EVALUATION OF COWPEA VARIETIES (*VIGNA UNGUICULATA*, L WALP) FOR INTERCROPPING WITH OKRA (*ABELMOSCHUS ESCULENTA*, L MOENCH)

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ABSTRACT

The study on the evaluation of cowpea varieties for intercropping with okra was conducted during the late cropping seasons of 2008 and 2009 at the experimental farm of the Federal University of Agriculture, Abeokuta, Nigeria. The experiment was laid out in Randomised Complete Block Design replicated three times. Four cowpea varieties (oloyin, sokoto, IT84S 2246-6 and IT90K 2772-2) with determinate and indeterminate growth habits were planted as sole crop or intercropped with NHAe-47-4 variety of okra. Land equivalent ratio (LER) used to assess the productivity of the mixtures was consistently greater than unity in all treatments. Okra yield was not significantly reduced by intercropping in both years except in okra + IT84S 2246-6. Leaf area, LAI, number of flowers/plant and number of pods/plant were not significantly different (P=0.05) except in okra + IT84S 2246-6 in sole and intercrop mixtures. Intercropping enhanced the growth and yield of cowpea varieties compared to sole cropping. Oloyin, IT90K 2772-2 and Sokoto gave yield advantages of 147, 133 and 92% respectively.

Keywords: okra, cowpea, intercrop, LER, growth habit.

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INTRODUCTION

It is becoming more important to raise crop productivity in order to meet the increasing food requirements of an increasing population all over the world. Moreover, crop production per unit area must be increased because of remaining fixed or diminishing suitable land for food production. More than 70% of food crops consumed in humid tropics, especially in the tropical Africa come from intercropping. Intercropping, through more effective use of water, nutrients and solar energy, can significantly enhance crop productivity compared to the growth of sole crops (Midmore, 1993). It has been demonstrated that the advantages of intercropping in vegetables could lead to better land use efficiency as an important component of sustainable farming (Guvene and Yildrin, 1999).

Intercropping ensures efficient utilization of light and other resources, reduces soil erosion, suppresses weed growth, and thereby helps to maintain greater stability in crop yield in okra/cowpea intercropping system (Susan and Mini, 2005). It also guarantees greater land occupancy and thereby higher net returns. Other advantages ascribed to intercropping include

insurance against crop failure thereby minimizing risk, better use of resources by plants of different heights, rooting depths and nutrient requirements and a more equal distribution of labor through the growing season (Okpara *et al*., 2004). Maximization of yields in crop mixtures will always be on the basis of high species compatibility (Baker, 1982). Advantages of intercropping with legumes have been demonstrated in numerous studies; tomato or okra with cowpea (Olasantan, 1991), amaranth with cowpea (Susan and Mini, 2005), cucumber with cowpea (Susan and Mini, 2005), maize with cowpea (Akande *et al.*, 2006), cassava with cowpea (Mohammed *et al.*, 2006). These studies have indicated that intercropping was more productive than sole cropping because of the complimentary effect of intercrops. Leguminous plants currently present very good opportunity in sustainable maintenance of soil fertility. Of the various leguminous crops, cowpea appears to be one of the most important crops in playing this role (IITA, 1990). Cowpea can fix up to 88 kg N/ha (Fatokun *et. al.*, 2002) and in an effective cowpea-rhizobium symbiosis, more than155 kg N/ha is fixed which can supply 80-90% of plants total N requirement. It is estimated that cowpea supplies about 40% of the daily protein requirements to most of the people in Nigeria (Muleba *et al*., 1997). Okra (*Abelmoschus esculentus* L. Moench) is a crop featuring prominently in mixed cropping system in Nigeria for the supply of vitamins and minerals for man. Okra is consumed on daily basis by most families in Nigeria. Apart from being rich in iodine, its' viscous nature also makes it preferred in the consumption of many starchy food that are often eaten swallowed by both children and adult. Cowpea varieties have both determinate and indeterminate growth habit; similarly, while some early maturing varieties of okra might be short, late maturing varieties grow quite tall. There is thus paucity of information on cowpea/okra intercropping system, especially with regard to determinate and indeterminate growth pattern of cowpea.

The objectives of this study are: to evaluate the effect of cowpea varieties with contrasting growth habit on growth and yield of okra and to evaluate the performance of the cowpea varieties in the crop mixtures.

MATERIALS AND METHODS

Two field experiments were carried out between August through October in 2008 and 2009 at the Teaching and Research Farm of the University of Agriculture, Abeokuta, Nigeria (Latitude 7^{o} 15`N and Longitude $3^{o}$25`E).

The treatments were replicated three times in a randomized complete block design. The experimental field was ploughed and harrowed with each plot measuring 5 m x 4 m. Two local (oloyin and sokoto white) and two improved (IT845 2246-6 and IT90K 2772-2) varieties of cowpea with determinate (oloyin and IT90K 2772-2) and indeterminate (sokoto + IT84S 2246-6) growth habits were planted as sole crop or intercropped with an early maturing okra variety NHAe-47-4 and a sole crop okra was the nineth treatment.

Planting was carried out in the second week of August in both years. The planting space of 60 cm x 40 cm for both cowpea and okra was used with 2 and 3 seeds per hole respectively in a 5 m x 4 m plot size. Okra was thinned to two seedlings per hole giving a population density of 83,333 plants ha^{-1} for cowpea and okra. Okra was planted two weeks earlier than cowpea as suggested by Muoneke and Asiegbu (1996). The cowpea was planted between okra rows (additive series). The okra plants occupied eight (8) while cowpea occupied seven (7) rows in a

plot. A pre-emergence herbicide: Force Top (a.i. Pendimethalin 50 % EC) was applied at the rate of 2.5 L/ha a day after planting okra. NPK 15:15:15 at 200 kg/ha was applied to okra, three weeks after planting (3 WAP), cyperdi Force (a.i. cypermethrin plus and dimethoate): an insecticide was applied at the rate of 25 ml/20 L water to control insect pests infestation on both okra and cowpea at 4 WAP for okra and at 7 and 9 WAP for both crops. One hoe weeding was done at 5 WAP, after which the cowpea formed sufficient ground cover to control weeds effectively.

Five plants of each crop randomly selected were used for determination of: number of leaves/plant, leaf area (cm^2)/plant, number of flowers/plant, number of pods/plant, pod weight, weight of 100 grains weight (g) and threshing percentage for cowpea. For okra: number of leaves/plant, plant height (cm), Leaf area (cm^2) (Asif and Greig, 1977), number of flowers/plant, number of pods/plant and fruit weight (kg/ha). Leaf area index (LAI) was calculated for the two crops and Land Equivalent Ratio (LER) was used to determine the yield advantage of the mixture.

Data from each season were subjected to Analysis of Variance (ANOVA). Duncan Multiple Range Test at 5% probability was used for treatment mean separation.

Total monthly rainfall was highest in August in 2008 and in September in 2009 (Table 1). The year 2009 gave a higher total annual rainfall (1,706.3 mm) compared to 2008 (1,115.6 mm).

Table 1. Meteorological data of the site during the period of the experiments

Month	Rainfall (mm)		Temperature (^{0}C)		Relative humidity (%)	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**
Jan.	0.0	0.0	27.9	27.4	53.0	70.1
Feb.	0.0	59.1	29.5	28.9	76.4	72.8
Mar.	91.0	67.3	29.4	29.0	75.4	80.5
Apr.	128.8	274.0	29.0	27.7	81.4	82.3
May	74.5	286.8	27.7	27.3	78.1	80.0
June	167.2	258.0	26.4	27.0	85.4	83.5
July	299.2	221.5	26.2	26.2	88.3	88.5
Aug.	106.7	165.0	26.3	26.5	86.6	80.7
Sept.	136.8	180.0	26.1	30.0	86.7	72.0
Oct.	84.5	139.2	28.1	26.7	84.5	74.7
Nov.	0.0	55.7	30.1	27.5	80.9	82.2
Dec.	26.9	0.0	28.3	28.2	75.9	79.1
Total	1,115.6	1,706.3				

Source: Department of Agro meteorological and Water Management, Federal University of Agriculture, Abeokuta.

RESULTS AND DISCUSSION

Growth response of okra to intercropping with cowpea

Number of leaves/plant was significantly reduced by the intercrop (Fawusi,1985 and Omotunde ,1996) while plant height was significantly increased by the intercrop in 2008, though these parameters were not significant in 2009 but followed the same trend as observed in 2008 (Table 2). The increase in the plant height of okra could be attributed to competition for light especially with oloyin and IT84 8-2246-6 varieties. Obasi (1989) and Orkwor *et.al.* (1991) observed that the most important feature of plants that determine their competitive ability for light is height. They concluded that a successful competitor for light is the component that has its foliage at a higher canopy layer.

Intercropping increased leaf area and LAI in oloyin + okra, sokoto + okra and IT90K 2772-2 + okra mixtures in both years though these were not significantly different. Reduction of leaf area and LAI was noticed in okra + IT84S 2246-6 in both parameters. This could be as a result of the aggressive growth habit of this cowpea variety as it climbed all over the okra.

Influence of intercropping with cowpea on yield parameters of okra

Significant differences were observed in the yield parameters such as number of flowers/plant, number of pods/plant and fruit yield in 2008 and 2009 (Table 3). Fruit yield (kg/ha) was not significantly reduced by intercropping in both years except in Okra + IT84S 2246-6. The fruit yield of okra + IT84S 2246-6 was significantly lower ($P < 0.05$) compared to the sole okra. This could be due to the significantly reduced number of flowers/plant and number of pods/plant which could be as a result of aggressive growth habit of the variety as it climbed all over okra especially during the reproductive phase lowering the number of

flowers/plant through abortion. The fruit yield of okra + oloyin with determinate growth habit and okra+ IT84S 2246-6 with indeterminate growth habit did not differ significantly in 2009. Complimentary relation between okra and cowpea variety IT84S 2246-6 might be weak while oloyin and IT90K 2772-2 and Sokoto had complimentary effect on growth and yield of okra due to their growth habit. Muoneke and Asiegbu (1997) and Manga *et. al.*, (2003) had reported reduction in growth and yield of some component crops in mixtures. Sole okra gave the highest fruit yield compared to intercropping because of less inter-specific competition among the crops as observed in the intercrop. This agrees with the report of Omotunde (1996) in okra/cowpea.

Table 2: Effect of intercropped cowpea varieties on growth of okra

Cropping system	Number of leaves/plant		Plant height (cm)		Leaf area/leaf (cm^2)		Leaf area index (LAI)	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Sole Okra	7.0a	7.0a	16.5b	20.7a	223.5a	204.3a	2.5a	2.4a
Oloyin + Okra	6.0b	7.0a	22.8ab	21.4a	211.6a	198.9a	2.8a	2.5a
Sokoto + Okra	6.0b	7.0a	23.6a	20.6a	208.6a	203.9a	2.9a	2.6a
IT84S 2246-6 + Okra	6.0b	6.0a	21.6ab	18.5a	157.7a	129.9a	2.1a	1.8a
IT90K 2772-2 + Okra	6.0b	6.0a	17.6ab	19.3a	202.9a	185.9a	3.0a	2.2a
SE±	0.1	ns	1.1	ns	ns	ns	ns	ns

Means followed by same letter within a column are not significantly different at *P = 0.05*

ns – not significant

Table 3: Effect of cowpea intercrop on yield and yield component of okra

Cropping system	Number of flowers/plant		Number of pods/plant		Fruit yield (kg/ha)	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**
Sole Okra	21.3a	21.1b	20.3a	20.8ab	2778a	3144ab
Oloyin + Okra	21.3a	21.3a	20.0a	20.4b	1752ab	2388b
Sokoto + Okra	21.2a	21.1b	20.3a	20.9ab	1285abc	3497ab
IT84S 2246-6 + Okra	14.3b	15.5c	10.0b	20.6ab	691c	2279b
IT90K 2772-2 + Okra	21.3a	21.4a	20.0a	30.2a	1451abc	3754a
SE±	0.1	0.2	10.0	0.2	299.7	287.6

Means followed by same letter within a column are not significantly different at *P = 0.05*

Effect of intercropping with okra on growth of cowpea

The number of leaves/plant of cowpea varieties in this study were not significantly reduced by intercropping as values obtained in cowpea intercrops were not significantly different from sole crop (Table 4) in 2008 except IT84S 2246-6 + okra and IT90K 2772-2 + okra. The numbers of leaves in the intercrop were higher than sole crops except in IT90K 2772-2 + okra in 2008 and in IT84S 2246-6 + okra in 2009. This could be due to the complimentary effect of fixation by legumes which was translated to vegetative growth. The leaf area in intercrop cowpea varieties were higher though not significantly different compared to their respective sole crops in 2008 and 2009, while LAI was improved by intercropping and was significantly different compared to sole cropping in 2008. In 2009, cropping system did not influence LAI.

Njoku and Muoneke (2008) similarly reported that the leaf area index (LAI) of cassava was highest with the highest cowpea planting density in 2005/2006, but in 2004/2005 cropping season both cropping system and planting density did not influence the LAI of cowpea. Cowpea LAI was similar in the 2 seasons with the highest planting density (80,000 plants/ha) producing the highest LAI. Competition for light could have resulted in the production of higher number of leaves/plant in intercrop and this could have translated to a higher leaf area and LAI.

Table 4: Effect of intercropped cowpea varieties with okra on growth of cowpea

Cropping system	Number of leaves/plant		Leaf area/leaf (cm^2)		Leaf area index (LAI)	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**
Sole Oloyin	20.0ab	12.1bc	64.2bc	85.9bc	2.3c	3.6a
Sole Sokoto	22.3ab	12.1bc	65.3bc	88.2ab	2.6c	3.7ab
Sole IT84S 2246-6	20.7ab	13.6ab	59.4cd	89.3a	2.3c	3.7a
Sole IT90K 2772-2	20.3ab	12.6abc	47.9e	85.1c	1.6c	3.6c
Oloyin + Okra	21.7ab	13.6ab	77.2a	87.8abc	5.7ab	3.7abc
Sokoto + Okra	23.0ab	14.1a	73.6ab	89.9a	6.4a	3.8a
IT84S 2246-6 + Okra	25.3a	11.8c	72.1ab	87.6abc	7.6a	3.7ab
IT90K 2772-2 + Okra	18.7b	12.0bc	50.6de	90.0a	3.9bc	3.8a
SE±	1.0	0.8	2.0	1.7	0.4	1.8

Means followed by same letter within a column are not significantly different at *P = 0.05*

Influence of intercropping with okra on yield parameters of cowpea

Significant differences were observed in cowpea yield parameters except in number of flower/pod, pod yield, grain yield in 2009 and threshing percentage in both years (Table 5). IT84S 2246-6 significantly differed in number of pods/plant in 2008 in the sole and intercrop compared with other varieties. This could be due to the indeterminate growth habit of the variety. The determinate (oloyin and IT90K 2772-2) and indeterminate (sokoto and IT84S 2246-6) varieties of cowpea were not significantly different in the production of flowers as number of flowers/plant were not significant in 2009. In 2008, sole IT84S 2246-6 was significantly different from sole IT90K 2772-2 in number of flowers/plant but not from the intercrop. The weight of 100 grains (g) was affected by the growth pattern (determinate or indeterminate) of the cowpea varieties but differed significantly in the sole and intercrop in 2008. The number of pods/plant and weight of 100 grains (g) differed significantly in both years. The weight of 100 grains (g) had higher significant values in the intercrop in both years compared to the sole crops except in sole IT90K 2772-2 in 2008 and IT84S 2246-6 in 2009. Sole IT84S 2246-6 had the highest value in number of pods/plant in 2008 and oloyin + okra in 2009. This differed significantly from sole sokoto and sole IT90K 2772-2 in 2008. The threshing percentage was not significant in both years.

Land equivalent ratio (LER) in cowpea/okra intercropping system

The LER of the cowpea/okra intercrop is shown on Table 6. Oloyin + okra had the highest value in LER in 2008 while the lowest value was observed in IT84S 2246-6 + okra in both years. Intercropping reduced okra yield and increased yield of cowpea varieties as partial LER for both crops showed that the contribution to the total was more from the cowpea in 2008.

This finding is in agreement with Magdy *et al*. (2007) with the report that partial LER of cowpea was greater than that of okra in okra/cowpea mixtures. In 2009, the partial LER showed that the contribution to the total LER was more form the okra. This could be attributed to high amount of rainfall within the period of the experiment (Table 1) that increased the yield of okra except in the oloyin + okra mixture. The yield advantages demonstrated with okra/cowpea intercrops were ascribable to the soil N economy often associated with inclusion of legume in the mixture (Fatokun *et. al.,* 2002) and ability of the cowpea varieties to establish rapidly to achieve high LAI to smother weeds and modify environmental factors to reduce their adverse effects in crop mixtures.

CONCLUSION

Intercropping favoured higher yield in cowpea compared with sole cropping irrespective of the growth pattern of cowpea. Okra yield was not significantly reduced by intercropping in both years except in okra + IT84S 2246-6 which was as a result of the indeterminate growth pattern of the cowpea variety. The okra crop benefits from the nitrogen fixed by the cowpea. The advantage in growing okra and cowpea in intercrop was in order of oloyin + okra > IT90K 2772-2 + okra > sokoto + okra as yield advantage of 147%, 133% and 92% were obtained through the practice. The findings from the study show that oloyin, IT90K 2772-2 and sokoto can be intercropped with okra; if okra is planted two weeks earlier and IT84S-2246-6 is not recommended to be grown with NHAe-47-4 okra variety.

Table 5: Effect of intercropped cowpea varieties with okra on yield and yield components of cowpea

Cropping system	Number of flowers/ plant		Number of pods/ plant		Pod yield (kg/ha)		Grain yield (kg/ha)		Weight of 100 grains (g)		Threshing %	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Sole Oloyin	23.7ab	16.1a	20.7de	16.0a	292b	288a	185b	182a	16.7b	17.9b	63.0a	63.2a
Sole Sokoto	24.7ab	15.8a	23.3cd	14.2bc	428b	277a	237b	207a	16.4b	18.3b	52.7a	74.7a
Sole IT84S 2246-6	31.3a	16.4a	29.0a	16.0ab	1350a	632a	767a	559a	12.0d	24.4a	56.7a	88.4a
Sole IT90K 2772-2	23.0b	15.4a	24.0cd	12.9c	492b	258a	258b	197a	17.4ab	16.4b	51.3a	76.4a
Oloyin + Okra	23.7ab	17.0a	23.0cde	16.7a	618b	294a	325b	218a	18.1a	21.8ab	52.9a	74.2a
Sokoto + Okra	31.3a	16.8a	22.7cde	14.8abc	633b	283a	308b	213a	14.2c	22.9ab	49.5a	75.3a
IT84S 2246-6 + Okra	24.7ab	15.1a	25.7b	15.2ab	1442a	286a	825a	225a	11.5d	22.9ab	56.9a	78.7a
IT90K 2772-2 + Okra	23.3b	15.7a	24.3bc	14.6abc	608b	280a	387b	232a	18.3a	21.1ab	60.6a	82.9a
SE±	0.3	ns	0.8	0.9	76.2	ns	53.7	ns	0.4	0.5	ns	ns

Means followed by same letter within a column are not significantly different at *P = 0.05*, ns – not significant

Table 6: Land Equivalent Ratio in Cowpea/Okra intercropping system in 2008 and 2009 cropping seasons

	Land Equivalent Ratio					
Cropping system	2008			2009		
	Partial		Total	Partial		Total
	Cowpea	Okra		Cowpea	Okra	
Oloyin + Okra	2.08	0.63	2.71	1.20	0.76	1.96
Sokoto+ Okra	1.30	0.46	1.76	1.03	1.11	2.14
IT84S 2246-6 + Okra	1.08	0.25	1.33	0.41	0.75	1.16
IT90K 2772-2 + Okra	1.50	0.52	2.02	1.18	1.19	2.37
SE±			0.3			0.4

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