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Performance of Okra (*Abelmoschus esculentus* L.) and Maize (*Zea mays*) under Okra/Maize Intercrop as Influenced by Nutrient Sources at Ibadan, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors GOI and RRI designed the study and wrote the protocol, Author RRI performed the statistical analysis, and wrote the first draft of the manuscript. Authors RRI and OSOA managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Farmers' practice of planting more than one crop under mixed cropping without fertilizer application has been a source of concern in Nigerian agriculture due to inherent low fertility status and fragile nature of the soils. This study was set up to assess the performance of okra (*Abelmoschus esculentus* L.) and maize (*Zea mays*) under okra/maize intercrop as influenced by nutrient sources at Ibadan, Nigeria Okra (*Abelmoschus esculentus* L.) and maize (*Zea mays*) were each sown as sole and in mixed crop at 1, 2 and 3 seeds hole^{-1}. Fertilizers were used as organic {kola (Kola nitida) pod husks, KPH} applied at 5 and 10 t ha^{-1} and inorganic (NPK) applied at 80 and 160 kg N ha^{-1} and control The field experiment was conducted in randomized complete block design with three replicates at Ibadan, Nigeria on 30 April, 2010 for early cropping and 15 August, 2010 for late cropping season. Data obtained included okra plant height, girth, fruit yield and grain yield for maize. The land equivalent ratio (LER), aggressivity and monetary value (MV) were calculated. Okra plant height, girth, fruit and maize grain yield values were significantly higher in sole than in mixed cropping in both early and late

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cropping seasons. The fertilizers resulted in significantly higher okra performances compared to the control during both cropping seasons. The NPK fertilizer reduced okra yields in the late season compared to the early season, while it increased for KPH fertilizer. Maize grain yield in both seasons was in similar trend to that obtained for okra fruit yield. Planting okra and maize in mixture at 2 plants stand^{-1}resulted to LER values that were generally greater than unity and resulted to 5.7-45-7% of land area saved, with low level of aggressivity and higher monetary value (MV) compared with sole maize and okra. The use of 2-plants stand^{-1} was optimum for better performance of okra and maize either planted sole or as okra/maize intercrop, while KPH @ 5 tons ha^{-1} and NPK @ 80 kg N ha^{-1} were optimal rates for better growth and yield of okra and maize both in monoculture and intercrops.

Keywords: Cropping pattern; okra/maize; crop yield; fertilizer; nutrient management.

1. INTRODUCTION

The art of planting two or more arable crops in mixed cropping pattern is a common practice by majority of Nigerian farmers. The practice aimed at maximizing the scarce land and labour resources as well as to guide against total crop failure amongst other advantages [1]. Okra, a fruit vegetable and maize, a staple cereal food, are notable food crops common in the food menu of a greater number of the Nigerian families [2]. The crops are grown sole and as mixed crop at different plant populations per stand per hectare without fertilizer application [3] due to scarcity and prohibitive procurement cost [4], which is the major reason why most small-scale farmers in tropical Africa often apply little or no fertilizer [5]. The crops therefore, depend entirely on native soil fertility and nutrients from trash materials for growth [6]. The scarcity and high cost of fertilizers in the present day Nigeria, has led to intensification of research into low-cost, internally sourced, cheap, affordable and adoptable organic materials that could serve as fertilizers [7]. Earlier reports had indicated the great potential on the use of kola pod husks as fertilizer for okra production [8] and better growth performance of coffee seedlings [9] in Nigeria but not yet on maize. Farmers' complaint of low yield from multiple cropping of field over the years prompted the conduction of investigation into the optimal plant population rate under sole and mixed cropping pattern and fertilizer rate for better yield of okra (*Abelmoschus esculentus* L.) and maize (*Zea mays*) for optimal economic benefits to the farmers, as well as for sustainable use of scarce land resources.

2. MATERIALS AND METHODS

2.1 Field Activities

A fallowed plot size of 53.5m x 30.5m was cleared of weed, divided into 3 blocks of 6.5m x 30.5m each with 2.0 m space between blocks. Each block was divided into 5 sub-plots of 2.5 m x 30.5 m with 1.0 m space between sub-plots. The sub-plots were each cultivated into beds of 2.5 m x 2.5 m with 1.0 m space between beds for a total of 9 beds per sub-plot. The sub-plot beds were numbered randomly against the 9 cropping patterns investigated. The sub-plots in each block were tagged randomly according to the 5 fertilizer treatments viz: (a) control (b) Kola (Kola nitida) pod husk - KPH at 5 t ha^{-1} (c) KPH at 10 t ha^{-1} (d) NPK at 80 kg N ha^{-1} and (e) NPK at 160 kg N ha^{-1}. The NPK was formulated from urea (45 % N) to supply

80 kg N, SSP (18% P2O5) to supply 40 kg P and muriate of potash (60 % K2O) to supply 40 kg K, while KPH was fortified with urea at 20 % of total N supply.

Okra and maize seeds were each sown sole and in okra/maize mixture under nine cropping patterns as follow: (1) sole okra at 1 seed/hole, (2) sole okra at 2 seeds/hole (3) sole okra at 3 seeds/hole; (4) sole maize at 1 seed/hole, (5) sole maize at 2 seeds/hole (6) sole maize at 3 seeds/hole; (7) okra/maize intercrop at 1 seed/hole, (8) okra/maize intercrop at 2 seeds/hole (9) okra/maize intercrop at 3 seeds/hole. In the intercrop, okra and maize were planted in alternate separate rows of 2 rows each/bed. Maize seeds were planted at 30 cm space within the rows for a total of 9 maize stands/row and 75 cm between rows Okra seeds were sown at 60 cm within the rows for a total of 5 okra stands/row and 75 cm between rows. At the sole crop level, each crop was planted in 4 rows /bed. The experiment under split plot design was conducted at Ibadan, Nigeria in 2010 early and late cropping seasons. The early cropping date of sowing was 30 April, 2010, while the late cropping was sown on 15 August, 2010. At 1st cropping, fertilizers treatments were applied while, there was no treatment application carried out. The crops were sown to see the residual effects of the treatments on the performance of the crops. Data on plant height, girth, fruit yield of okra and grain yield of maize were collected. The data were statistically analyzed by analysis of variance (ANOVA), while the treatment mean differences were separated by LSD at P=0.05. [10] Productivity evaluation of okra/maize intercrop compared to their sole cropping was assessed using the land equivalent ratio (LER) [11], aggressivity [12] and the current market price of N300 kg-1 for maize and N150 kg-1 for okra were used in calculating the monetary values (MV) [13] where N = Nigeria Naira and US$1 = N160.

2.2 Soil Analysis

Pre-planting analysis of the site soil was carried out by collecting soil samples at 0-30 cm randomly across the plot, air dried, sieved and mixed into composite and then representative samples were analyzed for total N by Kjeldahl approach, available P by Bray-P1 extraction followed by molybdenum blue colorimetry [14]. Exchangeable K, Ca, Mg were extracted using 1N ammonium acetate at pH 7. The K content was determined by use of flame photometer, while Ca and Mg were by atomic absorption spectrophotometer (AAS). Soil pH was determined by pH meter in 1:2.5 soil/water suspensions. Soil organic matter (SOM) was determined by wet dichromate method [15].

2.3 Organic Fertilizer Preparation and Analysis

The kola pod husks used for the organic fertilizer were collected fresh from the kola processing unit of the Cocoa Research Institute of Nigeria, Ibadan. They were air dried, milled and sieved using 2 mm sieve. The milled material was weighed into polythene bags, added fertilizer was analyzed for N by micro-Kjedahl approach, while samples for P, K, Ca and Mg determination were digested using nitric-perchloric-sulphuric acid mixture on hot plate and the elements determined as for soil.

3. RESULTS AND DISCUSSION

3.1 Soil and Fertilizer Materials

The soil pH was 5.6, while the available P value was 8.45 mg kg^{-1} soil, with total N and organic C contents of 1.3 and 25.1 g kg-1 soil respectively. The exchangeable K, Ca and Mg

values were 3.71, 2.43 and 5.22cmol kg-1 soil respectively (Table 1). The kola pod husk (KPH) contained 2.78% N and 30.5% organic C. The P, K, Ca and Mg contents were 0.88, 2.58, 3.61 and 0.50% respectively. The soil total N and available P values were considered to be very low and needed to be supplemented by addition of fertilizers. The soil K, Mg and Ca were moderate, while the soil pH was within the range suitable for most arable crops. The low total; N and available P contents and the acidic pH conditions were probably due to the nature of the soil parent material, high rainfall regime and intensity with associated faster weathering and leaching of nutrients, which are typical of the most tropical soils [7]. The kola pod husk (KPH) in addition to N, P and K contained Ca and Mg, with a C/N ratio of 10.3, which showed that it could readily decompose and supply the nutrients for plant use in the soil.

Table 1. Nutrient contents of soil and fertilizer materials used

Properties		Soil	KPH	Urea	SSP	MOP
N	(g kg^{-1}; %)	1.3	2.78	46	-	-
P	(mg kg^{-1}; %)	8.95	0.88	-	18	-
K	(cmol kg^{-1}; %)	3.71	2.58	-	-	60
Ca	(cmol kg^{-1}; %)	2.43	3.61	-		-
Mg	(cmol kg^{-1}; %)	5.22	0.50	-		-
Organic C	(g kg^{-1})	25.1	30.5	-	-	-
pH	(soil/H_2O of 1:2)	5.6	-	-	-	-

KPH = Kola pod husk, SSP = Single superphosphate, MOP = Muriate of potash

3.2 Okra Growth Parameters

Okra plant height at 1st cropping season ranged from 100-173 cm under sole cropping and 103-141 cm under okra/maize intercrop (Table 2). There was no regular trend on okra plant height under the sole and mixed cropped patterns, but okra plant height was higher for control and organic fertilizer treatments in sole okra than in okra/maize intercrop. This may be due to faster nutrient distribution and ease of intake under sole okra compared to okra/maize intercrop, with more completion between crop roots for available nutrients in the soil. The reverse was the case for the NPK treated okra plants. At 2nd cropping, okra plant height values ranged from 54.5-107 cm for sole okra plants and 60.9-106 cm for okra plants under okra/maize intercrop (Table 2).

Table 2. Okra plant height (cm) under sole and mixed cropping patterns

Treatments	Okra in sole okra			Okra in okra/maize		
	Seed rate/stand*			Seed rate/stand*		
	1	2	3	1	2	3
1st cropping						
Control	173	126	125	103	117	106
KPH (5 t ha^{-1})	116	121	127	114	118	118
KPH (10 t ha^{-1})	112	126	117	119	98.3	113
NPK (80 kg N ha^{-1})	110	114	110	141	125	128
NPK (160 kg N ha^{-1})	126	100	120	139	118	115
LSD (5 %)	10	4.3	6.8	5.1	10.3	7.2
2nd cropping						
Control	83.8	98.3	76.4	65.5	88.0	75.6
KPH (5 t ha^{-1})	87.5	67.3	81.4	91.5	95.9	87.5
KPH (10 t ha^{-1})	81.5	77.7	67.0	101	73.2	82.8
NPK (80 kg N ha^{-1})	54.5	85.5	107	106	76.4	101
NPK (160 kg N ha^{-1})	86.5	54.9	76.9	93.1	60.9	78.8
LSD (5 %)	4.2	12.1	9.8	4.8	9.0	11.2

**(1) okra at 1 plant stand^{-1} (2) okra at 2 plants stand^{-1} (3) okra at 3 plants stand^{-1}*

The values at the 2nd cropping season were generally shorter compared to values for the 1st cropping probably due to non-application of fertilizer at the 2nd cropping, which was aimed at assessing the residual effects of the applied fertilizers on the performance of the crops. This corroborated the previous reports on the assessment of residual effect of NPK and organomineral fertilizers on maize (*Zea mays*) performance in two ecological areas in Nigeria [16].

Okra plant girth ranged between 1.35 - 1.91 cm for okra plants under sole cropping and it was 1.05 - 1.52 cm for okra plants under okra/maize intercrop at the 1st season cropping (Table 3). The values ranged between 0.75 - 1.50 cm and 0.85 - 1.65 cm for okra plants under sole and okra/maize intercrop respectively at the 2nd cropping.

At each population level, okra plants under sole cropping had higher plant girth compared to those for okra/maize intercrop. This probably arises from less competition for space at the ground level due to standard spacing of 60cm x 75 cm that was maintained between the okra plants. Fertilizer treatments resulted in higher plant girth values compared to control, which corroborates earlier report in Nigeria [8].

Table 3. Okra plant girth (cm) under sole and mixed cropping patterns

Treatment	Okra in sole okra			Okra in okra/maize		
	Seed rate/stand			Seed rate/stand		
	1	2	3	1	2	3
1st cropping						
Control	1.65	1.35	1.20	1.45	1.05	1.02
KPH (5 t ha^{-1})	1.65	1.78	1.46	1.44	1.10	1.08
KPH (10 t ha^{-1})	1.91	1.84	1.52	1.52	1.18	1.11
NPK (80 kg N ha^{-1})	1.18	1.49	1.31	1.13	1.05	1.07
NPK (160 kg N ha^{-1})	1.65	1.62	1.41	1.46	1.44	1.04
LSD (5 %)	0.12	0.22	0.08	0.21	0.10	0.04
2nd cropping						
Control	0.85	1.50	1.30	1.10	1.25	1.25
KPH (5 t ha^{-1})	0.85	0.90	0.90	0.85	1.00	0.90
KPH (10 t ha^{-1})	0.75	1.30	0.85	1.65	0.85	1.20
NPK (80 kg N ha^{-1})	1.10	1.20	1.15	1.35	1.25	0.90
NPK (160 kg N ha^{-1})	0.90	0.95	1.40	1.45	0.95	0.95
LSD (5 %)	0.10	0.05	0.13	0.15	0.09	0.07

**(1) okra at 1 plant stand^{-1} (2) okra at 2 plants stand^{-1} (3) okra at 3 plants stand^{-1}*

3.3 Okra Fruit Yield

Fruit yield of okra under sole cropping generally increased with increase in okra plant population stand^{-1}. The yield increase ranged from 5.7-53 % and 18.8-65.8 % when okra population increased from one plant/stand to 2 and 3-plants stand^{-1} respectively (Table 4). Irrespective of okra plant population/stand, the use of both organic and NPK fertilizers significantly (P=0.05) resulted in higher okra fruit yield compared to the control. The range of okra fruit yield was 3.82-6.22 t ha^{-1} for KPH, 3.28-5.94 t ha^{-1} for NPK and 2.50-3.81 t ha^{-1} for control at 1st cropping, while it was 3.92-5.31 t ha^{-1} for KPH, 2.11-3.30 t ha^{-1} for NPK and 1.25-2.55 t ha^{-1} for control at 2nd cropping. Increase in fertilizer rate from 80 kg N ha^{-1} to 160 kg N ha^{-1} or organic manure from 5 t ha^{-1} to 10 t ha^{-1}, were not able to significantly increase okra fruit yield compared to the lower rate in both seasons. When okra was planted in mixture with maize, okra fruit yield decreased significantly across the fertilizer treatment levels compared with yields for sole okra. The range was 1.66-2.70 t ha^{-1} for KPH, 1.62-2.48 t ha^{-1} for NPK and 1.19-1.69 t ha^{-1} for control at 1st cropping, while it was 2.03-2.89 t ha^{-1} for KPH, 0.95-1.88 t ha^{-1} for NPK and 0.72-1.51 t ha^{-1} for control at 2nd cropping. The general decrease in okra yield under the intercrop may probably be due to aerial competition for space and light source to the crops for optimum expression of their yield potentials [17], while at the same time they were competing for the restricted amount of soil available nutrients, air and water supply.

Table 4. Okra fruit yield (t ha^{-1}) under sole and mixed cropping patterns

Treatment	Okra in sole okra			Okra in okra/maize		
	Seed rate/stand			Seed rate/stand		
	1	2	3	1	2	3
1st cropping						
Control	2.50	3.81	2.87	1.19	1.45	1.69
KPH (5 t ha^{-1})	3.83	4.05	6.22	1.66	2.70	2.23
KPH (10 t ha^{-1})	4.14	5.09	5.22	1.83	2.66	2.16
NPK (80 kg N ha^{-1})	3.28	4.53	5.39	2.48	1.76	1.84
NPK (160 kg N ha^{-1})	3.58	3.89	5.94	1.52	1.61	1.97
LSD (5 %)	0.25	0.11	0.68	0.45	0.53	0.27
2nd cropping						
Control	1.25	2.55	2.34	0.72	1.28	1.51
KPH (5 t ha^{-1})	3.92	4.30	4.38	2.03	2.41	2.18
KPH (10 t ha^{-1})	4.25	4.73	5.31	2.53	2.89	2.91
NPK (80 kg N ha^{-1})	2.11	2.45	3.03	1.45	1.88	1.67
NPK (160 kg N ha^{-1})	3.13	2.83	3.30	0.95	1.53	1.86
LSD (5 %)	0.81	0.70	0.59	0.66	0.52	0.41

**(1) okra at 1 plant stand^{-1} (2) okra at 2 plants stand^{-1} (3) okra at 3 plants stand^{-1}*

3.4 Maize Grain Yield

Maize yield under sole cropping was higher upon fertilizer usage compared to the control without fertilizer application (Table 5). The maize grain yield range was 2.30 - 3.20 t ha^{-1} for KPH, 1.66 - 2.98 t ha^{-1} for NPK and 1.22 - 1.92 t ha^{-1} for control at 1st cropping, while it was 3.36 - 4.38 t ha^{-1} for KPH, 1.27 -2.42 t ha^{-1} for NPK and 1.72 - 2.20 t ha^{-1} for control at 2nd cropping under sole cropping. The value was 1.31 - 2.06 t ha^{-1} for KPH, 0.80 - 1.67 t ha^{-1} for NPK and 0.97 - 1.31 t ha^{-1} for control at 1st cropping, while it was 1.26 - 2.81 t ha^{-1} for KPH, 1.02 - 1.81 t ha^{-1} for NPK and 0.48 - 1.03 t ha^{-1} for control at the 2nd cropping under intercrop. The fertilizers were generally optimum at the lower rate of 5 tons ha^{-1} for organic and 80 kg N ha^{-1} for NPK than at higher rates.

Maize yield increase was higher using organic fertilizer compared to NPK. Similar increase in grain yield of maize has been reported [18] when cocoa pod husk was applied to maize crop, while application of inorganic fertilizer at 80 - 120 kg N ha^{-1} was reported optimum for growth and yield of maize [4]. However, maize population/stand did not have particular regular pattern of effect on maize grain yield. Maize grain yield under okra/maize intercrop was generally lower than maize grain yield under sole maize probably due to competition between okra and maize for the available growth factors [1]. Okra/maize intercrop at rate of 3-plants stand^{-1} resulted in depressed maize yield compared to 1 and 2 plants stand^{-1} but the plant population/stand was optimum at 2-plants stand^{-1}.

Table 5. Maize grain yields (t ha^{-1}) under sole and mixed cropping patterns

Treatments	Maize in sole maize			Maize in okra/maize		
	Seed rate/stand*			Seed rate/stand*		
	1	2	3	1	2	3
1st cropping						
Control	1.77	1.22	1.92	1.31	1.16	0.97
KPH (5 t ha^{-1})	2.81	3.20	3.00	1.52	2.06	1.17
KPH (10 t ha^{-1})	2.30	2.47	2.69	1.31	1.56	0.97
NPK (80 kg N ha^{-1})	2.59	1.66	2.98	0.80	1.67	1.08
NPK (160 kg N ha^{-1})	2.73	1.77	2.94	1.11	1.55	0.91
LSD (5 %)	0.21	0.43	0.41	0.11	0.32	0.09
2nd cropping						
Control	1.72	2.20	1.89	0.48	0.95	1.03
KPH (5 t ha^{-1})	3.98	4.38	3.59	1.26	2.19	1.80
KPH (10 t ha^{-1})	3.36	3.98	3.44	1.80	2.66	2.81
NPK (80 kg N ha^{-1})	1.64	1.27	2.05	1.36	1.36	1.73
NPK (160 kg N ha^{-1})	2.19	1.42	2.42	1.02	1.73	1.81
LSD (5 %)	0.55	0.28	0.63	0.09	0.41	0.32

**(1) maize at 1 plant stand^{-1} (2) maize at 2 plants stand^{-1} (3) maize at 3 plants stand^{-1}*

3.5 Productivity Evaluation of Okra/Maize Intercrop

The yield advantage of growing okra and maize together under okra/maize intercrop compared to their sole cropping assessed using the land equivalent ratio (LER) showed that planting okra and maize in mixture at 2 plants stand^{-1}resulted to LER values that were generally greater than unity (Table 6), which could result to 5.7-45-7% of land area being saved at both cropping seasons. At 1 and 3 plants stand^{-1}, the LER values were mostly below unity at both cropping seasons. This indicates that it will not be optimally economical to continue with such a cropping pattern for a sustainable farming business [19]. Since the Nigerian farmers are not used to monoculture practice, especially in respect to arable farming [1], the seedling rate of 2 plants stand^{-1} with productivity advantage on LER would be a better option.

The values of aggressivity calculated showed that there is no consistency on either okra or maize having absolute dominance over each other (Table 6). This indicates that there may not be any serious deleterious level of competition between the two crops in the intercropping system for essential growth factors. Hence, the aggressive level may be for mutual benefits of the two crops in maintaining check and balances of the locality.

Table 6. Land equivalent ratio (LER) and aggressivity in okra/maize intercrop

Treatment	Land equivalent ratio			Aggressivity		
	Okra/ maize plants stand^{-1}			Okra/ maize plants stand^{-1}		
	1	2	3	1	2	3
1st cropping						
Control	1.26	1.33	1.09	0.53	1.14	-0.17
KPH (5 t ha^{-1})	0.97	1.31	0.75	0.19	-0.08	0.06
KPH (10 t ha^{-1})	1.01	1.15	0.72	0.26	0.22	-0.11
NPK (80 kg N ha^{-1})	1.07	1.39	0.70	-0.89	1.24	0.04
NPK (160 kg N ha^{-1})	0.83	1.29	0.64	-0.04	-0.92	-0.04
CV (%)	12.2	8.7	15.4	12.5	11.2	10.4
2nd cropping						
Control	0.86	0.93	1.19	-0.59	-0.14	-0.20
KPH (5 t ha^{-1})	0.84	1.06	0.99	-0.40	-0.12	0.01
KPH (10 t ha^{-1})	1.13	1.30	1.47	-0.12	0.11	0.54
NPK (80 kg N ha^{-1})	1.52	1.84	1.40	0.28	0.61	0.59
NPK (160 kg N ha^{-1})	0.77	1.76	1.31	0.32	1.36	0.37
CV (%)	17.4	10.1	13.3	15.7	9.8	14.6

The monetary value (MV) calculated for the 1st cropping showed that revenue from the sales of maize and okra under monoculture was higher than the revenue of their component in the okra/maize intercrop (Table 7). The combined revenues from the sales of maize grains and fresh okra fruits resulting from okra/maize intercrop was greater than values for maize sole but generally less than that of okra sole. The mean monetary value differences were significant (p=0.05). At the 2nd cropping season, maize and okra at sole cropping were each better than their corresponding components in the intercrop.

The combined monetary values of the maize and okra in the okra/maize intercrop were generally higher than for sole okra across the 1, 2 and 3 plants stand^{-1} while it was at the 2 and 3 plants stand^{-1} planting pattern for maize. The combined effects of 1st+2nd cropping seasons monetary values showed the superiority of okra + maize in okra/maize intercrop over their monoculture and the beneficiary residual effect of KPH over mineral fertilizer. The okra/maize intercrop was optimal at 2 plants stand^{-1} with KPH application at 5 t ha^{-1} being more economical.

Table 7. Monetary value in Nigeria Naira (N000 t^{-1}) of maize and okra yield in okra/maize intercrop under fertilizer treatment

TRT	Sole cropping						Maize/okra intercropping						Total		
	Maize plant/stand			Okra plant/stand			Maize plant/stand			Okra plant/stand			Maize/okra plant/stand		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1st															
T1	531	366	576	625.0	802.5	717.5	393	348	291	297.5	362.5	422.5	690.5	710.5	713.5
T2	843	990	900	957.5	1012.5	1555.0	456	618	351	415.0	675.0	557.5	871.0	1293	908.5
T3	690	741	807	1035	1272.5	1305.0	393	468	291	457.5	665.0	540.0	850.5	1133	831.0
T4	777	498	894	820.0	1132.5	1347.5	240	501	324	620.0	440.0	460.0	860.0	941.0	780.0
T5	819	531	882	895.0	972.5	1485.0	333	465	273	380.0	402.5	492.5	713.0	867.5	765.5
LSD (5%)	60.5	100	97.4	204.1	230.8	421.2	72.7	69.2	NS	102.1	88.5	NS	45.9	250.3	61.1
2nd															
T1	516	660	567	312.5	637.5	585.0	144	285	309	180.0	320.0	377.5	324.0	605.0	686.5
T2	1194	1314	1077	980.0	1075	1095	378	657	540	507.5	602.5	545.0	885.5	1259.5	1085.0
T3	1008	1194	1032	1062.5	1182.5	1327.5	540	798	843	632.5	722.5	727.5	1172.5	1520.5	1570.5
T4	492	381	615	527.5	612.5	757.5	408	408	519	362.5	470.0	417.5	770.5	878.0	936.5
T5	657	426	726	782.5	707.5	825.0	306	519	543	237.5	382.5	465.0	543.5	901.5	1008.0
LSD (5%)	315	220	274	391.3	205.1	284.6	62.5	113	107	140.3	125.1	62.7	252.1	288.3	245.7
1st+2nd															
T1	1047	1026	1143	937.5	1440.0	1302.5	537	633	600	477.5	682.5	800.0	1014.5	1315.5	1400.0
T2	2037	2304	1977	1937.5	2087.5	2680.0	834	1275	891	922.5	1277.5	1102.5	1756.5	2552.5	1993.5
T3	1698	1935	1839	2097.5	2455.0	2632.5	933	1266	1134	1090	1387.5	1267.5	2023.0	2653.5	2401.5
T4	1269	879	1509	1347.5	1745.0	2105.0	648	909	843	982.5	910.0	877.5	1630.5	1819.0	1716.5
T5	1476	957	1608	1677.5	1680.0	2310	639	984	816	617.5	785.0	957.5	1256.5	1769.0	1773.5
LSD (5%)	105	241	211	421.3	271.7	417.1	183.	103	147	233,1	163.1	142.4	255.7	326.2	204.8

TRT=Treatment, T1= Control, T2= KPH (5 t ha^{-1}), T3= KPH (10 t ha^{-1}), T4= NPK (80 kg N ha^{-1}), T5= NPK (160 kg N ha^{-1}), 1st &2nd =1st and 2nd cropping.

4. CONCLUSION

The use of fertilizers either as organic or inorganic form resulted in significant growth and yield increase of okra and maize plants at sole and intercropping patterns. The use of kola pod husk relative to NPK was superior for better growth and yield performance of okra and maize at 5 tons ha^{-1}, while the NPK was optimum at 80 kg N ha^{-1}. However, planting of okra and maize as sole crops resulted to higher yield performance compared to their individual component in the intercrop. Okra and maize were optimum at plant population of 2 plants $stand^{-1}$. The LER values were generally higher than unity with low level of aggresivity and more monetary value (MV) under okra/maize intercrop compared with sole maize and okra. It therefore showed that there could be great potential of reducing fertilizer bills in okra and maize production through the recycling of kola (Kola nitida) pod husks as a major waste from kola plantations in Nigeria for sustainable land use.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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