., 2007). Hence, okra production is common on less than 0.4 to 1.6 ha and grown in intercrops with maize, yam, cassava, pepper, pineapple, maize and yam, yam and pepper, cassava and pepper, cassava and beans, beans and maize amongst other combinations depending on locality (Bamire and Oke, 2003; Iken and Amusa, 2004; Raji, 2007).

Studies have been carried out on sole okra and maize as well as their intercrops as influenced by plant density for early maturing cultivars of okra (Iremiren et al., 2007, 2013; Iyagba et al., 2012) but not yet on the late maturing cultivars either as sole or as in okra-maize intercropping system. The experiment was conducted to investigate the influence of cocoa pod husk fertilizer on late maturing okra and maize production in okra-maize intercropping system under different maize densities and okra plant spacing on the field at Uhonmora, Edo State, Nigeria.

MATERIALS AND METHODS

A field plot of 60.2 x 18.5 m was cleared and divided into 3 blocks each of 17.4 x 14.5 m with 2.0 m distance between blocks. The blocks were each made into 28 flat beds of 7 rows with 4 beds row^{-1}. Each flat bed was 3.6 x 1.5 m size with 1.0 m space between the beds within the rows. There was 1.0 m space between rows of beds and 2.0 m edge row space round the entire plot.

Late maturing okra variety (*Abelmoschus caillei* [A. Chev] Stevols) seeds were planted in 3 rows bed^{-1} as sole at (1) 0.60×0.75 m, (2) 0.90×0.75 m, (3) 1.20×0.75 m and as intercrop with maize at (4) 0.60×0.75 m with 1 maize stand between 2 okra stands, (5) 0.90×0.75 m with 2 maize stands between 2 okra stands, (6) 1.20×0.75 m with 3 maize stands between 2 okra stands and (7) sole maize at 0.3×0.75 m for a total of 7 cropping patterns. The 7 cropping patterns were each randomly allocated to the 7 rows of 4 beds each. Where okra or maize was planted, 4 seeds of the crop were sown and thinned to one plant $stand^{-1}$ 2 weeks after sowing. Cocoa pod husk (CPH) was collected, dried, pulverized and composed for 21 days (Iremiren et al., 2007) as organic fertilizer and applied at 0, 1.0, 2.0 and 4.0 t ha^{-1} across the 7 rows of 4 beds each, with each bed having a rate of CPH application to give a 7×4×3 factorial in split plot design, with cropping patterns as main plot and KPH rates as sub-plot. The plant population in each cropping pattern is given in Table 1. The first cropping trial commenced on 30th April, 2010, while the second cropping trial commenced on 5th May, 2011. The two cropping trials were under rain fed condition.

Hoe weeding was carried out bi-monthly and harvesting of maize was carried out after 120 days of planting. Harvested maize cobs were sun dried, shelled and the grains dried to 10% moisture content and weight (g $plant^{-1}$) taken. Okra fresh fruit harvest (g $plant^{-1}$) commenced 27 weeks after sowing and continued every 5 days for 15 cumulative harvests, when harvests became negligible. The data for both maize and okra were averaged for the mid row plants and extrapolated to yield ha^{-1}, which excluded the border plants of each bed per treatment. Data were statistically analyzed by ANOVA and significant mean differences separated by LSD at 5% probability. Productivity evaluation of okra/maize intercrop compared to their sole cropping was assessed using the land equivalent ratio (LER) (Mead and Wiley, 1980), aggressivity (McGilchrist, 1965) and the monetary values (MV) (Gomez and Gomez, 1983) was calculated using the current farm gate price of ₦300 kg^{-1} for maize and ₦150 kg^{-1} for okra.

Pre-planting soil sample was analyzed for pH using glass electrode pH meter at soil/water 1:2.5 ratio; particle size distribution was by hydrometer method, available P was by Bray P-1 method (Bray and Kurtz, 1945); N by micro Khjeldal method (Bremmer, 1996); organic C by Walkey-Black wet oxidation method (Nelson and Sommers, 1982). The exchangeable cations were determined by extracting the soil with 1.0N NH_4AOC at pH 7.0 (Tel and Rao, 1982). The K was measured using flame photometer while Ca and Mg were by atomic absorption spectrophotometer (AAS). The CPH was analyzed for N and organic C as described for the soil. The K, Ca and Mg content was by AAS after ashing the CPH sample in Murphy furnace at 500°C and the ash dissolved with 4% HCl and made to volume with distil water. The rainfall data of the study location in 2010 and 2011 were taken.

RESULTS

Soils and fertilizer material

The study site soil was sandy clay loam in texture and

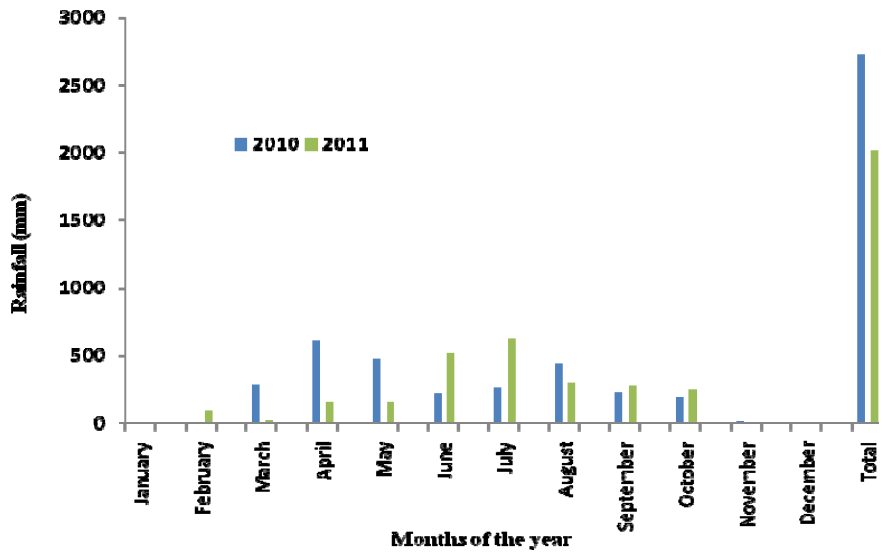

Figure 1. Rainfall distribution for 2010 and 2011 at Uhonmora, Edo State, Nigeria.

contained moderate amount of organic C, total N, available P and Ca with very low K and Mg contents (Table 2). The soil was slightly acidic with pH value of 5.4. The cocoa pod husk contains considerable amount of N, P, K, Ca and Mg with C:N ratio of 16.6.

Rainfall data

The rainfall data showed that rainfall commenced late in 2010 but stopped late in the month of November, while it started earlier in 2011 and stopped in October. However, there was more rain in 2010 than recorded in 2011 (Figure 1). The amount and distribution of the rainfall during the cropping periods were more even in 2010 than in 2011.

Okra fruit yield

Okra fruit yield was 867.8 to 4622.2 kg ha^{-1} in 2010 cropping season, while it was 845.9 to 4216.4 kg ha^{-1} in 2011 cropping season (Table 4). The okra fruit yield increased with increasing okra plant stands ha^{-1} in both sole and intercropping systems. The okra fruit yield was higher under okra/maize intercropping system compared to values obtained under sole okra cropping (Table 3). The fruit yield values were higher with the application of CPH than for the control for both years of cropping. The values were 867.8 to 2217.8 kg ha^{-1} for control and 2105.5 to 4622.2 kg ha^{-1} for CPH applied okra in 2010, while it was 845.9 to 1850.2 kg ha^{-1} for the control and 2017.5 to 4216.4 kg ha^{-1} for CPH applied okra in 2011. Thus, weight of okra fruits obtained increased with CPH application rate and the values were more for 2010 compared to 2011.

Maize grain yield

Maize grain yield was 3.40 to 5.67 t ha^{-1} for 2010, while it was 3.71 to 5.96 t ha^{-1} for 2011. The maize grain yield increased with maize population ha^{-1} at both cropping years (Table 4). On cocoa pod husk fertilizer application, maize yield was 3.40 to 4.63 t ha^{-1} for control and 3.56 to 5.67 t ha^{-1} with CPH application in 2010, while it was 3.71 to 4.60 t ha^{-1} for control and 3.87 to 5.96 t ha^{-1} with CPH application in 2011. The grain yield generally increased with rate of CPH application. Under okra/maize intercropping pattern, maize grain yield increased with rate of CPH application up to 2 Mt ha^{-1} application rate and then decreased, while under sole maize, the maize grain yield increased from 4.63 to 5.67 t ha^{-1} at 1.0 t ha^{-1} of CPH application and thereafter decreased with increased CPH application (Table 4).

Maize grain yields were generally higher in 2011 cropping season than for 2010. Cocoa pod husk application resulted to 4.13 to 27.96% increase in maize grain yield over the control. The maize grain yield under sole maize cropping was 0.87 to 31.71% higher than those under okra/maize intercrop. The mean differences between the cropping patterns and CPH application rates for both 2010 and 2011 cropping seasons were significant at $p \leq 0.05$.

Productivity evaluation of okra/maize intercrop

The yields of okra and maize in the okra/maize intercrop compared to their sole cropping resulted to land

Table 2. Some properties of site soil and cocoa pod husk (CPH) organic fertilizer used.

Material s	pH	Organic C	N	P	K	Ca	Mg	Sand	Silt	Clay
Soil		← g/kg	→	mg/kg	← cmol/kg		→	← g/kg soil		→
	5.4	32	1.0	7.2	0.3	2.56	0.05	67.6	14.2	18.2
Cocoa pod husk		←		%			→			
	-	24.3	1.46	0.15	3.96	0.8	0.3	-	-	-

Table 3. Fresh okra fruit yield (kg ha^{-1}) under different cropping pattern and cocoa pod husk fertilizer.

Cropping pattern	Cocoa pod husk application rate (t ha^{-1})			
	0.0	1.0	2.0	4.0
	← Fresh okra fruit yield (kg ha^{-1}) →			
2010 cropping				
Okra/Maize at 60 cm	2217.8	3173.3	3377.8	3515.5
Okra/Maize at 90 cm	1760.5	2394.8	2105.5	2470.1
Okra/Maize at 120 cm	867.8	2884.4	2664.4	2532.2
Sole okra at 60 cm	1532.2	2902.2	3835.5	4622.2
Sole okra at 90 cm	1887.9	3254.3	2978.3	3017.2
Sole okra at 120 cm	896.8	2340.0	2508.9	2784.4
LSD = 0.05	100.2	131.6	109.1	264.7
2011 cropping				
Okra/Maize at 60 cm	1850.2	2975.8	2895.5	3281.4
Okra/Maize at 90 cm	1711.8	2402.1	2217.2	2403.8
Okra/Maize at 120 cm	871.3	2732.6	2583.6	2433.5
Sole okra at 60 cm	1346.1	2900.4	3183.6	4216.4
Sole okra at 90 cm	1698.4	2984.1	2597.1	2889.7
Sole okra at 120 cm	845.9	2092.7	2017.5	2142.5
LSD = 0.05	152.5	125.2	211.6	207.8

LSD = Least significant difference.

equivalent ratio (LER) values that were greater than unity with value range of 1.39 to 2.18 in 2010 and 1.68 to 2.39 in 2011 cropping seasons respectively (Table 5). This culminated to land area of about 28.1 to 54.1% in 2010 and 40.5 to 58.2% in 2011 being saved. The aggressivity values calculated due to intercropping of the late maturing okra variety with maize were positive at okra spacing at 60×75 cm and 90×75 cm, while it was negative for okra spaced at 120×75 cm.

The monetary value (MV) was higher under okra/maize intercrop than either of okra or maize cultivated separately (Table 6). The maize component of the okra/maize intercrop contributed more than okra to the calculated monetary values. On the overall, the monetary values were highest under okra spacing at 120×75 cm with 3 maize stands between two okra stands. However, the aggressivity values calculated for okra/maize at 120 cm x 75 cm spacing were all negative (Table 6), while it was positive for okra/maize intercrop at 90×75 cm and 60×75 cm okra spacing.

The combined monetary values for 2010 and 2011 cropping seasons showed the superiority of okra + maize in okra/maize intercrop over sole cropping of okra and maize. The okra/maize intercrop was optimal at the 90×75 cm okra spacing with 2 stands of maize between 2 okra plants. The beneficiary effects of the cocoa pod husk as nutrient source was fully revealed when the marginal monetary value was calculated (Table 7). The marginal monetary values that resulted from additional unit tone of the cocoa pod husk were generally higher at 1.0 t ha^{-1}.

DISCUSSION

The sandy clay loam nature of the site soil coupled with the soil organic C content of 32 g kg^{-1} soil indicates that

Table 4. Maize grain yield under Okra/maize intercrop and CPH application.

Cropping pattern	Cocoa pod husk application rate (t ha^{-1})			
	0	1.0	2.0	4.0
	← Maize grain yield (t ha^{-1}) →			
2010 cropping				
Okra/Maize at 60 cm	3.40	3.70	4.38	3.56
Okra/Maize at 90 cm	4.03	4.53	5.27	4.81
Okra/Maize at 120 cm	4.46	4.81	5.37	5.09
Sole maize at 30 cm	4.63	5.46	5.55	5.67
LSD = 0.05	0.12	0.34	0.27	0.42
2011 cropping				
Okra/Maize at 60 cm	3.71	3.87	4.07	5.15
Okra/Maize at 90 cm	4.44	4.82	5.44	5.44
Okra/Maize at 120 cm	4.56	4.96	5.83	5.33
Sole maize at 30 cm	4.60	5.81	5.96	5.53
LSD = 0.05	0.35	0.21	0.15	0.31

LSD = Least significant difference.

Table 5. Land equivalent ratio (LER), land use saved and aggressivity in okra/maize intercrop.

Cropping pattern	Land equivalent ratio				Land use saved (%)				Aggressivity			
	Cocoa pod husk rate (t ha^{-1})				Cocoa pod husk rate (t ha^{-1})				Cocoa pod husk rate (t ha^{-1})			
	0	1.0	2.0	4.0	0	1.0	2.0	4.0	0	1.0	2.0	4.0
2010 cropping												
Okra/Maize at 60 cm	2.18	1.77	1.70	1.39	54.1	43.5	41.2	28.1	0.02	0.26	0.76	1.18
Okra/Maize at 90 cm	1.80	1.57	1.69	1.67	44.4	36.3	40.8	40.1	0.09	0.14	0.05	0.05
Okra/Maize at 120 cm	1.93	2.10	2.07	1.81	48.2	52.4	51.7	44.8	-0.65	-1.14	-0.74	-0.62
CV (%)	6.11	10.1	11.5	11.2	8.12	12.1	10.5	11.3	14.2	16.5	12.2	15.3
2011 cropping												
Okra/Maize at 60 cm	2.22	1.83	1.68	1.71	54.9	45.4	40.5	41.5	0.31	0.58	0.64	1.08
Okra/Maize at 90 cm	2.02	1.81	1.89	1.82	50.5	44.8	47.9	45.1	0.01	0.40	0.27	0.23
Okra/Maize at 120 cm	2.07	2.24	2.39	2.10	51.7	55.4	58.2	50.0	-0.67	-1.24	-1.08	-0.98
CV (%)	4.12	6.25	5.83	7.44	8.61	7.01	12.3	8.71	15.4	13.8	17.2	14.6

CV = Coefficient of variation.

the soil physical, biological and chemical conditions were moderate for optimum crop production (Singh et al., 2011). The soil pH was within pH 5.0 to 6.5 range which is considered adequate for arable crops (Crozier et al., 1999). However, the soil N, P and Ca contents were generally moderate, while the K and Mg contents were very low for either okra or maize cropping. This informed the need for application of nutrients for sustainable production of the crops, especially under intercropping systems, because, they are high nutrient demanding crops (Afolayan et al., 2006). The high N, P, K, Ca and Mg contents of cocoa pod husk, with C/N ratio of 16.6 showed that it could readily decompose, mineralize and release nutrients in the soil for crop use (Ipinmoroti, 2013). Its high K and moderate Mg contents makes it a good nutrient source for soils that are low in K and Mg as depicted by the soil of the studied location.

Okra fruit yield was higher under okra/maize intercrop compared to values obtained under sole okra cropping except that the okra/maize intercrop was optimal at 90 × 75 cm okra spacing. The weight of okra fruits obtained increased with CPH application rate and the mean okra fruit yield differences were significant at $p \leq 0.05$. This suggests that better okra fruits could be obtained with proper nutrient management of the soil. This attests to the fact that the soil was inherently low in K and Mg

Table 6. Monetary value in naira (#000 t^{-1}) of okra and maize yield in okra/maize intercrop under cocoa pod husk (CPH) fertilizer treatment.

Cropping pattern	Crop	2010 cropping CPH rate (t/ha)				2011 cropping CPH rate (t/ha)				Total for 2010 and 2011 cropping CPH rate (t/ha)			
		0	1.0	2.0	4.0	0	1.0	2.0	4.0	0	1.0	2.0	4.0
	Okra	333	476	507	527	278	446	434	492				
Okra/Maize at 60 cm	Maize	1020	1110	1314	1068	1113	1161	1221	1545	2744	3193	3476	3632
	Total	1353	1586	1811	1695	1391	1607	1655	2037				
	Okra	264	359	316	371	267	360	333	361				
Okra/Maize at 90 cm	Maize	1209	1359	1581	1443	1332	1446	1632	1632	3108	3524	3862	3807
	Total	1473	1718	1897	1814	1599	1806	1965	1993				
	Okra	130	433	400	380	131	410	388	365				
Okra /Maize at 120 cm	Maize	1338	1443	1611	1527	1368	1488	1749	1599	2967	3774	4148	3871
	Total	1468	1876	2011	1907	1499	1898	2137	1964				
Okra sole 60 cm	Okra	229.8	435.3	575.3	693.3	201.9	435.1	477.5	632.5	431.7	873.4	1052.8	1324.8
Okra sole 90 cm	Okra	283.2	488.2	446.8	452.6	254.8	447.6	389.6	433.5	538.0	935.8	836.4	886.1
Okra sole at 120 cm	Okra	134.5	351.0	376.3	417.2	126.9	313.9	302.6	321.4	261.4	664.9	678.9	738.6
Maize sole	Maize	1387	1637	1604	1701	1320	1443	1579	1659	2707	3080	3183	3360

Table 7. Marginal monetary value in naira (₦000) in okra/maize intercrop for additional tone of cocoa pod husk (CPH) fertilizer application ha^{-1}.

Cropping pattern	Crop	2010 Cropping CPH rate (t/ha)				2011 Cropping CPH rate (t/ha)				Total for 2010 and 2011 cropping CPH rate (t/ha)			
		0	1.0	2.0	4.0	0	1.0	2.0	4.0	0	1.0	2.0	4.0
Okra/Maize at 60 cm	Okra	-	233	278	-58	-	216	48	191	-	449	283	78
Okra/Maize at 90 cm	Okra	-	245	179	-41.5	-	207	159	14	-	452	338	-27.5
Okra /Maize at 120 cm	Okra	-	408	135	-52	-	399	239	-86.5	-	807	374	-138.5

(Table 2), which are some of the major nutrient needs of the crop for optimum growth performance and better fruit bearing (Afolayan et al., 2006). The trend corroborates the reports of other authors that made use of organic fertilizers for maize, okra, tomato and vegetable production in Nigeria (Iyagba et al., 2012; Iremiren et al., 2007; Ayeni, 2010; Adeoye et al., 2001, 2005).

The better okra fresh fruit production under okra/maize intercrop compared to sole okra showed that the decomposition and eventual mineralization of the maize roots and the resultant corn stubbles must have improved on the soil organic matter, which must have subsequently helped to conserve the soil water, improved the physical, chemical and biological conditions of the soil (Fioretto et al., 2005). The maize stands in the intercrop must have helped to reduce impact of rain drops on the ground thereby improving water infiltration and water holding capacity of the soil, while the floor of the sole okra plot was left bare to heavy down pour of rain impact with its attendant side effects on the soil physical and chemical properties (Mbagwu and Obi, 2003).

The better performance of the CPH treated okra plants suggested that there is need for constant application of nutrients for sustainable okra cropping on the soil. This is true in that tropical soils could not support sustainable cropping over a long period without fertilizer application due to the fragile nature of the soils (Tolessa and Friesen, 2001). The general lower fresh okra fruit yield in 2011 compared to 2010 may probably be due to early stoppage of the rain in October, 2011 compared with late November in 2010 (Figure 1). Rainfall amount and distribution have been reported to affect cropping activities and eventual crop production in any particular cropping season, most especially fruit production (Omran, 2012).

The CPH application resulted to 4.49 to 23.53% increase in maize grain yield over the maize plants without CPH application. Maize grain yield under sole cropping was however, higher than maize under okra/maize intercrop by 3.24 to 37.21% and 0.87 to 31.71% in 2010 and 2011 respectively. This was in similar trend with previous reports by Ijoyah et al. (2012), Iremiren et al. (2013, 2007) and Muoneke et al. (2007). The CPH application was optimum at 1.0 t/ha rate, while the mean differences between CPH application rates and cropping patterns for both cropping seasons were significant at p≤0.05. On the overall, the cropping pattern, fertilizer rate application and their interaction contributed significantly to the mean differences in yields of okra fruits and maize grain at both cropping seasons.

The land equivalent ratio (LER) values for okra and maize in the intercrop were greater than 1.0 with a range of 1.38 to 2.39 and about 28.1 to 58.2% of land area could be saved. The positive aggressivity values at 60×75 cm and 90×75 cm okra planting indicated that there was little or no deleterious competitiveness in the intercrop of the late maturing okra with maize. On the other hand, the negative values obtained at 120×75 cm okra planting showed that the maize component was too dense that both aerial and underground competition was too much (McGilchrist, 1965), that the okra plants could not express their full potentials in growth and fruit production. It would therefore not be advisable to ask farmers to adopt such a planting pattern for the late maturing okra in okra/maize intercrop for sustainable farming business. Nigerian farmers are used to polyculture practice, especially in respect to arable farming (Okpara and Omaliko, 1995), hence, the best of the okra/maize intercropping patterns with productivity advantage on LER and aggressivity would therefore be advisable to the farmers.

The okra/maize intercrop resulted to significantly (p≤0.05) higher monetary values (MV) compared to either okra or maize cultivated sole. The monetary values were generally highest at the 120×75 cm okra spacing in the intercrop. However, the cropping pattern could not be recommended to farmers because of the negative aggressivity values and the attendant implications that would result from competitions between the component crops in the intercrop (Iyagba et al., 2012; McGilchrist, 1965). The monetary value was higher at 90×75 cm than 60×75 cm okra spacing in the intercrop, with positive aggressivity. Therefore, putting all the productivity indices into consideration, the 90×75 cm okra spacing in okra/maize intercrop becomes the most optimal cropping pattern.

The combined monetary values for 2010 and 2011 cropping seasons showed the superiority of okra + maize in okra/maize intercrop over sole okra or maize cropping. The okra/maize intercrop was optimal at the 90×75 cm okra spacing with 2 stands of maize between 2 okra plants. The marginal monetary values that resulted from the use of additional unit tone of cocoa pod husk as nutrient source was generally higher at application rate of 1.0 t ha^{-1}. Hence, cocoa pod husk application at 1.0 t ha^{-1} was found to be more economical.

Conclusion

Cocoa pod husk resulted in significant increased yield of okra and maize plants with increased rate of application than control without fertilizer. Okra and maize yields were optimum at okra/maize intercrop planted at 0.90×0.75 m with 2 maize stands between 2 okra stands with cocoa pod husk application at 1.0 t ha^{-1}. The land equivalent ratio (LER) was greater than 1.0 across the various cropping patterns of okra/maize intercrop. However, the aggressivity values were negative when okra was planted at 1.20×0.75 m with 3 maize stands between 2 okra stands, which indicates serious competition between the component crops. The monetary value (MV) was more under okra/maize intercrop but the marginal monetary value (MMV) of CPH application was optimum at 1.0 t ha^{-1} when okra was planted at 0.90×0.75 m with 2 maize stands between 2 okra stands and was recommended.

Conflict of Interest

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The effort of Messrs. Edibo, G.; Oguigo P.; Umehoin, A. and Ebiale B. for the field data collection and Messrs Adewoye, G. and Adedotun, D. for the laboratory analysis is acknowledged.

REFERENCES

Adeniji OT (2007). Genetic studies on earliness in West African okra (Abelmoschus ceillei [A. chev.] Stevels). Int. J. Agric. Res. 2:750-753. http://dx.doi.org/10.3923/ijar.2007.750.753

Adeoye GO, Sridhar MKC, Adeoluwa OO, Akinsoji NA (2005). Evaluation of naturally decomposed solid wastes from municipal dumpsites for their manurial value in southwest Nigeria, J. Sustain. Agric. 26(4):143-162. http://dx.doi.org/10.1300/J064v26n04_09

Adeoye GO, Sridhar MKC, Ipinmoroti RR (2001). Potassium recovery from farm wastes for crop growth. Communications in Soils and Plant Anal. 32(15-16):2347-2358. http://dx.doi.org/10.1081/CSS-120000377

Afolayan SO, Bindrabam P, Ajayi E (2006). Performance evaluation of drip irrigation and fertigation systems on Telfairia occidentalis in Ibadan, south western Nigeria. Nig. J. Hortic. Sci. 11:36-41.

Agbede OO, Kalu BA (1995). Constraints of small-scale farmers in increasing crop yields: Farm size and fertilizer supply. Nig. J. Soil Sci. 11:139-152.

Ayeni LS (2010). Effect of cocoa pod ash, NPK fertilizers and their combinations on soil chemical properties and yield of tomato (*Lycopersicom lycopersicom*) on two soil types. New York Sci. J. 3(4):1-11.

Bamire AS, Oke JT (2003). Profitability of vegetable farming under raining and dry season production in south-western Nig. J. Veg. Crop Prod, 9:11-18. http://dx.doi.org/10.1300/J068v09n02_03

Bray RA, Kurtz LT (1945). Determination of total organic and available forms of phosphorus in soils. Soil Sci. 59(3):9-45.

Bremmer JM (1996). Methods of Soil Analysis, Part 3: Soil Science of America and America Society of Agronomy SSSA Book series No. 5, Madison, USA.

Crozier CR, Naderman CC, Tuckan MR, Sugg RE (1999). Nutrient and pH stratification with conventional and no-till management. Communications in Soil Sci. Plant Anal. 30(1&2):65-74. http://dx.doi.org/10.1080/00103629909370184

Farinde AJ, Owolarafe OK, Ogungbemi OI (2007). An overview of production, processing, marketing and utilization of okra in Egbede Local Government Area of Osun State, Nig. Agric. Eng. Int. 9:1-17.

Fioretto AC, Nardo D, Papa S, Fuggi A (2005). Lignin and cellulose degradation and nitrogen dynamics during decomposition of three leaf litter species in a Mediterranean ecosystem. Soil Biol. Biochem. 37:1083-1091. http://dx.doi.org/10.1016/j.soilbio.2004.11.007

Gomez AA, Gomez KA (1983). Multiple cropping in the humid tropics of Asia. IDRC, Ottawa. IDRC-Abe. P. 249.

Ijoyah MO, Adagba EO, Iorlaman T (2012). Productivity of okra-maize intercropping system as influenced by varying maize plant densities in Makurdi, Nig. Int. J. Curr. Res. 4(4):059-063.

Iken JE, Amusa NA (2004). Maize research and production in Nigeria. Afr. J. Biotechnol. 3:302-307.

Ipinmoroti RR (2013). Decomposition and nutrient release patterns of some farm wastes under control room temperature. International J. Agric. Forest. 3(4):185-189.

Iremiren GO, Okiy AO (1999). Effect of spacing on the growth, yield and quality of okra in southern Nig. J. Agric. Sci. 10(1):12-26.

Iremiren GO, Ipinmoroti RR, Hamzat RA, Adedeji RA (2007). Effect of fermentation period of kola pod husk, Time of application and urea supplementation on growth, yield and sensory properties of okra (*Abelmoschus esculentus* L). J. Appl. Trop. Agric. 12(2):70-72.

Iremiren GO, Ipinmoroti RR, Akanbi OSO (2013). Performance of Okra (*Abelmoschus esculentus* L.) and Maize (*Zea mays*) under Okra/Maize intercrop as influenced by nutrient sources at Ibadan, Nig. Int. J. Plant. Soil Sci. 2(2):190-201. http://dx.doi.org/10.9734/IJPSS/2013/4796

Iyagba AG, Onuegbu BA, Ibe AE (2012). Growth and yield response of okra (*Albelmoschus esculentus* [L.] Moench) varieties to weed interference in south eastern Nigeria, Global J. Sci. Front. Res. Agric. Veter. Sci. 12(7):1-17.

McGilchrist CA (1965). Analysis of competition experiments. Biometrics, 21:975-985. http://dx.doi.org/10.2307/2528258

Mead R, Wiley RW (1980). The concept of a land equivalent ratio and advantages in yields from intercrop. Exper. Agric. 16(3):217-228. http://dx.doi.org/10.1017/S0014479700010978

Muoneke CO, Ogwuche MAO, Kalu BA (2007). Effect of maize planting density on the performance of maize/soy bean intercropping system in a Guinea savanna agroecosystem. Afr. J. Agric. Res. 2(12):667-677.

Nelson DW, Sommers LE (1982). Organic carbon and soil extracts. In: Methods of soil Analysis, Part 2,- Chemical and microbiological properties. Agronomy Monograph No. 9, 2nd Edition, American Society of Agronomy, Soil Sci. Soc. Am. Madison, WI, USA. pp. 539-579.

Mbagwu JSC, Obi ME (2003). Land degradation, agricultural productivity and rural poverty: Environmental implication. Proceedings of the 28th Annual Conference of the Soil Science Society of Nigeria, held at Umudike, Umuahia, Nigeria, 4-7 November, 2003; pp. 1-11.

Okpara DA, Omaliko CPE (1995). Productivity of yam in bean/yam intercropping. Indian J. Agric. Sci. 65(12):880-882.

Omran WM (2012). Quantifying Medicago sativa yield under deficit irrigation technique in sandy soil. Int. J. Plant. Soil Sci. 2(2):202-211. http://dx.doi.org/10.9734/IJPSS/2013/4981

Raji JA (2007). Intercropping soy bean and maize in a derived savanna ecology. Afr. J. Biotechnol. 6(16):1885-1887.

Singh CM, Shamarma PK, Kishor PK, Mishra PK, Singh AP, Verma R, Raha P (2011). Impact of integrated nutrient management on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.). Asian J. Agric. Res. 5(1):76-83. http://dx.doi.org/10.3923/ajar.2011.76.82

Tel D, Rao F (1982). Animated and semi-animated methods for soil and plant analysis pp. 201-207.

Tolessa D, Friesen DK (2001). Effects of enriching farmyard manure with mineral fertilizers on grain yield maize at Bako western Ethiopia. Seventh Eastern and Southern Africa Regional Maize Confer. pp. 335-337.

Uzozie PR (2001). Effect of intercropping maize on the performance of cassava-maize intercrop. J. Agric. Sci. 12:18-21.

Yadev SK, Dhanker BS (2002). Performance of 'Varsha Uphar' cultivar of okra as affected by growing dates and plant geometry. Veg. Sci. 27:70-74.