Performance of Three Cultivars of Okra (*Abelmoschus esculentus*) as Influenced by Densities of Vegetable Cowpea (*Vigna unguiculata* L. Walp) in Ganye L.G.A., Adamawa State, Nigeria.

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Abstract

Field experiment was conducted during 2021 cropping season at the teaching and research farm of the college to determine the performance of three cultivars of okra as influenced by densities of vegetable cowpea (maimadara). The experiment was laid out in a randomized complete block design (RCBD). There were 13 treatment combinations replicated three times. Treatments include intercrop of three cultivars of okra (Clemson (O1), Lady's finger (O2), and LD 88 (O3), with vegetable cowpea at three planting density (20,000 stands per hectare (C1), 30,000 stands per hectare (C2), 40,000 stands per hectare (C3)) and 30,000 stands per hectare vegetable cowpea (C2) were solely planted as control. Data were collected on growth parameters (Seed germination percentage, plant height/length of vine, number of leaves and leaf breadth at 4, 6 and 8 weeks after planting. Yield data collected includes vegetable cowpea and okra fresh fruits yield. Data were analyzed using analysis of variance (ANOVA) and mean were separated by Duncan multiple range test (DMRT). The result shows that okra and vegetable cowpea intercrop significantly influenced cowpea length of vine, Okra and cowpea leaf breadth, and Cowpea total seed weight. At 8 WAP, okra cultivar (Clemson (O1) recorded the highest leaf breadth (14.1cm) which was significantly higher than the leaf breadth in the other treatments. Okra and vegetable cowpea did not significantly influence okra fresh fruits yield, although cultivar O1 (Clemson) recorded highest yield in the total weight of fruits (61.4g/plant) which were significantly higher than all other varieties. Okra varieties and cowpea interaction significantly influenced cowpea total yield weight. Treatment O2C3 recorded highest seed weight (219.3g/plant) which was significantly higher than those obtained from other treatments. It was concluded that, Clemson okra cultivar was the best in all the parameters measured at 30.000 stands per hectare with the highest fruits yield of 52.0g/plant and is therefore suggested for cultivation to farmers in the study area and the environs.

Key words: Performance, Influence, Okra cultivars, Vegetable, cowpea, Treatment

INTRODUCTION

Vegetables are a critical component in the health of humans. The importance of vegetables and fruits in the human diet has been recognized by the World Health Organization (WHO), which promotes and recommends the consumption of at least 400 g of vegetables and fruits per day to provide the necessary nutrients lacking in other food groups (WHO, 2003). Under consumption of vegetables and fruits is among the top ten risk factors leading to micronutrient malnutrition and is associated with the prevalence of chronic diseases (Ezzati *et al*, 2002; WHO, 2003).

The World Health Organization acknowledges that the global intake of vegetables is less than 20-50% of the recommended amount. In developed countries, the significantly low vegetable intake is due to the consumer's preferences for convenience foods and not the scarcity of the vegetables. In the US more processed vegetables are consumed than fresh vegetables (Rickman *et al.*, 2007).

According to Ajibola *et al.,* 2014), Okra is a vegetable crop that belongs to the genus Abelmoschus, family Malvaceae and has two main species: *Abelmoschus esculentus* (L.) Moench and *Abelmoschuscaillei.* It originates probably from East Africa and today is widely distributed in the tropics, subtropics and warmer portions of the temperate region. The economic importance of okra cannot be overemphasized. Okra contains carbohydrate, proteins and vitamin C in large quantities. The essential and nonessential amino acids that okra contains are comparable to that of soybean. Hence it plays a vital role in human diet. Young immature fruits are usually considered best for consumption.

Okra is the most important fruit vegetable crop and a source of calories (4550kcal/kg) for human consumption. It ranks first before other vegetable crops (Antoinett *et al.,* 2013). It is one of the most commonly grown vegetable crops in the tropics. Okra cultivation and production has been widely practiced because of its importance to the economy development and can be found in almost every market in Africa.

Okra is a warm-season annual herbaceous vegetable crop which can be found in nearly every market in Africa. It is grown primarily for its young immature green fruits and fresh leaves used in salads, soups and stews. The crop, which is generally self-pollinated, belongs to the Malvaceae (mallow) family. It provides an important source of vitamins and minerals, significant levels of carbohydrate, potassium and magnesium. The seeds of okra are reported to contain between 15 and 26% protein and over 14% edible oil content (Oppong-Sekyere *et al.,* 2011).

Okra production constitutes about 4.6 percent of the total staple food production in Nigeria in the year 1970 – 2003 (CBN, 2004). The production of Okra in Nigeria ranged from 630,000 tonnes/hectare to 730,000 tonnes/hectare between 1993-2006 (FAO, 2009). Adejuwon (2012) observed that, Nigeria has two noticeable distinct seasons, and these are the wet (April-October) and the dry (November to March) seasons. The wet season is characterized by longer days and warm humid weather, while the dry season is associated with relatively shorter days, high day and low night temperatures. These changes in weather have been reported to affect the growth pattern and consequently, the productivity of okra. Okra is sensitive to low temperatures and develop poorly below 15 ^{o}c. Okra requires high temperatures of about 70 ^{o}C and long-day length for optimum growth and development. Studies on the optimum weather requirement for high yield okra in the tropics show that okra does best when the minimum and maximum temperatures are 18 ^{o}C and 35 ^{o}C respectively. Temperatures between 25-40 ^{o}C are required for optimum growth and yield of okra, while a critical day length of 12½ hours are required for flower initiation and fruit yield. An improvement in the performance of okra is when rainfall was about 750 mm, evenly distributed and relative humidity was between 90-95 %. However, low temperatures of28.9o-29.2 ^{o}c(maximum) and 17.9-19.8 ^{o}c (min) and short day-lengths of 5.2-5.7 hours resulted in a higher number of flowers.

According to Ano and Ubochi (2008) Vegetable cowpea (*Vigna unguiculata*) is originated from West and Central Africa but widely grown in Latin America and South-East Asia. The

crop is one of the important vegetable crops which are a source of protein in the diet, especially in the derived savanna zone of South- East Nigeria where it is grown for its succulent pods (Ndungu *et al.,* 2005), Opined that African leafy vegetables (ALVs) also referred to as traditional green vegetables play an important role in household nutrition throughout Kenya. They noted that these vegetables are a main source of vitamin A and C and iron which makes them an important food source to people who are nutritionally vulnerable such as HIV/AIDS infected, nursing and pregnant mothers, children and the elderly. African Leafy Vegetables have recently gained importance and are marketed both in the local and the urban markets. Vegetable cowpea is a dual-purpose crop grown for both the green pods and vegetable. The fresh pods are snapped into small pieces and boiled with young shoot to a soft consistency and served with yam and palm oil to produce good dietary balance. Legumes particularly vegetable cowpea is one of the most important sources of protein, carbohydrate and vitamins in the diet of many populations especially in developing countries (Edeh and Gberi, 2012).

Vegetable cowpea, like other edible leguminous crops have the potentials to improving physical, chemical and microbiological properties of the soil and thereby boosting subsequent crop yield. Such crops have been recommended for fertility enhancement, and it has shown to be beneficial to the crop in association. Since intercropping is the dominance cropping system in the country, leguminous crop in intercropping system would serve as a good opportunity to guarantee stainable soil fertility maintenance in view of soil fertility constraints across Nigeria. (Ekpo and Daeyo, 2014).

Intercropping is the growing of two or more crops in proximity to promote interaction between them. Intercropping offers farmers the opportunity to engage nature's principle of diversity on their farms. Spatial arrangements of plants, planting rates, and maturity dates must be considered when planning intercrops. Intercrops can be more productive than growing pure stands. Many different intercrop systems are discussed, including mixed intercropping, strip cropping and traditional intercropping arrangements. Pest management benefits can also be realized from intercropping due to increased diversity. At present, soil amendment in okra production is low and consequently the yield potentials in various improved varieties of okra are not often attained. (Njokuand muoneke., 2008). Therefore, this research was undertaken to examine the optimum cowpea (*maimadara*) density that would enhance growth and yield of okra and minimize weed interference. According to Ijoyah *et al.,* 2009), Unwanted weeds grow throughout the crop life cycle reduces okra fruits yield between 88 and 90 percent compare with those kept weed free throughout the growth period. It has been noted that the critical period of weed competition in okra occurred between 3 and 7 weeks after sowing. Keeping the crop weed free until 3 weeks after planting and there after keeping the plots weed free had no adverse effect on okra plant.

Dahmardeh *et al.,* 2010), reported that whether the crop grown as a sole crop or as an intercrop, the problems of weed interference still persist. Excessive weed growth is one of the most serious factors affecting the performance of crops generally and vegetables in particular. Such effect may be direct or indirect and the degree of competition encountered by an

individual crop depends on the spacing, fertility of the soil, species of weed associated as well as other climatic factors. Substantial evidence has shown that when weed interferes with vegetables like okra, it affects their vegetative and reproductive growth. Cover crop (especially vegetable cowpea), can improve soil fertility and reduces weed problems. It will also provide a source of nitrogen for subsequent crop reduces erosion, reduces run-off and contamination of soil water, utilize soil nitrogen that might otherwise be lost to leaching, improve soil physical properties, suppress nematodes population and reduces cost of weed management (Akintoye *et al*., 2011). The still added that, studies in the developed countries have shown that using cover crops as an alternative in weed management system result in higher yield of crops, since without them; soil deterioration could be most rapid due to high leaching rate of soil nutrient.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Teaching and Research Farm of the Department of Agricultural Technology, Adamawa State College of Agriculture, Ganye, Adamawa State and within the Gunea Savannah Agro-ecological Zone of Nigeria. (Adebayo and Tukur, 2000). The experiment was established during cropping season from second week of July to November 2021.

Experimental Design and Layout

The experiment treatments were replicates of three cultivars of okra (O1= Clemson, O2= Lady's finger, O3= LD 88,) and three different levels of vegetable cowpea (*Vigna unguiculata* L. Walp*)* which is locally known as (*maimadara*) in the study area. Randomized Complete Block Design (RCBD) was used for the experiment for the experiment with 13 treatments combination as shown in Table 1 and replicated three times given a total of 39 plots. The site was measured at 41.5m by 11m covering an area of 456.5m^2 (0,04565ha). The site was divided into plots. Each plot measured 3m by 1.5m and 0.5m gap in between the plots and 1m between the blocks as shown in Table 1:

Table 1: Treatment Combination

S/N0	Treatment notation of okra variety	Description of akidi density/hectare	Description of stand of okra and akidi/plot
1	O1A1	Clemson +20,000	Clemson +9
2	O1A2	Clemson +30,000	Clemson +14
3	O1A3	Clemson +40,000	Clemson +18
4	O2A1	Lady's finger +20,000	Lady's finger +9
5	O2A2	Lady's finger +30,000	Lady's finger +14
6	O2A3	Lady's finger +40,000	Lady's finger +18
7	O3A1	LD 88 +20,000	LD 88 +9
8	O3A2	LD 88 +30,000	LD 88 +14
9	O3A3	LD 88 +40,000	LD 88 +18
10	SOLE O1	Clemson	Clemson
11	SOLE O2	Lady's finger	Lady's finger
12	SOLE O3	LD 88	LD 88
13	SOLE A2	30,000 Stands	14 Stands

Material Used

The material for the research was axe and cutlass for clearing grass, pegs for plot demarcation, and hoe for tilling soil. Others are ranging pole for straightening line and measuring tape for measuring the plots. The planting materials for the research were three cultivars of okra seeds and vegetable cowpea seeds.

Source of experimental seeds

The experimental seed (okra) was purchased from farm field shop Yola, while the cowpea seed was purchased from Ganye main market.

Cultural practices

Following are the practices carried out during the research period.

Land preparation: The experimental plot was cleared and tilled manually into flat and raised beds to provide well drained arable soil for easy penetration of roots and adequate aeration in the soil.

Planting: Planting of both okra and vegetable cowpea seeds was done manually. The different cultivars of okra and Vegetable cowpea at three (3) planting density (A1=20,000 stands, A2=30,000 stands and A3=40,000 stands) which was reduced down to plot size (9 stands, 14 stands and 18 stands). The inter-row spacing between okra plants was 60cm and intra-row spacing between plants to plant were measured as 30cm. On each bed there were 5 rows and 25 stands per plot. Three (3) seeds were planted per hole. The germination percentages of the seeds have been observed from 5 days after planting. While the spacing of vegetable cowpea were measured as 50cm intra-row between plant to plant and 100cm inter-row between plants. It gives a sum total of 3 rows with planting sport. The seed was planted 3-5 per hole.

Weed management; Hoe weeding was done once at three (3) weeks after planting (WAP) in all the treatments. The presence of cover crop also helps in weed management.

Harvesting of okra

Harvesting of fresh fruit okra was done once in five days and the method of harvest was manual. In each of the harvest, data was collected on the weight of the plant fruit, particularly on each of those 4 plants that the first sacraments were collected, and the numbers of fruits on that plant were also noted.

Harvesting of vegetable cowpea

When the large percentage of the pods has change color from green to yellowish, then they were harvested, and the harvest was done manually.

Data collection

Data was collected from different stages of growth and yield parameters as follows:

Plant sampling: Four okra plants was randomly selected from each plot and was tagged for sampling at various stages of growth and development, and in the case of vegetable cowpea, three plants were selected and tagged for the sampling.

Germination parameter: Germination percentage of the seeds was observed from 4-5 days after planting.

Growth and development parameters of okra and vegetable cowpea: The parameter measured were plant girth, plant height, number of leaves per plant and leave breadth.

Yield parameter of okra: Number of fruits per each sampled plant and weight of fresh fruit yield per plot was considered.

Yield parameter of cowpea: The following data collection was considered during harvest of vegetable cowpea:

i. Weight of the whole plant with the roots.
ii. Weight of the below ground biomass
iii. Weight of the above ground biomass (i.e. the plant with the pods without roots).
iv. Weight of the pods per plot.
v. Weight of the whole seeds per plot.
vi. Weight of 100 seeds per plot.

Data analysis

Data collected was subjected to ANOVA and Mean (X) was separated using DMRT at 5% with the aid of SAS.

Results and Discussion

Effect of okra variety and cowpea density on germination percentage of okra and vegetable cowpea

The effect of okra variety and cowpea density on germination percentage of okra and vegetable cowpea (*maimadara*) is presented on Table 2. There was no significant interaction of okra variety and cowpea density on okra and vegetable cowpea seed germination. However, most of the sole and the intercropped planted varieties attend maximum germination percentage in okra and 100 percent in cowpea. That could be as a result of the well-prepared beds and availability of moisture at the planting time. This result agrees with Doijode (2001), who reported that germination and initial growth of okra improves greatly by cultural practices that lower soil temperature, e.g., mulching and watering before the hottest part of the day. The similar percentage of germination may be as a result of the bed preparation and availability of moisture during planting time in all the plots.

Table 2: Effect of okra varieties and cowpea density on germination percentage (%) of okra and cowpea.

Varieties	Okra	Cowpea
O1	91.1a	100.0 a
O2	93.3a	100.0 a
O3	91.1a	100.0 a
Cowpea density		
C1	91.2a	100.0 a
C2	92.8a	100.0 a
C3	90.7a	100.0 a
Varieties X cowpea density	NS	NS

Source: Field Data (2021).

Mean with the same letter (s) in the same column are not significant difference at 5% using DMRT.O1 (Clemson), O2 (Lady's finger), O3 (LD-88), 20,000 st/ha (C1), 30,000 st/ha (C2), 40,000 st/ha (C3). NS (Not significant).

Effect of okra varieties and cowpea density on height, number of leaves, leaf breadth, and total weight of fruit of okra at 4-8 WAP

The effect of okra varieties and cowpea density on plant height (cm) of okra is presented on Table 3 below. There was no significant difference among okra varieties and cowpea density. At 4and 6 WAP Clemson (O1) recorded the highest height (7.6cm, 10.6cm), while C2 gives the highest in both week 4and 6 (7.0cm, 9.9cm). Variation in okra plant height may be as a result of different cultivars planted.

There was no significant interaction of okra variety and cowpea density on number of leaves of okra. At 4 WAP, variety O1 recorded the highest number of leaves (5.4), followed by O3 (5.0). The least was recorded in O2 and O4 (4.9). O1 recorded the highest (6.8) at 6WAP while O3 has the least. At 8 WAP, O2 has the highest (7.8) numbers of leaves and the least (7.5) was in O1 and O3. Number of leaves under cowpea density at 4WAP was higher in C1 and C2 (5.1) with C3 as the least (5.0). C3 was the highest at 6 and 8 WAP (6.7 and 8.0 respectively). These could be as a result of different cultivars used.

The effect of okra variety and cowpea density on leaf breadth of okra variety significantly affects the leave breadth of okra. At 8 WAP, leave breadth of O1 was significantly higher (13.1cm) than other varieties. Cowpea density did not significantly influence leave breadth of okra. This report agrees with Antoinette et al, (2013). Who stated that changes in leaf breadth could be as a result of climatic differences especially due to the amount of rainfall received? They received same rainfall; effective utilization of rain by better ones.

There was no significant interaction of okra varieties and cowpea density on weight of fruits of okra for sample plants. Cultivar O1 was observed to have the highest weight of fruits (61.4g/sample plant) and the least was from O2 (30.4g/sample plant) Okra weight of fruits under cowpea density C2 has recorded the highest fruits (52.0g/sample plant) while C3 has the least (41.4g/sample plant). The differences in weight of fruits could be best on the cultivar. The result agrees with the findings of katung (2007) who reported that fruits harvested from Clemson and spineless cultivar of okra was found to have the longest and heaviest fruits than other varieties.

Effect of okra varieties and cowpea density on length of vine, number of leaves, leaf breath and total seed weight of cowpea at 4-8 WAP

Table 4 presented the effect of okra variety and cowpea density on the length of vine of cowpea. Variety did not significantly influence the length of vine of cowpea except at 6 WAP. Cowpea recorded the highest vine (12.3cm/sample plant) in O1 plot which was significantly longer than vine length in O2 and O3 plots. Cowpea density did not significantly affected length of vine of cowpea except at 6WAP.This could be due to complementary effect of fixation by legume which was translated to vegetative growth as the population density in C3 is higher than C1 and C2.

The effect of okra variety and cowpea density on number of leaves of cowpea is still presented in table 4. Okra variety and cowpea density did not significantly influence the number of leaves of cowpea except at 6WAP.That could be due to complementary effect of fixation by legume which was translated to vegetative growth as the population density in C3 is higher than C1 and C2.

Table 4 revealed theeffect of okra variety and cowpea density on the leave breadth of cowpea. Variety did not significantly influence the leave breadth of cowpea except at 4WAP. Cowpea recorded the leave breadth (5.6cm) in O1 and O3 plots, which is significantly wider than O2

plot. Cowpea density did not significantly affect the leave breadth of cowpea.This result disagrees with Ijoyah*et-al.*2012). Who reported that a reduction in leaf breadth of intercropped cowpea (*maimadara*) as compared to sole crop as many of the treatments in the intercrop are higher than the sole cowpea (C2). This may be as a result of unfavorable condition of soil such as unavailable nutrients, unbalanced pH or planting spacing.

It also revealed the effect of okra variety and cowpea density on total yield weight of cowpea. Okra variety significantly affects the total seed weight per plot. The total seed weight of O2 (174.0g) was significantly higher than O3 and O1. Cowpea density also significantly influence total seed weight of cowpea.The highest total seed weight obtained from 40,000 St/ ha of cowpea could be as a result of the high population density of the crop. The result is in line with the findings of Njoku and uoneke (2008) who reported that enhancement of cowpea yield goes along with the increase density at 20,000, 30,000 stands per hectare.

Table 3: Effect of okra varieties and cowpea density on height, number of leaves, leaf breadth, and total weight of fruit of okra at 4-8 WAP

Treatment	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP	
	Height	Height	Height	Number of Leaves	Number of Leaves	Number of Leaves	Leaf Breadth	Leaf Breadth	Leaf Breadth	Total Weight Fruits
Varieties										
O1	7.6a	10.6a	13.8a	5.4a	6.8a	7.6a	4.5a	9.3a	13.1a	61.4a
O2	6.2a	8.4a	11.6a	4.9a	6.6a	7.8a	4.0a	7.5a	11.5ab	30.4a
O3	6.4a	9.2a	12.1a	5.0a	6.4a	7.6a	4.0a	7.1a	10.9b	49.0a
Cowpea density										
C1	6.8a	9.4a	10.3a	5.1a	6.3a	7.4a	4.2a	8.7a	12.6a	47.5a
C2	7.0a	9.9a	11.1a	5.1a	6.6a	7.7a	4.5a	8.2a	11.7a	52.0a
C3	6.7a	9.7a	11.4a	5.0a	6.7a	8.0a	3.9a	7.8a	11.1a	41.4a
Varieties x cowpea density	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

Source: Field Data, 2021: Mean with the same letter (s) in the same column are not significant difference at 5% using DMRT.NS = (Not significant), * = Significant

Table 4: Effect of okra varieties and cowpea density on length of vine, number of leaves, leaf breath and total seed weight of cowpea at 4-8 WAP

Treatment	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP	
	Length of vine	Length of vine	Length of vine	Number of Leaves	Number of Leaves	Number of Leaves	Leaf Breadth	Leaf Breadth	Leaf Breadth	Total Seed Weight
Varieties of okra										
O1	8.1 a	12.3a	119.6a	5.9 a	8.4 a	116.6 a	3.9ab	4.6 a	5.6 a	159.1 ab
O2	7.6 a	9.2b	112.3a	5.7 a	8.5 a	107.9 a	3.6ab	4.2 a	5.1 a	174.0 a
O3	7.6 a	9.8ab	119.3a	5.6 a	8.3 a	112.7 a	3.3 b	4.3 a	5.6 a	136.6 ab
Cowpea density										
C1	8.0a	10.5a	113.6a	5.8 a	8.5ab	107.6 a	3.6 a	4.3 a	5.4 a	138.9ab
C2	7.5 a	10.3a	112.1a	5.8 a	8.8 a	118.2 a	3.7 a	4.5 a	5.7 a	154.1b
C3	8.0 a	9.7a	120.7a	5.6 a	7.7 b	114.0 a	3.6 a	4.3 a	5.4 a	178.3a
Varieties x cowpea density	NS	*	NS	NS	NS	NS	*	NS	NS	*

Source: Field Data, 2021: Mean with the same letter (s) in the same column are not significant difference at 5% using DMRT.NS = Not significant, * = Significant

CONCLUSION

Okra and vegetable cowpea intercrop significantly influenced okra and cowpea length of vine, Okra leaf breadth and Cowpea total seed weight. Okra cultivar O1 (Clemson) was observed to be the best cultivar as it recorded highest in most of the growth (leaf breadth 14.1cm) and yield parameters (fruits weight 61.4g) measured, while vegetable cowpea (maimadara) was also observed to play vital role as cowpea 30,000 stands/hectare (C2) resulted in the highest okra yield (52.0g/plant). This system of intercropping improves soil status, provides sustainable protein in food crops and provides more income and is therefore suggested to farmers especially in the study area and the environs.

RECOMMENDATION

The following recommendations were made:

1. Farms should adopt the intercropping mostly the vegetable cowpea (maimadara) at 30,000 stands /hectare (A2) for high yield of okra.
2. Okra cultivar (Clemson) is recommended for farmers in the study area.

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