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Research Article

Cassava-Maize Intercropping System; Implication for Growth of Cultivars, Land Equivalent Ratio in the Southern Guinea Savanna Agro-ecological Zone of Nigeria

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Abstract: Intercropping has been an ancient farming practice that is recently gaining attention in present day research due to the robust agronomic potential embedded and land use efficiency. Understanding the efficacy of land use will help farmers reduce production cost, maximize nutrient use and other production resource for optimum yield. This field experiment was conducted at Prince Abubakar Audu University Research Farm during the 2021/2022 rainy season to investigate the implication of Cassava – Maize intercropping on growth of cassava and maize cultivars, Land Equivalent Ratio in Anyigba, Kogi State. The treatments were four cassava cultivars; TMS0581, TME419, Local (N.S 8082) and TMS30572, three maize cultivars; Samaz52, Oba super6 and Local combined in respective sole and mixed cropping pattern to give a total of 19 treatments altogether. The experiment was laid in a Randomized Complete Block Design with three (3) replicates to give a total of 57 plots. Results showed that intercropping Tms0581 cultivar of cassava with Obasuper6 hybrid maize produced the tallest maize plants at 4WAS, while Local/Samaz52 produced the tallest maize plants at 6WAS. Ni significant effect of cropping system was recorded for plant height at 8WAS, Number of leaves at 4, 6 & 8WAS and leaf length at 8WAS respectively. Tme419/Samaz52 and Tms0581/Obasuper6 produced maize with the longest leaves at 4 & 6 WAS respectively. Sole cropping of TME 419 cassava cultivar produced significantly, tallest cassava plants at 4, 6 & 8MAP respectively. Longest petiole was obtained with Tms30572/Obasuper6 at 4MAP, Tms30572/Obasuper6 (sole) at 6MAP, and Local/Samaz52 at 8MAP respectively. Local/Samaz52 (sole) and N.S 8082 performed best for number of leaves at 6 and 8MAP as no significant effect of cropping system was observed at 4MAP. Interaction of cropping system shows that Tme419 cassava had the highest intercropping advantage with Samaz52 on cassava heights, Local cassava cultivar on number of leaves against Obasuper6 variety of maize. Petiole of Tme30571 cassava cultivars became more developed and elongated than other cultivars when intercropped with Obasuper6 LER of TME419/SAMAZ52 being the highest confound best result and intercropping advantage for growth characteristics of component crop cultivars.

Keywords: Cultivars, Growth Characters, Intercropping, Land Equivalent Ratio.

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INTRODUCTION

Agricultural intensification as currently promoted aggravates competition for resources and can lead to overexploitation and unsustainable use of production resources such as water, soil, and nutrients (Kopittke *et al*., 2019). Traditional Agriculture, as practiced through the centuries, has always included different forms of inter-cropping, where farmers grew a variety of crops often intermingle in the same field, to sustain themselves and their families (Oyewole 2011). Intercropping can be described as the planting of two or more crops simultaneously on the same piece of land during the growing season (Palaniappan 2000). The main types of intercropping systems include strip row, relay and mixed row (Dwomon & Quainoo 2012).

Cassava-maize intercropping is traditional and popular in southern Nigeria where solar radiation and rainfall are abundant. Maize can be harvested early in the season, i.e., 3 – 4 months after planting, for food and sales, while cassava can be harvested piecemeal starting from 9 to 12 months after planting in most cases, throughout the year (Rahmani 2016). Reports have shown that the combination of short and long season crops enhanced radiation capture and efficient utilization through improved temporal patterns of canopy development compared to sole cropping: e.g. maize and groundnut (Awal *et al*., 2006), maize and cowpea or groundnut or soybean (Kermah *et al.*, 2017), The cassava/maize intercrops have been reported to be highly productive and compatible, mainly because maize is a short season crop while cassava is a long duration crop (Ikeorgu, 2002).

Land degradation and water scarcity are among the most visible manifestations of such unsustainable competition (FAO, 2017). It is estimated that overall 52% of agricultural land is already moderately or severely degraded as a result of agricultural crop commodification (ELD Initiative, 2015); a process which has resulted in little or no attention being paid to the traditional production systems of mixed- or intercropping. Intercropping is a traditional cropping system that supports the livelihoods of smallholder households (Fung *et al*., 2019) and possesses the potential to use natural resources such as nutrients and water more efficiently than sole cropping. Thus, intercropping offers opportunities of mitigating the challenges in current agriculture through species diversification and complementarity that results in increased resource use efficiency (Ogindo 2003). For many farmers, a lack of adequate attention to intercropping systems has created barriers to improving livelihoods and escaping poverty (FAO 2017; Rundgren 2015). Hence, there is a need for locally adapted agronomic management strategies that improve the capture, conservation, and use efficiencies of natural production resources in crop mixtures. This study was designed to evaluate the effects of cassava-maize intercropping system, its implication on growth characters and competitive advantages using Land Equivalent Ratio in Anyigba Kogi state Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out during the rainy season of 2021 at Prince Abubakar Audu University Research Farm, Anyigba, Kogi State, Nigeria, Latitude $7^{0}29^{1}$N and longitude $7^{0}11^{1}$E at 420 m above sea-level within the Southern Guinea Savannah Ecological Zone of Nigeria, Anyigba has a mean rainfall of 180 mm distributed between April and October. Mean monthly minimum and maximum temperature is 17^{o} C and 36.2^{o} C respectively. The soils generally are sandy to sandy-loam. Temperature shows some variation throughout the years. Mean monthly temperature varies between 15.1^{o}C and 31.3^{o}C (Amhakhian *et al.*, 2012)
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Treatments And Experimental Design

The treatments were four cassava cultivars; TMS0581, TME419, Local (N.S 8082) and TMS30572 coded as C_1, C_2, C_3, C_4 respectively (obtained from NCRI Badeggi) combined with three maize cultivars; Samaz52, Oba super6 and Local coded as M_1, M_2, M_3 (obtained from IAR Zaria) in respective sole and mixed crop pattern to give a total of 19 treatments altogether; Samaz52 + TMS0581 (M_1C_1) Samaz52 + TME419 (M_1C_2), Samaz52 + Local (M_1C_3), Samaz52 + TMS30572 (M_1C_4), Obasuper6 + TMS0581 (M_2C_1), Obasuper6 + TME419 (M_2C_2), Obasuper6 + local (M_2C_3), Obasuper6 + TMS30572 (M_2C_4), Local + TMS0581 (M_3C_1), Local + TME419 (M_3C_2), Local + Local (M_3C_3), Local + TMS30572 (M_3C_4), Samaz52 (M_1), Oba super6 (M_2), Local (M_3), TMS0581 (C_1), TME419 (C_2), Local (C_3) and TMS30572 (C_4) respectively. The experiment was laid in a Randomized Complete Block Design with three replicates with each separated by 1.5 m spacing, each replicate consisted of 19 plots which contains every treatment assigned in a random number system. Each plot ($15m^2$, containing 4 ridges) was separated 1m apart, as ridges were separated by 0.5. the experiment consisted of a total of 57plots was used in the experiment. Planting was done on the 30th day of April 2021, (Soil moisture was sufficient at the time of planting).

Planting commenced with maize which was done 7days prior to cassava cultivation. Maize was planted at spacing; 75cm between rows and 50cm within rows at depth of 5cm. Cassava stems of 20 cm length was planted horizontally on ridges with 2/3 of its length thrusted underground. The cultivation was done at spacing; 1 m within row and 0.75 m between rows as described by Bationo and Buerkert (2001). NPK 20-10-10 fertilizer was applied to maize at the rate of 0.12 t/ha, in two split-dose (first at 3WAS and second dose at 6WAS) in ring form. To cassava, the fertilizer was applied at 0.25 t/ha in single dose. Plots were kept weed-free throughout the experiment. 0.25 % solution of Gammalin 20 was sprayed to control grasshoppers as Neem oil extract + Thiopsin 70% ppm was applied at 30ml/16litres of water at 3 weeks' interval to control disease.

Observations And Data Collection

Observations were made on growth characters of maize crop such as plant height, number of leaves/plant, leaf length while on cassava crop, growth character such as heights of cassava plants, number of cassava leaves/plant, length of petiole, leaf area and number of leaflet/palmate.

Analysis of Data

Growth data collected was subjected to Analysis of Variance (ANOVA) using the STAR Statistical Tool for Agricultural Research (STAR) as described by Snedecor and Cochran (1967). Mean treatments that was significant for characters measured were separated using N-DMRT at 5% level of probability. Intercropping advantage was calculated using Land Equivalent Ratio as described by Willey & Osiru (1972). LER indicates the efficiency of intercropping, using the environmental resources compared to mono-cropping (Mead & Willey 1980). When LER >1 the intercropping favours the growth and yield of the species. In contrast, when LER <1 there is no intercropping advantage and the inter-specific competition is stronger than the inter-specific interaction within intercropping system (Zhang et al. 2011). LER was calculated as;

LER = (LER cassava + LER maize);

$$\text{LER cassava} = \frac{Yci}{Yc} \qquad \text{LER maize} = \frac{Ymi}{Ym}$$

where Y_c is the yield of cassava as sole crops, Y_m is the yield of maize as sole crops, Y_{ci} is the yield of cassava as intercrops and Y_{mi} is the yield of maize as intercrops.

RESULT

Growth Characters of Maize As Affected By Cropping System And Interaction At Different Sampling Periods In Anyigba, During The 2022 Cropping Season

Growth characters of maize was significantly affected ($P \leq 0.05$) by sole and intercropping system in Anyigba. As presented in table 1.

Plant heights - were significantly affected by sole cropping, C/M intercrop and C x M interaction at 4 and 6 WAS. Local/Samaz52 intercrop though produced taller maize plants (18.61cm) but was at par with heights obtained with Tms0581/Obasuper6 (18.32cm) at 4WAS. Similarly, heights obtained with sole Local maize variety, Tme419/Samaz52 and Local/Local maize intercrops were significantly indifferent ($P \geq 0.05$), this was also applicable to Oba Super (sole), Tms0581/Samaz52, Tme419/Local, Tms30572/Samaz52, Tms30572/Local, Tms0581/Local, and Tms30572/Obasuper6 respectively. SamaZ52 (sole) and Tme419/Obasuper6 produced the shortest plants. At 6WAS, Tme419/Samaz52 produced the tallest maize plants (73.23 cm) which was not significantly different from Local/Samaz52 (68.55 cm). This was Followed by Tms0581/Samaz52, Tms0581/Obasuper6, Tms0581/Local, Local/Local maize, Tms30572/Samaz52, Tms30572/Obasuper6 and Tms30572/Local which were at par. Heights obtained with SamaZ52 (sole), Oba Super(sole), Local (sole), Tme419/Local and Local/Obasuper6 were also at par. Tme419/Obasuper6 consistently produced the shortest maize plants (52.73 cm). Heights were not significantly influenced by cultivars at 8WAS.

Number of leaves of maize were not significantly affected by cultivars across all sampling periods (table 1).

Leaf Length - Tme419/Samaz52 produced maize with the longest leaf (39.88 cm) at 4WAS. All cultivars had leaf length in both sole and intercrops which were significantly indifferent. However, numerical values for length differs slightly. Local/Local maize produced maize with the shortest leaf (27.27 cm). Similarly, at 6WAS, Tms0581/Obasuper6 produced maize with the longest leaf. This was significantly indifferent from other cultivars despite the slight variations amongst cultivars. Tme419/Obasuper6 and Tme419/Local had maize with the shortest leaf (67.53 cm and 67.94 cm) respectively. At 8WAS, sole cropping of maize varieties and mixtures with cassava had no significant effect on leaf length of maize crop.

Interaction of cassava and maize had significant effect on plant height and leaf area only at 4 and 6 WAS. No significant effect of C x M was observed with Number of leaves of maize at all sampling stages.

Interaction Of Cassava Versus Maize Intercropping Systems On Plant Height And Leaf Length Of Maize Crop At Different Sampling Periods During The 2022 Cropping Season In Anyigba, Kogi State

C x M interaction on maize heights and leaf length are presented in table 2. At 4WAS combination of Local cassava cultivar (N.S 8082) and Samaz 52 cultivars produced the tallest maize plant (18.61 cm). Same response was observed when TME 419 and Oba super6 was combined (18.32 cm). this was followed by the response obtained with TME 419 and Samaz 52 (17.70 cm). other cultivars behaved alike when mixed. At 6WAS, combination of TME 419 and Samaz 52 produced the tallest maize plant (73.23 cm), this was significantly indifferent for other mixtures like Local (N.S 8082)/Samaz 52 (68.55 cm), TMS 0581/Oba super6 (65.64 cm) and Local (N.S 8082)/Local (66.07 cm) respectively. Other varieties also behaved alike. Mixtures of TME 419 and Oba super6 produced the shortest maize height at 4 and 6WAS. For leaf length, combination of TME 419 and Samaz 52 though produced maize

with the longest leaves but was significantly different from those obtained with Local (N.S 8082)/Samaz52, TMS 0581/Oba super6, TMS 0581/Local respectively at 4WAS. Other maize cultivars behaved alike in different mixtures. Similarly, all maize/cassava mixtures had maize leaf length at par at 6WAS with TME 419/Oba super6 producing the maize with the shortest length.

Growth Characters Of Cassava As Influenced By Cropping System And Interaction At Different Sampling Periods In Anyigba, During The 2022 Cropping Season

Table 3 present the effect of cropping systems and interaction on some growth characters of cassava crop in Anyigba environment.

Heights of Cassava - At 4MAP, sole planting of TME 419 and N.S 8082 cultivars were the tallest (98.5cm & 70.0 cm) and this was significantly different from other cropping systems adopted. Tme419/Samaz52 and Tms30572/Obasuper6 intercrops produced heights (76.83 cm & 76.00cm) which follows the sole cropping system. Other sole cassava cultivars and mixtures in various intercropping systems produced heights that were significantly indifferent. However, Local/Samaz52 produced the shortest (39.33 cm) cassava plants consistently. Similarly, at 6MAP, TME 419 (sole), Tme419/Samaz52 and Tme419/Obasuper6 had cassava plants with the tallest heights which were significantly indifferent. Other cropping systems also had cassava plants whose heights were at par. The shortest cassava was obtained with Local/Samaz52 (64.17 cm). at 8MAP, sole planting of TME 419 produced the tallest cassava plants (158.33 cm). This was however not significantly different from those obtained with N.S 8082 (sole) (146.67 cm), Tme419/Samaz52 (140 cm) and Tms30572/Obasuper6 (145.00 cm) respectively. Other sole cropping and intercropping system produced cassava with significantly indifferent heights respectively. Shortest cassava was recorded with Local/Samaz52 (77.0 cm).

Number of Cassava Leaves/plant - were significantly not affected by cropping system at 4MAP. However, at 6MAP, sole cropping of TMS 0581 produced 55.17 cassava leaves which was at par with TME 419 (49.83) and N.S 8082 (47.00). Number of leaves obtained from other intercropping systems were also at par. Intercropping Tms30572 with Local maize variety produced cassava with the least number of leaves. At 8MAP, 116.17 leaves were produced by sole planting of N.S 8082 which was at par with other cassava varieties planted sole. All intercropping systems were significantly indifferent. Tms0581/Obasuper6 produced the lowest leaves (42.17).

Length of Petiole - was significantly affected at 4MAP as Tms30572/Obasuper6 produced cassava with the longest leaf petiole (29.9 cm). This was however not significantly different from petioles of sole N.S 8082 (27.2 cm) and sole TME 419 (26.17 cm) respectively. Leaf petioles obtained from other cropping systems were significantly indifferent. Tms0581/Local and Tms0581/Obasuper6 produced cassava with the shortest petioles (17.77cm, 17.70 cm) respectively. Similarly, at 6MAP, TMS 30572 (sole) produced cassava with the longest petiole (30.83 cm) which was at par with Local/Samaz52, Local/Obasuper6, Local/Local maize and Tms30572/Samaz52 respectively. Other cropping systems also had the same leaf petiole. Sole planting of TME 419 and N.S 8082 gave the shortest petiole (18.67 cm, 19.50cm) respectively. Petiole length obtained with Local/Samaz52 and Tms30572/Obasuper6 though highest but at par at 8MAP. Petiole length obtained with other intercropping and sole cropping systems were significantly indifferent. Though Tme419/Obasuper6 gave the shortest petiole (20.00cm). C x M interactions was significant for cassava heights and leaf petiole length at 4, 6 and 8MAP and number of cassava leaves at 6 and 8 MAP respectively.

Interaction Of Cropping Systems On Some Growth Characters Of Cassava At Different Sampling Periods In Anyigba, During The 2022 Cropping Season

Height of Cassava **-** At 4MAP (table 4), heights of cassava plants were at maximum (76.83cm) when TME 419 intercropped with Samaz 52. Taller plants (70.00 cm) were obtained when TME 419 was intercropped with Oba super6. Other cultivars in different intercropping patterns behaved alike. At 6MAP, tallest plants (108.33 cm) were obtained when TME 419 was intercropped with Oba super6. This was however at par (106.67 cm, 101.67 cm) with TME 419/Samaz 52 and TMS 30572/Oba super6 intercrop. Other mixtures although behaved alike as Local (N.S 8082)/Samaz 52 produced consistently, the shortest cassava plants. Similarly, at 8MAP, TMS 30572/Oba super6 produced tallest cassava plants (145.00 cm) which was at par with Samaz 52/TME 419 and TME 419/Oba super6 respectively. Other combinations also produced significantly indifferent cassava heights.

Number of Cassava Leaves **-** table 5 present the interaction of cropping systems on number of leaves. at 6MAS, intercropping TMS 30572 and Oba super6 produced cassava with the highest number of leaves (41.00), this was however not significantly different from the number of leaves produced with Samaz 52/TMS 0581 (39.83) Local/TME 419 (39.33) and Samaz 52/TME 419 (38.00) respectively. Other mixtures behaved alike. At 8MAP, intercropping Local (N.S 8082) with Oba super6 though produced cassava with the highest number of leaves (64.5) but was at par with other cropping systems adopted. Samaz 52/TMS 30572 produced the lowest number of leaves.

Length of Cassava Leaf Petiole **–** Petioles were longest (29.90 cm) when TMS 30572 was intercropped with Oba super6 (table 6). This was significantly different from other intercropping systems which were at par. At 6MAP, intercropping Samaz 52 with Local (N.S 8082) produced the longest petioles (29.50cm), this was not significantly different the behaviors of Oba super6/TMS 0581 and Samaz 52/TMS 30572 respectively. Petiole length with other intercropping systems were significantly indifferent. Similarly, at 8MAP, Oba super6/TMS 30572 produced the longest petioles (29.20 cm) which was at par with Samaz 52/Local (N.S 8082). Other mixtures had petioles at par with Oba super6/TME 419 producing the shortest petioles.

As presented in table 7, Leaf Area and Number of Leaflet/Palmate were not significantly affected by sole and intercropping systems in Anyigba. Additionally, Interaction of intercropping system did not significantly influence these characters throughout the experiment.

Effect of Cropping Systems on Sole, Intercrop Yields And Ler Values of Cassava Plant

From the result of land equivalent ratio (LER) in table 8 below there was clear indication that the intercrop properly utilized the land given TME419/SAMAZ52 had the highest mean value of (1.79) followed by Tms30572/Obasuper6 (1.77) and Tms30572/Local (1.77), Tms0581/Samaz52(1.70), Local/Samaz52(1.61), Local/Local maize (1.60), Local/Obasuper6 (1.51), Tms30572/Samaz52(1.43), Tme419/Obasuper6 (1.27) and Tms0581/Local (1.16) then the least is Tme419/Local with value of (1.07).

Table 1. Growth Characters of Maize as Influenced by Sole maize, C/M Intercropping system in Anyigba, during 2021/2022 raining seasons.

Treatments	Plant Height			Number of Leaves/plant			Leaf Length (cm)		
	Sampling Periods (Weeks After Planting)								
	4	6	8	4	6	8	4	6	8
Sole									
SamaZ52(M_1)	12.29^{e}	56.30^{bcd}	111.00	4.50	8.15	11.00	29.25^{ef}	68.92^{cd}	78.97
Oba Super(M_2)	14.97^{bcde}	55.00^{cd}	109.73	4.33	8.50	11.20	30.93^{cdef}	70.03^{bcd}	83.43
Local (M_3)	16.96^{abc}	57.11^{bcd}	111.07	5.08	7.92	11.83	32.70^{b-f}	72.03^{a-d}	86.47
S.E (±)	2.98	2.98	2.98	1.17	1.14	0.87	2.25	2.61	30.61
Intercrops									
Tms0581/Samaz52	15.09^{bcde}	63.74^{abcd}	118.03	4.92	8.10	11.27	33.98^{a-e}	77.61^{ab}	76.70
Tms0581/Obasuper6	18.32^{a}	65.64^{abc}	213.53	5.08	8.42	11.93	37.69^{ab}	79.78^{a}	85.57
Tms0581/Local	13.02^{de}	61.46^{abcd}	106.13	5.17	8.60	11.87	33.60^{a-f}	76.31^{abc}	88.47
Tme419/Samaz52	17.70^{ab}	73.23^{a}	136.33	4.83	9.02	11.43	39.88^{a}	76.76^{ab}	85.10
Tme419/Obasuper6	12.29^{e}	52.73^{d}	101.47	4.75	8.42	11.02	28.78^{ef}	67.53^{d}	160.00
Tme419/Local	14.33^{cde}	55.33^{cd}	94.42	5.33	8.08	11.33	30.90^{cdef}	67.94^{d}	83.33
Local/Samaz52	18.61^{a}	68.55^{ab}	119.70	5.00	8.92	12.27	37.32^{abc}	73.09^{abcd}	80.03
Local/Obasuper6	13.48^{de}	53.65^{cd}	112.93	4.33	8.25	12.30	39.49^{def}	71.32^{bcd}	81.83
Local/Local maize	16.79^{abc}	66.07^{abc}	108.73	4.50	7.67	11.70	27.27^{f}	72.80^{bcd}	83.87
Tms30572/Samaz52	15.08^{bcde}	61.13^{abcd}	116.67	4.75	8.42	11.87	33.36^{bcdef}	73.93^{abcd}	80.38
Tms30572/Obasuper6	12.75^{de}	64.16^{abcd}	127.40	5.08	9.08	12.43	32.28^{bcdef}	73.48^{abcd}	88.37
Tms30572/Local	15.46^{bcd}	63.03^{abcd}	114.50	5.25	9.08	12.60	36.93^{abcd}	73.10^{abcd}	82.57
S.E (±)	2.98	2.98	2.98	1.17	1.14	0.87	2.25	2.61	30.61
P- Value$_{(0.05)}$	0.000	0.012	0.224	0.058	0.132	0.238	0.003	0.023	0.705
Interaction (s)									
C x M	*	*	ns	ns	ns	ns	*	*	ns
C.V (%)	2.98	12.59	14.	8.2%	7.0%	6.5%	9.1%	8.4%	45.7%

*Means followed by same letters within a sampling period are not statically different at 5% level of probability using N-DMRT. * -* Significant at 5% level of test, *ns - not significant.*

Table 2. Interaction of Maize and Cassava cultivars on the growth characters of maize at various sampling periods in Anyigba, during the 2022 Cropping season.

Growth characters	Sampling Periods		Maize Varieties		
		Cassava Cultivars	Samaz 52	Oba super6	Local
Plant height	4WAS	TMS 0581	15.09^{bcde}	18.32^{a}	13.02^{de}
		TME 419	17.70^{ab}	12.29^{e}	14.33^{cde}
		Local (N.S 8082)	18.61^{a}	13.48^{de}	16.79^{abc}
		TMS 30572	15.08^{bcde}	12.75^{de}	15.46^{bcd}
		SE (±)		0.98	
			Samaz 52	Oba super6	Local
	6WAS	TMS 0581	63.74^{abcd}	65.64^{abc}	61.46^{abcd}
		TME 419	73.23^{a}	52.75^{d}	55.33^{cd}
		Local (N.S 8082)	68.55^{ab}	53.65^{cd}	66.07^{abc}
		TMS 30572	61.13^{abcd}	64.16^{abcd}	63.03^{abcd}
		SE (±)		4.18	
			Samaz 52	Oba super6	Local
Leaf Length	4WAS	TMS 0581	33.98^{a-e}	37.69^{ab}	33.60^{a-f}
		TME 419	39.88^{a}	28.78^{ef}	30.90^{c-f}
		Local (N.S 8082)	37.32^{abc}	39.49^{dcf}	27.27^{f}
		TMS 30572	33.36^{b-f}	32.28^{b-f}	36.93^{a-d}
		SE (±)		3.16	
			Samaz 52	Oba super6	Local
	6WAS	TMS 0581	77.61^{ab}	79.78^{a}	76.31^{abc}
		TME 419	76.76^{ab}	67.53^{d}	67.94^{d}
		Local (N.S 8082)	73.09^{abcd}	71.32^{bcd}	72.80^{abcd}
		TMS 30572	73.93^{abcd}	73.48^{abcd}	73.10^{abcd}
		SE (±)		3.82	

Means followed by same letters within a sampling week are not statically different at 5% level of probability using N-DMRT.

Table 3. Cassava heights, Number of leaves and Length of petiole as Influenced by sole cassava, C/M Intercropping system in Anyigba, during 2021/2022 raining seasons.

Treatments	Heights of Cassava (cm)			Number of cassava Leaves/plant			Leaf of Petiole (cm)		
	Sampling Periods (Months After Planting)								
	4	6	8	4	6	8	4	6	8
Sole									
TMS 0581 (C_1)	62.43^{bcd}	89.67^{a-d}	122.67^{bcd}	33.67	55.17^{a}	91.33^{ab}	21.17^{cde}	23.83^{bcde}	21.00^{bc}
TME 419 (C_2)	98.50^{a}	123.00^{a}	158.33^{a}	35.00	49.83^{ab}	52.17^{ab}	26.17^{abc}	18.67^{e}	20.17^{c}
N.S 8082 (C_3)	70.00^{a}	88.00^{bcd}	146.67^{ab}	37.17	47.00^{abc}	116.17^{a}	27.20^{ab}	19.50^{e}	20.00^{ab}
TMS 30572 (C_4)	48.00^{bcd}	76.17^{bcd}	115.00^{bcd}	25.83	42.00^{abcd}	57.00^{ab}	23.90^{bcd}	30.83^{a}	27.93^{ab}
S.E (±)	09.93	10.91	10.63	9.34	5.4	23.32	1.93	2.41	2.56
Intercrops									
Tms0581/Samaz52	59.17^{bcd}	85.00^{bcd}	121.83^{bcd}	29.50	39.83^{bcd}	56.67^{ab}	20.62^{cde}	21.33^{cde}	23.33^{abc}
Tms0581/Obasuper6	58.00^{bcd}	85.83^{bcd}	101.67^{de}	22.67	33.67^{bc}	42.17^{b}	17.70^{e}	26.67^{abcd}	26.67^{abc}
Tms0581/Local	60.33^{bcd}	73.33^{bcd}	109.17^{cde}	25.83	36.67^{bcd}	64.33^{ab}	17.77^{e}	24.17^{bcde}	27.33^{abc}
Tme419/Samaz52	76.83^{ab}	106.67^{ab}	140^{abc}	45.67	38.00^{bcd}	48.17^{ab}	20.83^{cde}	23.33^{bcde}	21.33^{bc}
Tme419/Obasuper6	70.00^{bc}	108.33^{ab}	128.33^{a-d}	38.00	37.83^{bcd}	49.50^{ab}	21.48^{cde}	23.00^{bcde}	20.00^{c}
Tme419/Local	66.17^{bcd}	95.83^{a-d}	125.00^{a-d}	27.83	39.33^{bcd}	46.67^{ab}	19.03^{de}	20.33^{de}	24.00^{abc}
Local/Samaz52	39.33^{d}	64.17^{d}	77.00^{e}	31.00	31.67^{cd}	46.17^{ab}	21.10^{cde}	29.50^{ab}	29.00^{a}
Local/Obasuper6	63.17^{bcd}	88.33^{bcd}	121.00^{bcd}	37.50	36.33^{bcd}	64.50^{ab}	20.67^{cde}	25.17^{a-e}	21.00^{bc}
Local/Local maize	67.17^{bcd}	77.50^{bcd}	114.17^{bcd}	34.67	33.83^{cd}	44.67^{b}	20.17^{de}	25.33^{a-e}	23.67^{abc}
Tms30572/Samaz52	50.83^{bcd}	80.33^{bcd}	109.17^{cde}	38.33	32.00^{cd}	37.67^{b}	20.83^{cde}	27.67^{abc}	26.00^{ab}
Tms30572/Obasuper6	76.00^{ab}	101.67^{abc}	145.00^{ab}	40.83	41.00^{abcd}	41.33^{b}	29.90^{a}	24.80^{a-e}	29.20^{a}
Tms30572/Local	44.50^{cd}	69.33^{cd}	96.67^{de}	29.17	29.67^{d}	42.33^{b}	20.10^{de}	20.33^{de}	23.33^{abc}
S.E (±)	09.93	10.91	10.63	9.34	5.40	23.32	1.93	2.41	2.56
P- Value$_{(0.05)}$	0.009	0.026	0.001	0.941	0.035	0.020	0.000	0.004	0.040
Interaction (s)									
C x M	*	*	*	ns	**	*	*	*	**
C.V (%)	29.17	20.40	14.87	10.0%	11.11%	8.3%	13.4	14.4	16.2

Means followed by same letters within a sampling period are not statistically different at 5% level of probability using N-DMRT. * and ** = Significant at 5% and 1% level of test respectively. ns – not significant. *MAP (Months After Planting).*

Table 4. Interaction of Cassava and Maize cultivars on the height of cassava crops at various sampling periods in Anyigba, during the 2022 Cropping season.

		Maize Varieties		
Sampling Periods	**Cassava Cultivars**	**Samaz 52**	**Oba super6**	**Local**
4MAP	TMS 0581	59.17^{bcd}	58.00^{bcd}	60.33^{bcd}
	TME 419	76.83^{ab}	70.00^{bc}	66.17^{bcd}
	Local (N.S 8082)	39.33^{d}	63.17^{bcd}	67.17^{bcd}
	TMS 30572	50.83^{bcd}	76.00^{ab}	44.50^{cd}
	SE (±)	9.92		
		Samaz 52	Oba super6	Local
6MAP	TMS 0581	85.00^{bcd}	85.83^{bcd}	73.33^{bcd}
	TME 419	106.67^{ab}	108.33^{ab}	95.83^{a-d}
	Local (N.S 8082)	64.17^{d}	88.33^{bcd}	77.50^{bcd}
	TMS 30572	80.33^{bcd}	101.67^{abc}	69.33^{cd}
	SE (±)	11.93		
		Samaz 52	Oba super6	Local
8MAP	TMS 0581	121.83^{bcd}	101.67^{de}	109.17^{cde}
	TME 419	140.00^{abc}	128.33^{a-d}	125.00^{a-d}
	Local (N.S 8082)	77.00^{e}	121.67^{bcd}	114.17^{bcd}
	TMS 30572	109.17^{cde}	145.00^{ab}	96.67^{de}
	SE (±)	11.85		

Means followed by same letters within a sampling week are not statically different at 5% level of probability using N-DMRT. MAP (Months After Planting

Table 5. Interaction of Cassava and Maize cultivars on the Number of Leaves of cassava crops at various sampling periods in Anyigba, during the 2022 Cropping season.

		Maize Varieties		
Sampling Periods	**Cassava Cultivars**	**Samaz 52**	**Oba super6**	**Local**
6MAS	TMS 0581	39.83^{bcd}	33.67^{bc}	36.67^{bcd}
	TME 419	38.00^{bcd}	37.83^{bcd}	39.33^{bcd}
	Local (N.S 8082)	31.67^{cd}	36.33^{bcd}	33.83^{bcd}
	TMS 30572	32.00^{cd}	41.00^{a-d}	29.67^{d}
	SE (±)		5.33	
		Samaz 52	Oba super6	Local
8MAS	TMS 0581	56.67^{ab}	42.17^{b}	64.33^{ab}
	TME 419	48.17^{ab}	49.50^{ab}	46.67^{ab}
	Local (N.S 8082)	46.17^{ab}	64.50^{ab}	44.67^{b}
	TMS 30572	37.67^{b}	41.33^{b}	42.33^{b}
	SE (±)		23.31	

Means followed by same letters within a sampling week are not statically different at 5% level of probability using N-DMRT. MAP (Months After Planting)

Table 6. Interaction of Cassava and Maize cultivars on the Length of Cassava Leaf Petiole at varying sampling periods in Anyigba, during the 2022 Cropping season.

		Maize Varieties		
Sampling Periods	**Cassava Cultivars**	**Samaz 52**	**Oba super6**	**Local**
4MAS	TMS 0581	20.62^{cde}	17.70^{e}	17.77^{e}
	TME 419	20.83^{cde}	21.48^{cde}	19.03^{de}
	Local (N.S 8082)	21.10^{cde}	20.67^{cde}	20.17^{de}
	TMS 30572	20.83$_{cde}$	29.90^{a}	20.10^{de}
	SE (±)		1.93	
		Samaz 52	Oba super6	Local
6MAS	TMS 0581	21.33^{cde}	26.67^{a-d}	24.17^{b-e}
	TME 419	23.33^{b-e}	23.00^{b-e}	20.33^{de}
	Local (N.S 8082)	29.50^{ab}	25.17^{a-e}	25.33^{a-e}
	TMS 30572	27.67^{abc}	24.80^{a-e}	20.33^{de}
	SE (±)		2.41	
		Samaz 52	Oba super6	Local
8MAP	TMS 0581	23.33^{abc}	26.67^{abc}	27.33^{abc}
	TME 419	21.33^{bc}	20.00^{c}	24.00^{abc}
	Local (N.S 8082)	29.00^{a}	21.00^{bc}	23.67^{abc}
	TMS 30572	26.00^{ab}	29.20^{a}	23.33^{abc}
	SE (±)		2.56	

Means followed by same letters within a sampling week are not statically different at 5% level of probability using N-DMRT. MAP (Months After Planting).

Table 7. Leaf Area, Leaflet/Palmate of Cassava crop as Influenced by sole cassava, C/M Intercropping system in Anyigba, during 2021/2022 raining seasons.

Treatments	Leaf Area (cm)			Number of Leaflet/Palmate		
	Sampling Periods (Months After Planting)					
	4	6	8	4	6	8
Sole						
TMS 0581 (C_1)	24.87	52.23	82.08	7.00	7.00	7.83
TME 419 (C_2)	20.61	66.87	83.52	7.00	7.00	7.50
N.S 8082 (C_3)	21.27	49.43	75.01	7.00	7.00	7.00
TMS 30572 (C_4)	23.31	52.85	75.58	7.00	7.00	7.00
S.E (±)						
Intercrops						
Tms0581/Samaz52	21.22	38.23	62.24	7.00	7.00	7.00
Tms0581/Obasuper6	26.18	40.60	64.03	7.00	7.00	7.83
Tms0581/Local	22.18	35.97	55.39	7.00	7.00	7.00
Tme419/Samaz52	20.42	43.25	65.52	7.00	7.00	7.00
Tme419/Obasuper6	19.15	41.10	65.91	7.00	7.00	7.50
Tme419/Local	20.27	34.30	59.02	7.00	7.00	7.00
Local/Samaz52	28.4	38.00	65.72	7.00	7.00	7.00
Local/Obasuper6	19.09	61.63	81.27	7.00	7.00	7.00
Local/Local maize	19.98	38.30	61.22	7.00	7.00	7.00
Tms30572/Samaz52	20.65	34.03	55.05	7.00	7.00	7.50
Tms30572/Obasuper6	20.69	40.23	63.76	7.00	7.00	7.83
Tms30572/Local	20.66	33.73	52.92	7.00	7.00	7.00
S.E (±)	3.67	13.01	11.97	0.33	0.33	0.67
P- $Value_{(0.05)}$	0.673	0.059	0.362	--	--	0.480
Interaction (s)						
C x M	ns	ns	ns	ns	ns	ns
C.V (%)	47.2%	28.6%	24.2%	13.4%	14.4%	16.2%

Means followed by same letters within a sampling period are not statistically different at 5% level of probability using N-DMRT. * and ** = Significant at 5% and 1% level of test respectively. ns – not significant. *MAP (Months After Planting).*

Table 8. Sole, Intercrop yields and LER values of different mixtures of maize and cassava grown in Anyigba, during 2021/2022 raining season.

Planting patterns (Sole & Mixtures)	Maize		Cassava		
	Sole	Inter	Sole	Inter	LER
Tms0581/Samaz52	-	4.80	-	10.03	1.70
Tms0581/Obasuper6	-	3.63	-	8.13	1.16
Tms0581/Local	-	3.13	-	8.13	1.16
Sole Maize (SAMAZ52)	3.67	-	-	-	-
Sole Cassava (TMS0581)	-	-	26.00	-	-
Tme419/Samaz52	-	5.30	-	12.70	1.79
Tme419/Obasuper6	-	3.57	-	6.20	1.27
Tme419/Local	-	2.80	-	6.93	1.07
Sole Maize (Obasuper6)	3.77	-	-	-	-
Sole Cassava (TME419)	-	-	19.63	-	-
Local/Samaz52	-	3.50	-	4.83	1.61
Local/Obasuper6	-	4.53	-	6.93	1.51
Local/Local maize	-	4.60	-	-	1.60
Sole Maize Obasuper6	3.87	-	-	-	-
Sole Cassava (TME419)	-	-	20.43	-	-
Tms30572/Samaz52	-	4.70	-	11.53	1.43
Tms30572/Obasuper6	-	74.70	-	13.03	1.77
Tms30572/Local	-	4.70	-	8.07	1.77
Sole Maize (Local)	38.87	-	-	-	-
Sole Cassava (TMS30572)	-	-	23.37	-	-

LER= Land equivalent ratio, Sole= (sole crop), Inter= (inter crop).

DISCUSSION

Effect of Cropping System And Interaction of Cassava Versus Maize on Maize Growth

Our results conform with several workers who have reported the effects of intercropping on agronomic characteristics of maize. Duncan (1958) and Early *et al.* (1967) indicated that this effect is mainly due to competition for light, moisture and soil nutrients which is evident in the significant effects of cropping systems observed amongst maize characters. Significant effect of cropping system (sole and intercrop) with plant height indicated that taller plants were observed in the intercrop crop of maize compared to sole. This could be compatibility of companion crops in various intercropping mixtures. The growth reduction of intercropped maize might be majorly due to partly interspecific competition between the intercrop components for growth resources (light, water, nutrients, air, etc.) and the depressive effects of cassava. Egbe and Idoko, (2012) made similar observations in their study and attributed it to inter- specific competition for light, nutrients, water, air and other growth resources. The environmental changes associated with different varieties intercropped have been reported to have modifying effect on the growth and development of maize plant (Maryam *et al, 2011*). Alternatively, insignificant effect on cropping systems observed with number of leaves may have resulted from very rigorous competition for growth resources amongst varieties in the intercrops. This result does not conform with Shivananda (2005) who reported that cassava has a wide range of growth habits which may influence the amount of solar radiation interception during growth (Adeniyan *et al.,* 2014).

Effect of Cropping System and Interaction of Cassava Vs Maize on Cassava Growth.

The behaviour of intercropping system on some growth characters of cassava such as leaf production, length of petiole, height of cassava among others as observed in this study could be attributed to the slight variation in planting dates. Cassava intercropped with maize on the same date was shaded on later dates during its association with maize. It could be deduced from this study that, at fourth month after planting, the cassava received less isolation for photosynthetic action. This is suggesting that, the competition of cassava with maize for light may result in the reduction of dry matter (DM) formation, and the stems may attain greater height and assimilate less. Hunt *et al*. (1977) reported that under condition of low photosynthesis caused by low light levels, the supply of carbohydrate is low and the proportion of dry matter in the roots is decreased. Similarly, our result on heights of cassava denoted that maize adversely competed with cassava for shading from the fourth to eighth month after planting. This serious competition observed resulted to the similar behaviour exhibited by components crops throughout the sampling periods this also accounted for the tallest cassava plants observed with sole planting rather than intercrops. Cassava plants would have been more established after maize plants had been completely removed. Studies at International Institute of Tropical Agriculture (IITA, 1981) showed that there probably exists a shade threshold above which cassava plants cannot recover to perform well. In this study, the shade effect on cassava that was intercropped with maize at the different date of planting with no effect on height at 6 and 8 MAP suggesting that the threshold of shade at which the cassava could no longer recover from the shade effect had neither been reached nor exceeded.

Land Equivalent Ratios Of Intercrops

Land equivalent ratio (LER) values above 1.0 obtained in all intercrop combinations and all treatments signifies that a robust intercropping advantages for all treatments. This indicates that all intercropping combinations were better in resource use efficiency compared to growing the two crops separately [(Negash and Mulualem 2014), (Ijoyah *et al.,* (2012)]. Negash and Mulualem (2014) also confirmed intercrop advantage in maize/cassava

intercropping systems. The differences in the rooting system of cassava and maize might have been responsible for the complementarity in the maize/cassava intercropping. These differences may have resulted in a fuller exploration of the whole soil profile by component crops than can be achieved by separate sole crops. Muoneke *et al.* (2007) reported that LER values above unity indicated complementarity in resource utilization by the component crops.

CONCLUSION

From the foregoing experiment we have concluded that cropping system affects significantly the growth characteristics of component crops in maize and cassava intercrop in Anyigba environment. Intercropping of Tme419 and Samaz52 produced the best heights and longest leaves for the maize component as proven by cultivar interactions. For cassava components, sole cropping of Tme419 produced tallest plants and had the highest intercropping advantage with Samaz52, Local cassava cultivar had higher advantage in terms of number of leaves when intercropped with Obasuper6. Petiole of Tme30571 cassava cultivars became more developed and elongated than other cultivars when intercropped with Obasuper6 LER of TME419/SAMAZ52 being the highest confound best result and intercropping advantage for growth characteristics of component crop cultivars.

REFERENCE

Adeniyan O.N. & S.O. Ojeniyi. (2005). Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nig. J. of Soil Sci.*, **15**:34-41.

Adeniyan, O.N., Aluko, O.A., Olanipekun, S.O., Olasoji, J.O. and Aduramigba, M. (2014). Growth and yield performance of cassava intercrop under different population densities of maize. *Journal of Agricultural Science,* **6**(8): 1916-9760.

Amhakhian, S., Osemwota, I., and Oyewole, C.I. (2012). Response of maize (Zea mays L.) Yield and Yield components to rate of applied fertilizer in the Guinea savanna soils of Kogi State, Nigeria. *Journal of biology, Agriculture and Healthcare* **2**(3): 2224-3208

Awal M.A. Awal, H. Koshi, T. Ikeda. (2006). Radiation interception and use by maize/peanut intercrop canopy Handb. Environ. Chem., Vol. 5: *Water Pollut*., 139 (1–2) (2006), pp. 74-83, 10.1016/j.agrformet.2006.06.001

Duncan, W. G. (1958). The relationship between corn population and yield. *Agron. J.,* **50**: 82-84. http://dx.doi.org/10.2134/agronj1958.00021962005000020008x

Dwomon I. B and Quainoo A. K. (2012). Effect of spatial arrangement on the yield of maize and groundnut intercrop in the northern guinea savanna agro-ecological zone of Ghana. *Int. J. Life. Sc. Bt & Pharm*. **1**(2).

Early, E. B., Melbrath, W. D., Seif, R. D., & Hageman, R. W. (1967). Effect of shade applied at different stages of plant development on corn production. *Crop Sci.*, **7**: 151-156. http://dx.doi.org/10.2135/cropsci1967.0011183X000700020018x

Egbe, M.O., and Idoko, J.A. (2012). Evaluation of pigeon pea genotypes for intercropping with maize and sorghum in southern Guinea Savanna: Economic benefits. *International Journal of Agriculture,* **2**: 108–114.

ELD Initiative, (2015). Economics of Land Degradation Initiative: Report for policy and decision-makers.

FAO. (2017). The future of food and agriculture: trends and challenges. The future of food and agriculture: trends and challenges (Vol. 4). https://doi.org/10.2307/4356839.

Fung, K.M., Tai A.P.K., Yong T., Liu X., Lam H. (2019). Co-benefits of intercropping as a sustainable farming method for safeguarding both food security and air quality. *Environ. Res. Lett*. **14** (4) doi: 10.1088/1748-9326/aafc8b.

Hunt, I. A., Wholey, D. W., & Cock, J. H. (1977). Growth physiology of cassava (*Manihot esculenta* crantz). *Field Crop Abstract.* **30**(2), 77-89.

IITA. (1982). Maize/Cassava Intercropping. *Annual Report* for (1981). Ibadan, Nigeria, pp. 141-142.

Ijoyah, M.O., Bwala, R.I and Iheadindueme, C.A. (2012). Response of cassava, maize and egusi melon in a three crop intercropping system at Makurdi, Nigeria. *International Journal of Development and Sustainability*. **1**(2):135-144.

Ikeorgu, J. E. G. (2002). Performance of yam minituber/maize intercrop in the humid tropics of Southeast Nigeria. Niger. *Agric. J.*, 33, 83-87.

Kermah, M. Kermah, A.C. Franke, S. Adjeinsiah, B.D.K. Ahiabor, R.C. Abaidoo, K.E. Giller . (2017). Maize-grain legume intercropping for enhanced resource use efficiency and crop productivity in the Guinea savanna of northern Ghana *Field Crops Res.*, **213:** 38-50. Doi: 10.1016/j.fcr.2017.07.008

Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A., Lombi, E. (2019). Soil and the intensification of agriculture for global food security. *Environ. Int.* **132** (May), 105078 https://doi.org/10.1016/j.envint.2019.105078

Maryam A. B, Saied K. K, Seyed H. S, Mandana D, Khodadad M and Mohammad G. (2011). A Study on Effects of Planting Dates on Growth and Yield of 18 Corn Hybrids (*Zea mays* L.) *American Journal of Experimental Agriculture*, **1**(3): 110-120.

Muoneke, C.O., Ogwuche, M.A.O., Kalu, B.A. (2007). Effect of maize planting density on the performance of maize/soybean intercropping system in a guinea savanna agro-ecosystem. *Afr. J. Agric. Res.*, **2**: 667-677.

Negash, F. and Mulualem, T. (2014). Enhanced land use system through cassava/maize intercropping in south region of Ethiopia. Sky. *Journal of Agricultural Research*, **3**(10):196 – 200.

Ogindo, H.O. (2003). Comparing The Precipitation Use Efficiency of Maize-Bean Intercropping with Sole Cropping in a Semi-Arid Ecotope. University Free State.

Oyewole C. I. (2013). Effect of planting pattern on the performance of intercropped maize (*Zea mays*) and egusi melon (*Colocinthis citrullus*) in Anyigba, Kogi State. Proc., 1st Nat. Conf. Crop Science Society of Nigeria (CSSN), UNN 2013 Eds: Bayeri et al., Pp 25-28.

Palaniappan, S. P. (2000). "*Cropping system in the tropic*", publ. Mohander Singh Sejwal for Wiley Eastern Limited, 4835/ 24 Ansori road, Daryagari, New Delhi 110002

Rahmani. A. (2016). Effect of Planting Date and Plant Densities on Yield and Yield Components of Sweet Corn (Zea mays L. var saccharata) *Am. J. Exp. Agric.*, **10**(2): 1-9, doi:10.9734/ajea/2016/19592

Rundgren, G. (2015). *Third world resurgence*: The illusion of cheap food under commodified agriculture. In Resurgence: The global commodification of agriculture and its perils (295th ed., Vol. 53, pp. 7–13).

Shivananda, C.M. (2005). Response of cowpea genotypes to plant density and fertilizer levels underrain-fed vertisols. *MSc. Thesis*; 23-51. Wageningen University, The Netherlands.

Willey, R. W, Osiru, D. S. O. (1972). Studies on mixtures of maize and beans (*Phaseolus vulgaris*) with particular reference to plant population. *J Agric Sci.* **79**: 517–529.

Willey, R. W., Rao, M. R. (1980). A competitive ratio for quantifying competition between intercrops. *Exp Agric.* **16**:117–125.

Zhang, G., Yang, Z., Dong, S. (2011). Interspecific competitiveness affects the total biomass yield in an alfalfa and corn intercropping system. *Field Crops Res.* doi:10.1016/j.fcr.2011.06.006.