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INFLUENCE OF VEGETABLE-COWPEA (*Vignaunquiculata* SUB SPECIES SESQUIPEDALIS) ON WEED BIOMASS AND SOIL N_2FERTILITY STATUSIN CASSAVA INTERCROP

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ABSTRACT

Soil fertility decline, weed infestation and incompatible cassava-intercrop also possess challenges to cassava production among small holders' farmers in Nigeria. Consequently, field experiments were carried out in 2023 and 2024 planting seasons to investigate the influence of vegetable-cowpea for sustainable productivity of cassava in the intercrop at Agricultural Research Farm, College of Education, AfahaNsit, AkwaIbom State. Nine treatments were laid-out in Randomized Complete Block Design (R.C.B.D.) with three replicates. The treatments were seven different population densities of vegetable-cowpea namely 62,500, 55,500, 41,666, 40,000, 33,333, 27,777 and 20,000. Other treatments were cassava planted sole (weeded thrice and weedy). Analysis of variance was carried out on data obtained on weed parameters, cassava agronomic characters, cassava tuberous root yield and yield of vegetable-cowpea. Means were separated using Duncan Multiple Range Test at 5% probability level. A partial budget analysis was conducted to determine the level of profitability in cassava-vegetable production enterprise. The result indicated that the weed biomass was significantly decreased with increased in the population density of vegetable cowpea (20,000-55,555). The result also showed that vegetable-cowpea enhanced total soil nitrogen status depending on the population density in this order 62,500 > 55,555 > 41,666 > 40,000 > 33,333 > 27,777 > 20,000. The weedy treatment plot reduced cassava tuberous root yield by 89.0% compared to the treatment plots of cassava inter-cropped with vegetable-cowpea population density (55,555). It was also found to produce a loss of 78 kobo for every one naira invested in the production business. The optimum cassava-vegetable cowpea (55,555) integrated with primextra (1.5kg ai/ha) gave the most satisfactory weed suppression resulting in the least weed biomass and produced the highest average cassava tuberous root yield (20.53t/ha) with advantage of 15% over the yield of cassava planted sole and weeded thrice. The same treatment also produced the highest monetary net benefit (₦641,730) and the highest marginal rate of returns (1.85). It is therefore recommended.
Keywords: Cassava, vegetable-cowpea, primextra, intercrop and net benefit.

INTRODUCTION

Cassava (*Manihotesculenta*Crantz) is apparently a crop of necessity during famine when other crops have failed due to its tolerance to soil fertility decline and weather fluctuations. The crop is the fastest expanding staple food in cassava consuming countries and most often the crop is grown on marginal lands not competitive for other crops (Ikuenonisan, Mafinisehi, Ajibefun and Adenegan, 2020). Furthermore, cassava has continued to gain prominence among farmers and is fitted into the farming system of the small holder farmers in the tropics (FAO, 2018). It is a widely acceptable energy dietary intake in diverse forms to over 600 million consumers across the globe (FAO, 2015); while the industrial demand is also rising consistently (FAOSTAT, 2019). The crop also maintains a choice crop for rural development, poverty alleviation, economic growth and ultimately food security (Eke-Okoro and Njoku, 2012).

However, demand for cassava within Nigeria is high with supply struggling to meet local demand for food and industries. Cassava production is facing a lot of challenges in Nigeria, which include soil fertility decline due to shortening of fallow period (Njoku and Muoneke, 2008), small farm size, cost of inputs, weed infestation and scarcity of labour (Ekpo and Udosen, 2011); mechanization suffers due to land fragmentation (Abass, LowilMukaka, Okechukwu, and Kanju, 2014).

Despite these challenges, Nigeria is still the largest producer of cassava in the world but the trend in yield performance remains low (3.2 tonnes/ha per farmer) (FAOSTAT, 2019). This is attributed to inefficient management of production resources (Mgbenka, Mbah and Ezeano, 2016). In addition, incompatible mixtures in cassava intercrop might adversely lead to the low potential yield of the crop.

Intercropping of cereal crops with cover-crop legume is gradually gaining popularity among few resource poor farmers in Northern Nigeria. Research reports have shown that cassava-vegetable cowpea intercrop is scarce especially in Southern Nigeria (Mbah, 2018); despite the fact that the cowpea improves healthy diet (Sable, Saravaiya and Sharma, 2020). It also provides animal feed and forage (Saravaiya, Pandya, Chaudari, patel and Kumar, 2014). The crop also enhances soil fertility and overall crop productivity (Mbah, 2018). Moreover, legumes generally have the potential to improving physical, chemical and microbiological properties of the soil thereby enhancing subsequent crop yield (Akpan and Ufot, 2020). In addition, legume cover crops present very good opportunity in sustainable and timely maintenance of weed suppression, increasing soil organic matter and reduction in water runoff and erosion (Etim, Asuquo and Ekpo, 2023).

At present, scanty research reports on cassava-vegetable cowpea intercrop are available in humid rainforest zone of Nigeria. Therefore, this research was undertaken to investigate the productivity of cassava-vegetable cowpea intercropping system.

MATERIALS AND METHOD

Study Area

The study was conducted in the Research Farm of College of Education, AfahaNsit. The area is 30km from Uyo, the capital city of AkwaIbom State. The state falls within latitude 04°32' and 05°33'S and longitude 07°21' and 08°25'E. The mean annual rainfall for Uyo was 2,816mm and 3,654mm in the coastal areas of Eket Local Government Area.

Layout and Experimental Design

The nine treatments were:

40 x 40 cm (spacing)	62,500 (plant population)
50 x 50 cm (spacing)	40,000 (plant population)
60 x 60 cm (spacing)	27,777 (plant population)
60 x 30 cm (spacing)	55,555 (plant population)
60 x 40 cm (spacing)	41,666 (plant population)
60 x 50 cm (spacing)	33,333(plant population)
1m x 1m (Two/hole)	20,000 (plant population)
Cassava (Sole) (Weeded 3x)	-
Cassava (Sole) (Weedy)	-

The nine treatments were laid out in a Randomized Complete Block Design (RCBD) with three replicates. Each plot measured 6 x 8m and spaced 2m apart. The gross land area was 2,112m^2.

Land Preparation

The farm area was cleared, biomass removed, stumping carried out, soil tilled and levelled manually.

Soil Analyses
Composite soil samples were analysed before planting.

Herbicide Application
A low level of Primextra (1.5 kg ai/ha) was sprayed across the area planted with cassava-cowpea intercrop after pre-field testing with Primextra at (1.0kg, 1.50kg and 2.0kg). Both crops were safe with 1.5kg. This dose did not affect the germination and growth of vegetable-cowpea.

Planting and Cultural Operations
The cassava variety (NR 8083) was used and the cuttings planted 1m x 1m. Two seeds of vegetable-cowpea were sown, thinned to one and spaced 40 x 40cm, 60 x 30 cm, 60 x 40cm, 50 x 50cm, 60 x 50cm, 60 x 60cm. However, 100cm x 100cm spacing were three seeds/hole and later thinned to two/hole as practice by the local farmers (personal interview, 2024). All the plots of cassava-vegetable cowpea intercrop were not weeded while sole cassava plots were weeded three times. The weedy treatment plots remained entirely unweeded throughout the study.

Collection of Weed Data
Percentage ground cover of vegetable-cowpea, weed density, weed morphological groups and weed biomass were carried out and recorded at 4, 8 and 12 weeks after planting (WAP); using a quadrat (1 x 1m). Weed biomass was determined by oven drying the weeds to a constant weight at 70°C and expressed in kg/ha.

Collection of Data on Vegetable-Cowpea
Seed yield was collected and weighed according to treatment at 4 months after planting.

Collection of Data on Cassava Growth Parameters
The parameters investigated and recorded were cassava plant height, number of leaves/plants, leaf area index and finally, the root-tuber yield.

Post-Harvest Soil Analysis
This was carried out to determine the total nitrogen status after harvesting the cassava crop.

Data Analyses: Data on weeds and cassava growth parameters, root-tuber of cassava and vegetable-cowpea dried seeds were analysed using analysis of variance (ANOVA). The treatment means were separated using Duncan’s Multiple Range Test at 5% level of probability.

Economic Analyses: Crop Partial Enterprise budget was determined for each treatment. The gross field benefits (₦/ha) were calculated on the prevalent price of cassava root-tuber and vegetable-cowpea seeds. Gross field benefit (₦/ha) was calculated based on the price of cassava tuberous root and dried vegetable-cowpea seeds. Marginal rate of return (MRR) was calculated as the change in the ratio of net benefit obtained to the total variable cost (TVC). No charge was included for land management and interest on operational capital, hence it is called Partial Budget.

RESULTS

General Properties of the Soil
The pre-cropping physico-chemical properties of the soil at the experimental site are presented in Table 1. The results indicated that the soil was high in organic matter content (52.9g kg^{-1}). Exchangeable cations ranged from 0.08 cmol kg^{-1} for Na to 0.9 cmol kg^{-1} for (Mg). The lowest extractible micro nutrient was copper (Cu) (0.9 mg kg^{-1}) while the highest was (Mn) 179.5 kg^{-1}.

The nutrient level of the soil indicated that the soil was fairly fertile and could support the growth and development of cassava.

Table 1.0: Pre-planting soil physical and chemical properties of the experimental site.

Soil Properties	Values
pH 1:1 (H_2^0)	5:5
Organic Carbon (g kg^{-1})	26.5
Soil organic matter (g kg^{-1})	52.9
Total N (g kg^{-1})	0.12
P (mg kg^{-1})	39.62
Exchangeable Cations (Cmol kg^{-1})	
Ca	0.16
Mg	0.9
Na	0.08
K	0.4
Extractible Micro Nutrient (Mg kg^{-1})	
Mn	179.5
Fe	20.9
Cu	0.9
Zn	17.8
Particle Size (g kg^{-1})	
Sand	615
Silt	322
Clay	63

Table 2.0: Effects of Cassava-Vegetable Cowpea Intercrop on percentage ground cover (m^{-2}).

Plant	Planting Season 2023			Planting Season 2024		
Density	4 WAP	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP
62,500	38.8^{a}	86.2^{a}	60.8^{a}	37.4^{a}	84.2^{a}	70.1^{a}
55,555	36.2^{ab}	82.4^{ab}	60.0^{ab}	35.9^{ab}	82.3^{ab}	68.7^{ab}
41,666	33.7^{b}	79.8^{b}	58.7^{b}	33.3^{b}	79.8^{b}	66.8^{b}
40,000	32.9^{b}	77.9^{b}	58.5^{b}	33.8^{b}	78.9^{b}	65.9^{b}
33,333	26.0^{c}	73.7^{c}	53.6^{c}	24.9^{c}	72.7^{c}	53.2^{c}
27,777	24.4^{cd}	71.8^{cd}	45.2^{d}	22.5^{cd}	70.2^{cd}	50.8^{cd}
20,000	21.9^{d}	67.8^{d}	38.3^{e}	19.1^{d}	67.8^{d}	47.7^{d}

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level. The mean percentage ground cover of vegetable cowpea/m^2 in cassava-cowpea intercropping is presented in Table 2. The mean percentage ground cover increased significantly with increase in the cowpea density in both cropping seasons (2023 and 2024). However, the percentage ground cover declined at 12 WAP due to senescence. The highest percentage ground cover was recorded with the vegetable-cowpea density of 62,500 while the least was obtained from the density of 20,000.

The effects of vegetable-Cowpea on average weed density (m^{-2}) and average weed biomass (kg^{-ha}) in cassava-vegetable cowpea intercrop in 2023 and 2024 planting seasons are presented in Table 3.0.

The results showed that the weed density decreased significantly with increase in the vegetable-cowpea density up to the density of 55,555. Similarly, the weed biomass followed the same trend in both years of planting seasons. The weedy and weeded treatment plots produced the highest significant values at 4WAP. However, at 8 WAP the highest values were obtained from weedy treatment plot followed by the weeded treatment plot.

Table 3.0: Effects of Vegetable-Cowpea on average weed density (m^{-2}) and weed biomass (kg^{-ha}) in cassava-vegetable cowpea intercrop in 2023 and 2024 planting seasons.

Vegetable-Cowpea Density	Weed Density (M^{-2}) Weeks after Planting			Weed Biomass (Kg^{-ha}) Weeks after Planting		
	4 WAP	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP
62,500	42.83^{f}	20.51^{f}	27.83^{f}	111.70^{e}	38.71^{f}	50.00^{f}
55,555	43.21^{f}	21.00^{f}	30.40^{ef}	113.40^{e}	39.80^{f}	50.10^{f}
41,666	47.00^{e}	25.10^{ef}	38.18^{e}	117.30^{d}	51.62^{e}	58.01^{ef}
40,000	49.97^{de}	27.60^{e}	35.22^{de}	117.91^{d}	52.20^{e}	60.42^{e}
33,333	53.24^{d}	35.51^{d}	38.72^{d}	153.38^{bc}	54.50^{e}	72.33^{d}
27,777	60.91^{c}	31.32^{de}	43.57^{c}	156.61^{c}	73.43^{d}	84.81^{c}
20,000	65.32^{b}	50.60^{c}	68.10^{b}	158.00^{b}	92.71^{c}	175.60^{b}
Hoe-Weeded (3x)	86.91^{a}	65.25^{b}	43.81^{c}	224.10^{a}	102.33^{b}	177.10^{b}
Weedy	88.10^{a}	105.60^{a}	217.53^{a}	223.90^{a}	266.50^{a}	710.11^{a}

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

Table 4.0: Effects of Cassava-Cowpea intercrop on weed morphological group (%).

Vegetable-Cowpea Density	Planting Season 2023 Weed Morphological Group (%)			Planting Season 2024 Weed Morphological Group (%)		
	Broad Leaves	Grasses	Sedges	Broad Leaves	Grasses	Sedges
62,500	88.0^{a}	5.7^{g}	6.3^{c}	85.0^{f}	5.8^{f}	9.2^{c}
41,666	83.2^{b}	9.0^{e}	7.8^{bc}	79.9^{b}	11.0^{e}	9.1^{c}
40,000	82.3^{b}	9.6^{e}	8.1^{b}	78.5^{b}	11.2^{e}	10.3^{b}
33,333	77.2^{c}	11.0^{de}	10.8^{a}	74.7^{bc}	15.0^{d}	10.3^{b}
27,777	75.1^{cd}	14.4^{d}	10.5^{a}	72.8^{c}	17.8^{cd}	9.4^{c}
20,000	72.8^{d}	18.3^{c}	8.9^{ab}	68.4^{d}	20.3^{c}	11.3^{a}
Hoe-Weeded (3x)	66.9^{e}	28.3^{b}	4.8^{d}	66.9^{e}	29.7^{a}	3.4^{d}
Weedy	61.8^{f}	32.7^{a}	5.5^{cd}	70.5^{cd}	25.7^{b}	3.8^{d}

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

The weed morphological group percentage is presented in Table 4.0. The results showed that the higher the cowpea density, the higher the values obtained on number of broadleaves/m^2 in both planting seasons. Similarly, the higher the density of vegetable-cowpea and the broadleaf weeds the lesser the grass-weeds population while the least values of sedges were obtained from weeded and weedy treatment plots in both planting seasons.

Table 5.0: Effects of Vegetable-Cowpea densities on Cassava Plant height in 2023 and 2024 planting seasons

Vegetable-cowpea density	Weeks After Planting (WAP)			Months After Planting (MAP)
	4	8	12	12
62,500	13.32^{a}	62.01^{a}	169.31^{a}	180.41^{a}
55,555	13.29^{a}	62.89^{a}	170.22^{a}	179.98^{a}
41,666	13.10^{a}	61.75^{a}	169.90^{a}	180.00^{a}
40,000	12.98^{a}	61.88^{a}	167.92^{a}	179.77^{a}
33,000	12.96^{a}	61.92	163.21^{bc}	177.88^{ab}
27,777	13.11^{a}	62.47^{a}	165.14^{b}	175.22^{b}
20,000	13.00^{a}	62.45^{a}	161.03^{c}	171.91^{c}
Hoe Weeded	13.45^{a}	62.53^{a}	170.00^{a}	180.62^{a}
Weedy	13.43^{a}	60.91	158.92^{d}	166.87^{d}
	NS	NS		

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

Cassava Plant height was not found to be significantly different at 4 and 8 WAP. Moreover, the treatment plots ranging from 62,500 – 40,000 densities produced non-significant values to each other. However, the values obtained at 12 WAP and 12 MAP showed significant differences with the least average obtained from weedy treatment plots followed by the average values obtained from the plot with 20,000 density of vegetable-cowpea in both 2023 and 2024 planting seasons.

Table 6.0: Effects of Vegetable-Cowpea Density on Average Number of Leaves/Cassava Plant and Leaf Area Index in Inter-cropping System (2023 and 2024 Cropping)

Vegetable-Cowpea Density	Average Number of Leaves/Plant Weeks After Planting (WAP)			Average Number of Leaves/Plant Months After Planting (MAP)			
	4	8	10	2	3	4	5
62,500	7.21^{a}	25.10^{a}	37.21^{a}	0.53^{a}	0.81^{a}	1.61^{a}	2.65^{a}
55,555	7.09^{a}	25.07^{a}	37.03^{a}	0.50^{a}	0.80^{a}	1.60^{a}	2.63^{a}
41,666	7.88^{a}	24.97^{a}	36.78^{a}	0.53^{a}	0.79^{a}	1.55^{b}	2.49^{b}
40,000	8.00^{a}	24.87^{a}	36.96^{a}	0.51^{a}	0.78^{a}	1.54^{b}	2.49^{b}
33,333	7.98^{a}	24.96^{a}	36.92^{a}	0.49^{a}	0.78^{a}	1.45^{c}	2.40^{c}
27,777	7.89^{a}	24.50^{a}	36.87^{a}	0.48^{a}	0.78^{a}	1.39^{d}	2.40^{c}
20,000	8.00^{a}	24.98^{a}	35.75^{ab}	0.49^{a}	0.87^{a}	1.35^{cde}	2.00^{cd}
Sole Cassava (Hoe Weeded)	8.01^{a}	24.96^{a}	36.00^{b}	0.49^{a}	0.79^{a}	1.31^{e}	2.89^{d}
Weedy	8.00^{a}	23.88^{a}	30.34^{c}	0.48^{a}	0.68^{b}	0.95^{f}	1.30^{e}

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

The average number of cassava leaves/plant was found to be non-significantly different at 4 and 8 WAP in both 2023 and 2024 planting seasons (Table 6). However at 10 WAP the significantly least average number of leaves/plant was obtained from weedy treatment plots. This was followed by the average value (30.34) from the sole cassava plots in both planting seasons.

The average cassava leaf area index was found to be non-significant at 2 and 3 months except the value (0.68) obtained from weedy treatment plots. However, at 4 and 5 MAP, the leaf area indices were significantly different among the treatments in both years except the values obtained from the treatment plots of vegetable-cowpea with population densities of 62,500 and 55,555.

Table 7.0: Effects of Vegetable-Cowpea Density on Cassava Tuberous Root Yield (t/ha) in 2023 and 2024 Planting Seasons and the Average Vegetable-Cowpea (kg/ha) Yield in both planting seasons.

Vegetable-Cowpea Density	**Fresh Cassava Tuberous Root Yield (t/ha) Planting Seasons**		**Average Vegetable-Cowpea Dried Seeds Yield (kg/ha)**
	2023	**2024**	
62,500	20.41^{b}	20.43^{b}	390.92^{b}
55,555	20.56^{a}	20.50^{a}	392.11^{a}
41,666	20.40^{b}	20.44^{b}	372.00^{c}
40,000	20.05^{c}	20.15^{c}	371.87^{c}
33,333	17.39^{d}	19.44^{d}	190.88^{d}
27,777	17.40^{d}	19.42^{d}	190.45^{d}
20,000	16.79^{e}	19.25^{e}	186.00^{e}
Sole Cassava (Hand Weeded)	16.01^{f}	18.98^{f}	-
Sole Cassava (Weedy)	1.98^{g}	2.51^{g}	-

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

The significantly highest value (20.56 t/ha) of fresh cassava tuberous root yield (t/ha) was obtained from the treatment plot of vegetable-cowpea (55,555 density/ha) in 2023 planting season. The same treatment produced also the highest yield (20.50 t/ha) in 2024. The yield obtained from the treatment plot of 20,000 vegetable-cowpea population density was significantly lower than the yields obtained from the treatment plots of vegetable-cowpea density ranging from 40,000 - 62,500 in both planting seasons. The significantly lowest yield (1.98 t/ha) was obtained from the cassava weedy plots in 2023 planting season followed by the yield 16.01 and 18.98 t/ha obtained from sole cassava treatment plots in 2023 and 2024 planting seasons respectively.

The average highest dried seeds (392.11 kg/ha) of vegetable-cowpea was obtained from the treatment plots of vegetable-cowpea with the density of 55,555. This was followed by 390.92 kg/ha produced by vegetable-cowpea with the density of 62,500. The values (371.87 and 372.00 kg/ha) obtained from the treatment plots of 40,000 and 41,666 did not differ significantly from each other. The lowest value (276.00 kg/ha) was obtained from the treatment plot of 20,000 population density of vegetable-cowpea followed by 290.88 and 290.45 kg/ha obtained from the treatment plots of 33,333 and 27,777 respectively.

Table 8.0: Post Harvest Nitrogen (N) status of the experimental site.

Vegetable Cowpea-Density	Total Nitrogen (N) (g kg^{-1})
62,500	0.19^{a}
55,555	0.16^{b}
41,666	0.14^{c}
40,000	0.13^{cd}
33,333	0.12^{d}
27,777	0.10^{e}
20,000	0.07^{f}
Sole Cassava (Hoe-Weeded)	0.02^{h}
Sole Cassava (Weedy)	0.03^{g}

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

The total Nitrogen status at pre-planting was 0.12 indicating that it was inadequate in terms of fertility status. The post-harvest investigation showed that the total Nitrogen was found to increase with increase in vegetable-cowpea population density ranging from 62,500-41,666. The density of vegetable-cowpea 41,666 and 40,000 generated values on Nitrogen status (0.14 and 0.13) respectively that were comparable to each other while the least population density (20,000) produced valued 0.07 that was found to be significantly different from the values produced by the vegetable-cowpea density of 27,777. The cassava treatment plots planted soled produced the least total Nitrogen values that were found to be significantly different from the treatment plots of cassava-vegetable cowpea intercrop.

The production of cassava and vegetable-cowpea in an intercrop system showed that the enterprise significantly increased net benefit than the value obtained from sole cassava cropping (Table 9.0). The highest net benefit (₦641,730.00) was obtained from the treatment plot of 55,555 density of vegetable-cowpea in cassava intercropping system followed by (₦634,870.00) obtained from the treatment plot of 65,200 density of vegetable-cowpea in a mixed cropping system with Cassava. The net benefit (₦184,500) obtained from sole cassava production was significantly lower than the values obtained from the intercrops.

The Weedy plot produced a great loss of ₦388,000 indicating that in every one naira invested in the enterprise a loss of 78 kobo was recorded.

Table 9.0: Partial Budget Analysis/ha for cassava production with vegetable-cowpea intercrop on average of two planting seasons (2023 and 2024).

Vegetable-Cowpea Density	Average Vegetable-Cowpea yield (kg/ha)	Average Cassava Tuberous root weight (t/ha)	Average total variable cost/ha (₦'000) Cassava and Vegetable-Cowpea	Average gross returns (₦'000) Cassava (kg = ₦50)	Average gross returns (₦'000) Vegetable-Cowpea (kg = ₦400)	Average gross returns Cassava and Vegetable-Cowpea (₦'000)	Net Benefit (₦'000)	Average Marginal rate of Returns (MRR)
62,500	390.921	20.42	542.55	1021.00	156.37	1177.37	634.82	1.17
55,555	392.11	20.53	541.62	1026.50	156.85	1183.35	641.73	1.85
41,666	372.00	20.21	541.50	1110.50	148.80	1159.30	617.80	1.14
40,000	371.87	20.10	541.48	1111.50	148.75	1153.75	612.27	1.13
33,333	290.88	18.42	541.30	921.00	116.35	1037.35	496.05	0.92
27,777	290.45	18.41	541.28	920.50	116.18	1036.68	495.40	0.92
20,000	276.00	18.02	541.25	901.00	110.40	1011.40	470.15	0.87
Sole Cassava (Weeded 3x)	-	17.50	690.50	875.00	-	-	184.50	0.27
Sole Cassava Weedy	-	2.25	500.50	112.50	-	-	-388	-0.78

DISCUSSION

The alternative biological and economical approach for weed suppression in any cropping system is the use of edible but efficient cover crops as suitable and profit-oriented compared to manual approach (Lawal*et al*, 2019). In this study, vegetable-cowpea an efficient cover crop with a population density (62,500) was found to produce the highest mean percentage ground cover (Table 2) and this characteristic enabled this population density to generate the least weed density and biomass (Table 3). The efficient coverage of the soil deprived the weed seeds the adequate sunlight and moisture for germination; hence the more the population density of the cover-crop the better the weed suppression ability due to lesser weed density. Similar finding was reported by Ekpo and Udom (2010) incassava-egusi intercrop.

The weed biomass followed the trend of the weed density (Table 2.0). The weedy treatment plots produced the highest weed density and biomass. This could be attributed to the favourable resources available in the crop environment for successful competition for a long period of time and hence utilized the above and ground resources thereby accumulated greater biomass at the expense of the cassava tuber yield as reported by Mbah (2018). These also explained why the weedy plot produced the least cassava tuberous root yield (Table 7.0). Moreover, cassava is susceptible to weed competition particularly at the early slow growth of the crop as observed by Lawal*et al.* (2019).

The study of weed morphological group indicated that broadleaf weeds dominated the cover crop treatment plots than grasses (Table 4.0). Probably, broadleaves are usually associated with an environment with shade unlike most grass weed species. Ekpo and Ekpo (2019) observed that broadleaf weeds are better competitors with low growing crops due to their survival mechanism, adaptive features and reproductive ability under shade. The sole cassava weeded plot produced the least sedges probably due to hoe-interference during the repeated weeding as was reported by Ekpo, Tijani-Eniola and Udosen(2011).

Cassava height, number of leaves/plant and leaf area index were significantly ($P<0.05$) influenced by the variation of the vegetable-cowpea densities (Table 5.0) particularly at the advanced stage of cassava growth probably the crop was initially slow in establishment and the vegetable-cowpea served as companion intercrop as observed by Udealor and Asiegbu (2005).

However, cassava crop increased in number of leaves/plant due to the increase in height. In the same vein the leaf area index (Table 5.0) and other agronomic characters increased as the population density of vegetable-cowpea increased up to 55, 555. This is in agreement with Mbah (2018) in cassava-cowpea intercrop in Umudike. The cassava tuberous root yield increased with the increase in the vegetable-cowpea population density to some extent (Table 7.0) and declined probably due to overcrowding effects and intra-specific competition for nutrients. Yield advantage was also reported by intercropping maize with vegetable-cowpea in lowland humid tropics (Okpara, 2000). In contrary, the highest cassava tuberous root yield was reported with highest vegetable-cowpea density (80,000) (Njoku and Muoneke 2008). Yield of the cassava-vegetable-cowpea intercrop gave an advantage over the yield obtained from cassava sole cropping. This was also reported by Okpara (2000), Njoku and Muoneke (2008). In contrary, Albuquerque (2012) reported that usually the yield in sole culture was superior to intercropping, of course this was not applied to combination with cowpea.

Generally, the growth and yield advantage of cassava with cowpea in intercrop suggested that vegetable-cowpea enhanced the growth and yield of crop in association as reported by Solubo (2000) by fixing-Nitrogen in the soil (Fatakun*et al,* 2002).

The vegetable-cowpea dried seeds yield was influenced by the vegetable-cowpea density (Table 7.0). There was yield increase as the population density increased to 55,555 and declined. This could be attributed to overcrowding effects resulted in severe competition for crop growth and development. This was also reported by Njoku and Muoneke (2008). However, in another planting season they did not observe any cowpea density effect. The post-harvest Nitrogen status in the soil of the experimental farm showed increase with the vegetable-cowpea population density up to 62,500 (Table 8). The root nodules might increase in number leading to efficient Nitrogen fixation per unit area as was also observed by Fatokun*et al* (2002).

At the prevailing price level in a rural setting (1kg of cassava tuberous root at ₦50 and 1kg of dried seeds of cowpea for ₦400) cassava intercropped with 55,555 vegetable-cowpea density gave the highest monetary returns (₦641,730) and marginal rate of returns (1.85) (Table 9.0). This was attributed to the advantage in cassava tuberous root yield and also the yield of the vegetable-cowpea seeds. Similar finding was reported by Chikoye (2000) across three locations in savanna zone of West Africa. A Weedy treatment plot produced a severe loss (₦388,000) indicating that the same treatment plot produced the least cassava tuberous root yield/ha. This study showed that 78kobo was recorded in the weedy treatment plot as a loss for every One Naira (₦1.00) invested in the farm business. A loss incurred with Weedy plot treatment has been reported by many researchers (Ekpo, TijaniEniola and Udosen 2011; Ekpo, Udosen and Etim 2010; and Ekpo and Ekpo, 2023).

CONCLUSION

i. Cassava-Vegetable Cowpea intercrop integrated with low rate of Primextra (1.5 kg ai/ha) suppressed weeds by producing relatively low weed biomass.
ii. Weed suppression associated with low weed biomass was mostly efficient with the population density (55,555 and 62,500) of vegetable-cowpea in cassava intercrop
iii. The optimum vegetable-cowpea population density at 55,555 produced the highest tuberous root yield and had an advantage of 15% over the yield of cassava planted sole.
iv. Cassava utilized the N_2fixed by vegetable cowpea for better growth and yield.
v. Vegetable-cowpea left residual total nitrogen at post-harvest ranging from 0.07 – 0.19 (gkg^{-1}) depending on the level of the population density.
vi. Cassava-cowpea intercrop produced monetary net benefit (₦) advantage over cassava planted sole. The cassava-vegetable-cowpea (55,555) intercrop produced the highest monetary net benefit with advantage of 71.2% over cassava planted soled.
vii. A loss of 78 kobo was realized for every one naira invested in the weedy cassava treatment plot.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

- Cassava-cowpea intercrop at 55,555 population density is recommended for satisfactory cassava tuberous root yield and monetary net benefit in cassava production enterprise.
- Vegetable-cowpea 55,555 (population density) integrated with low rate (1.5 kg ai/ha) of Primextra is recommended for satisfactory weed suppression accompanied with insignificant weed biomass as low input cost compared to three hoe-weedings.
- Vegetable-cowpea (55,555 population density) is recommended to enhance soil nitrog in cassava-intercrop.

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